

2022

63rd London International Youth Science Forum (Online)

SCIENCE Collection



阿思丹 | ASDAN
China

The London International Youth Science Forum was the brainchild of the late Arthur McTaggart-Short and Philip S Green MBE. In the aftermath of the Second World War an organisation was founded in Europe by representatives from Denmark, Czech Republic, the Netherlands and the United Kingdom in an effort to overcome the animosity resulting from the war. Plans were made to set up to group exchanges between schools and communities in European countries. This functioned with considerable success and in 1959 it was decided to provide a coordinated programme for groups from half a dozen European countries by following the belief that 'out of liked interests the strongest friendships grow'. Through principal lectures, seminars, visiting top research labs etc, LIYSF was designed to encourage students to know the cutting-edge science and scientific challenges in the world.

Each year has seen 600 students aged between 16–21 years old attending this two-week residential event from over 70 countries worldwide. Representatives are selected in participating countries by the selection committees, such as the Ministry of Education, academic institutions, teachers' unions, extracurricular scientific education agencies and regional well-known institutions. The selected students are mostly winners of global competitions or science exhibitions. Authorities like the United States National Research Council and the Youth Science Canada pick the winners from scientific exhibitions they hold. The LIYSF committee has authorized ASDAN China since 2015, as an agency for selecting and organizing the students for LIYSF attendance.

ASDAN and LIYSF committee co-organized the LIYSF 2022 China, as the first-ever attempt for the past 63 years to hold the online version of the event. Facing the challenge of the worldwide pandemic, new situation of scientific research communication has been changed but the enthusiasm of the students will be carried on.

Table of CONTENT

05	Attempt to popularize wind turbines as energy sources used in the polar areas' research stations.	42	Analyzation of Ocean Energy in Tropical Seas: How to minimize disturbance to benthic ecosystems
10	The Influence of Thermal Stress on the Expression of CCA1 in Zea mays	47	A study on the threat from sunscreen to the marine and aquatic ecosystem - the contamination from sunscreen, and ways people can do to minimize its threat when wearing sunscreen
12	Effects of different levels of progesterone in water on specific traits of zebrafish	51	Protein Folding Structure Prediction using Reinforcement Learning with Application to 2D and 3D Environments
15	Design and Implementation of "IC Campus Second-Hand Book Market" Based on WeChat Mini Program	54	Design of Intelligent Temperature Controlling and Automatic Turn on/off Energy-saving Electric Fan
19	Future Expectation of New Fish Skin Materials: How to process the waste fish by-product (fish skin) into biodegradable clothing materials, which can achieve the canvas texture and ensure the waterproof characteristics?	63	The Future Expectation of China's "Double Carbon Goal" from a Mathematical Perspective.
25	A study of air quality in major cities across the country	65	Evaluating Which of the Three Fibres Used in Composites is More Suitable to Reduce the Weight of Electric Vehicles
27	Using the boids model and MassMotion to study the evacuation of a nursing house in case of an earthquake	68	A study of algorithmic bias and how it affects our society
29	Improving current artificial leaf with the addition of atmospheric water technologies (shortened version)	70	Effect of Bifidobacterium longum on core symptoms in children with autism
32	Experimental study on flow induced noise interference between propeller and wing	74	Developing an artificial intelligent selfassessment strategy for internet addiction
38	Identification and Research into a Wild Parasitic Fungus and its Biological Characteristics	77	A Survey of SiO shown by the Gigahertz Spectrum of Sagittarius B2

Attempt to popularize wind turbines as energy sources used in the polar areas' research stations.

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Abstract

Human advancement knows no boundary. Since the north and south poles were first discovered, our brave scientists have never stopped researching and exploiting those regions. In many situations, it is the limited energy source that confines us. In this essay, one viable way using renewable and sustainable energy source will be analyzed. The design and testing processes of a wind turbine that can be used as the primary energy source during scientific research in polar areas will be illustrated. In contrast, a quantitative design of it would be proposed. Besides, the wind turbine's efficiency, feasibility, cost, and maintenance will also be considered. Hopefully, the mentioned method of wind turbines specialized in polar areas can be a green energy source, which could be seen as an optimal substitute for unrenewable sources like oil and gas.

Introduction: Why Wind Energy?

With the rapid rise in global average temperature, polar areas are widely seen as the most severe victim of global warming. Ironically, fossil fuels have dominated polar regions' share of energy sources since modern humans first discovered these areas. For instance, the Chinese Antarctica Zhong Shan research station consumes tons of diesel oil annually, depending on delivery from the other continents. At the same time, engineering techniques of wind turbines is mature enough to be utilized, up to an average value of 20 m/s (Davis, 2001). Besides, this act will conform with the suitable development goal proposed by the United Nations, as renewable and sustainable energy (RSE) is adopted.

Literature Review I.: Background of RSE & Wind Energy: Global Scale

In polar areas, the research stations require energy to be

constantly delivered. Asserted by Serova and Biev (2020), a self-sustainable energy supply system is what many polar countries pursue. Wind energy used in many pilot projects is proven to have the capacity of sufficient output power. According to the statistics from Examples of existing and upcoming RES in the Russian Arctic (Ivan M., 2020), the incredible productivity of wind energy can be viewed in the following table.

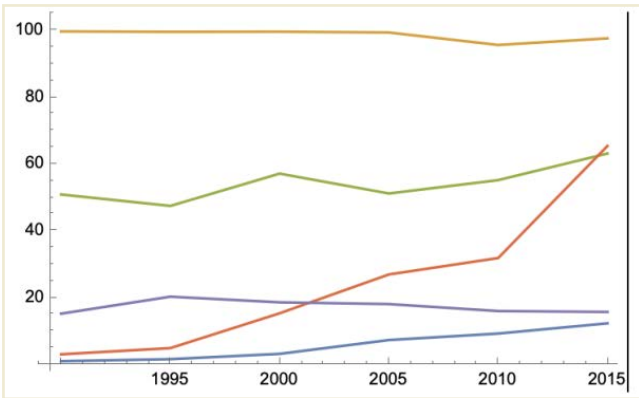


Figure 1 & Figure 2

Data are chosen only from countries/regions with high latitude due to implementation in polar areas. Figure 1 shows an example of an algorithm for data visualization, while figure 2 states the energy proportion occupied in these countries' market share from 1990 to 2015. There is an increasing tendency to use the RSE in these countries (Tishkov, 2020).

Literature Review II:
Fundamental principles

Wind turbines will be detailed and analyzed in this part concerning their engineering principles. When wind passes through the correctional area of a wind turbine, its velocity decreases as the loss of kinetic energy of the wind is converted into the kinetic energy of the rotating blades, which is just the content of the conservation of energy.

During the practical usage, *a Review of Wind Turbine Blade Design* (2012) pointed out other physics quantities that need to be considered, including *tip speed ratio, blade plan shape and quantity, configuration, and aerodynamics*.

Methods

(1). Research Framework

(a). Basic Principle.

Optimal rotor efficiency needs to be calculated within the boundary of the affordable cost while pursuing higher productivity.

Energy (P) carried by moving air is expressed as a sum of its kinetic energy [Equation (1)]:

$$P = \frac{1}{2} \rho A V^3$$

where:

ρ = Air Density.

A = Swept area.

V = Air Velocity.

As written in previous passages, not all the kinetic energy from the flowing wind can be extracted, which implies an existing physical limit for its efficiency. Summarized by Peter J. Schubel and Richard J. Crossley (2012), this limit is known as a parameter called power coefficient C_p , where the absolute value of a range of matter is $C_p \leq 0.593$, and the actual ratio could be significantly less than expected.

(b). Computer Modelling.

Step 1: Define the physical quantities: Theoretical Output is defined as "P", which is a function of blade length[R], and wind speed[V].

```
In[1]:= ClearAll["Global`*"]
[清除全部]

In[51]:= P[R_, V_] := Cp*0.5*\rho*(Pi*R^2)*V^3;
[圆周率]

\rho = 1.3;
Cp = 0.593;
```

Step 2: Use the interaction algorithm

```
In[54]:= pop {};
For[r = 1, r < 100, r = r + 1, {R = r;
[For循环]
For[v = 0, v < 100, v = v + 1, {V = v;
[For循环]
pop = Append[pop, {r, v, Evaluate[P[R, V]]}]]];
[追加] [计算]
ListPointPlot3D[pop, PlotRange -> All, ColorFunction -> "Rainbow"]
[点集的三维散点图] [绘制范围] [全部] [颜色函数]

In[40]:= Show[%39, AxesStyle -> Black]
[显示] [坐标轴样式] [黑色]
```

Step 3: Out-put 3D dot distribution diagram: X-axis: velocity of the wind; Y-axis: length of the blade; Z-axis: ideal power output). Based on hypothetical and theoretical calculations, here is the ideal output.

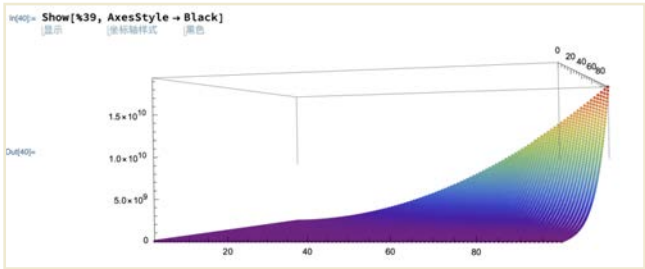


Figure 4: expected power output

(c). Wind Turbine Location

There is an equation that states the relationship between the amount of fluid flow, the flowing speed, and the cross-sectional areas [Equation (2)]:

$$V = Av$$

where:

V is the volume of fluid

v is the speed of the fluid

A is the cross-sectional area.

Therefore, cross-sectional area is inversely proportional to wind speed. Based on the geographical features, special location can be considered. As shown in figure 5, the darker and longer arrows refer to a higher speed. When passing a valley, the speed of wind has significantly increased.

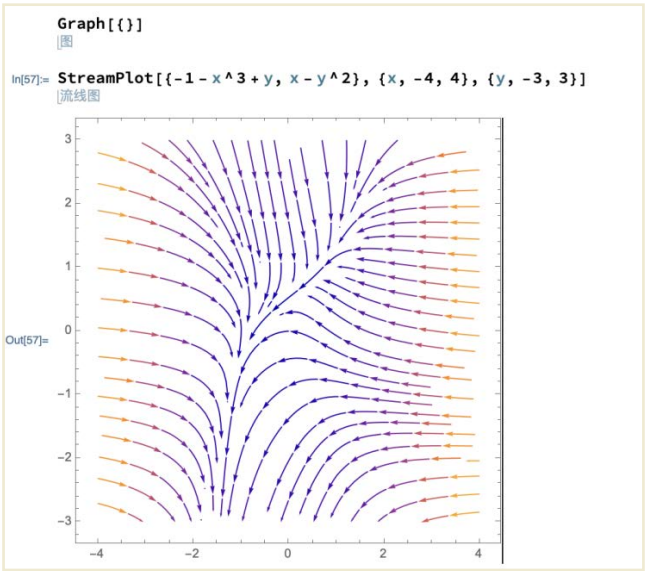


Figure 5: Variation of wind speed when meeting a valley

(d). Test the Model

Once the practical efficiency is calculated, the Chi-Square test can be carried out to check if the measured value fits the model or not [Equation (3)].

$$\sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i} \sim \chi_v^2$$

where:

O_i is each independently measured figure

E_i is the mean of the distribution of the model

v is the degree of freedom (n-2)

n is the number of measures

χ_v^2 is the corresponding Goodness-of-fit parameter.

Repetitive measures can be conducted to minimize the effect of the random error.

(e). Hybrid Complex

Wind turbines highly dependent on variable environmental factors may face emergencies that would cause the breakdown of the power supply system. For security issues, a complex of RSE & TE (renewable and sustainable energy and traditional energy) can be adopted as backup source.



Figure 6: Network for the hybrid complex

Start from the left-hand side:

Dot 1: Emergency maintenance

Dot 2: Wind turbine

Dot 3: User

Dot 4: Traditional Energy backup

(2). Research material and equipment

Material/Devices/Facility/Technology	Number of items
Steel (other metals) for construction	3 tons
Lubricant used at low temperature	1 liter
Gears (different scales: 10 teeth-200 teeth)	2 for each scale-200 in total
Heating rod	2
Insulating painting materials	10 liter
Rotors (different scales: 1kw-1Mw)	2
Conductive wires	20 meter long; 0.5 cm thick
Lithium battery sets	2
Ammeter	1 (Range: 100A, Precision: 1A)
Voltmeter	1 (Range: 2kV)
Mathematica	Computer application
Wind tunnel (with variable wind speed[10m/s – 80m/s] and direction [180 degrees])	Facility
Refrigeration house (below -50 Celcius degree)	Facility
Anemograph [0m/s – 80m/s]	Device
Computer (1 TB storage)	Device

Table: Material/Devices/Facility/Technology for preparation.

(3). Research steps

(a). Blueprint & Construction

- i. streamlined design: utilize aerodynamics to minimize drag effects.
- ii. collapsible: protective mechanisms during storms
- iii. braking gears: ensuring gentle turning
- iv. heating rod: heating the lubricant from freezing

(b). Control Variables

- i. with the same viable-direction wind (to simulate storm weather), using different braking gears to secure gentle turning.
- ii. with the same wind speed, use blades with different



- lengths.
- iii. find the best-match combination that maximizes the power output.
- iv. repetitive measurements and re-examination for a more extended period (one month) to test the model.
- v. record the data of energy output.

(c). Calculating the efficiency and cost of the wind turbine-further analysis,

- i., with the same output, does the wind turbine appear more competitive?
- ii. what would happen if such a wind turbine is used on a large scale

Hypothesis

- (1). There is a correlation between gears combinations, blade length, and wind turbine design productivity.
- (2). There is an optimal cost-effective design for the wind turbine.

Project Plan-flow chart

Therefore, two researchers may need to work together as

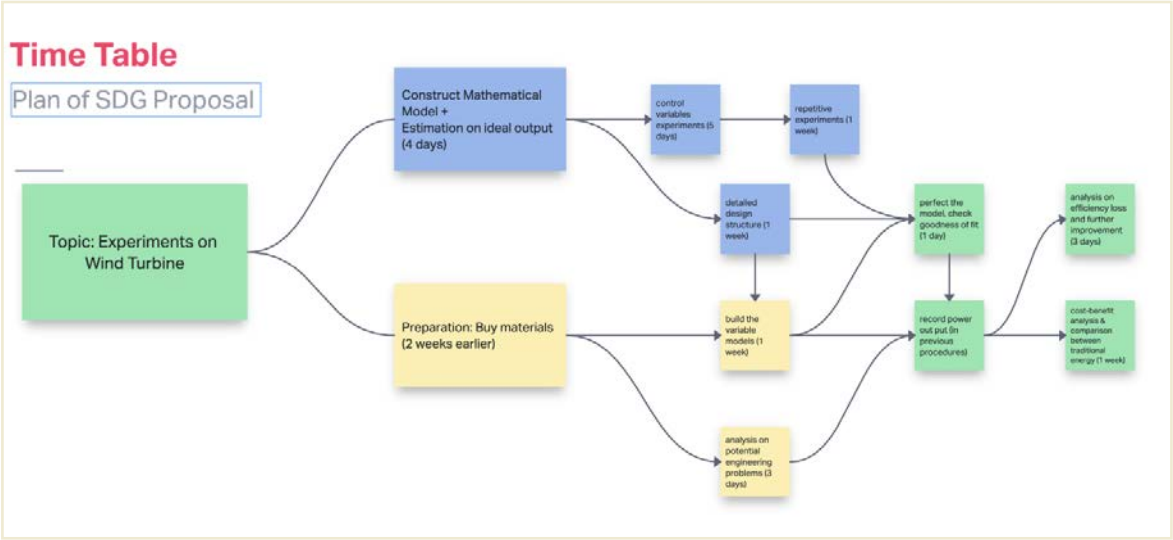


Figure 7: the flowchart for planning



Figure 8: Gantt Diagram for planning

a team. According to the diagram, the yellow bars refer to manual labor, and the orange ones refer to automatic processes.

Conclusion

To sum up, the innovation of human civilization is closely related to harnessing new types of energy. This proposal has only suggested one possible solution in the sea of all those viable methods. With the sustainable development goal in mind, the RSE would facilitate research in polar areas to a new extent.

Further Improvement in Practical Application

- (1). Seasonal changes that affect air density is not considered in this case due limited dimension for visualization.
- (2). The calculated cost may appear to be inaccurate. Once this turbine has been popularized, the cost would decrease, whereas fees spent on transportation are not included in the real world.
- (3). The cost of maintenance is also a crucial problem. The designed wind turbine should be able to withstand harsh and extreme environments.

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The Influence of Thermal Stress on the Expression of CCA1 in Zea mays

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Abstract

The aim of this study is to understand the effects of heat stress on Zea mays' Circadian Rhythm. Using qPCR to quantify CCA1 gene expression and the growth of plants to study the effect of heat stress on the Circadian Rhythm in Zea mays. The fresh and dry weight of Zea mays is expected to be lower when the plants are under heat stress. The gene expression and pattern of the major clock genes are expected to change as Zea mays are exposed to heat stress, affecting their growth and development.

Background & Significance

Zea mays (maize) is one of the most important food crops worldwide. With an annual production of 717 million metric tons and an energy density of 365Kcal/100g, Zea mays are a vital food source for many countries.

However, Zea mays growth is sensitive to temperature fluctuations. Production is reduced when the temperature is outside the optimal range. Global warming is causing Zea mays production to decline globally, which demands variants that are more heat- and drought-resistant (Sabagh, A. E. et al., 2020). Circadian rhythm plays a significant part in the metabolic and signaling pathways in plants, impacting photosynthesis and growth. Therefore, by studying the effects of thermal stress on the expression of major clock genes, we could better understand the impact of global warming on plant physiological processes and productivity. It could potentially pave the way toward developing genetically modified crop variants that are heat- and drought-resistant, which will improve yield under a hotter environment. This study focuses on the impact of heat stress on the expression of CCA1, a major clock gene, and its effect on the growth of Zea mays.

Literature Review

Zea mays rely on their circadian rhythm to anticipate and adapt to diurnal changes. Their circadian rhythm controls essential physiological processes, such as chemical signaling, carbon metabolism, and photosynthesis. The expression of these clock genes is different under the influence of biotic and abiotic factors, such as time of day, temperature, and osmotic stress (Venkat and Muneer, 2022).

The circadian rhythm in plants regulates photosynthesis and regulates the opening and closing of the stomata, which determines the Calvin Cycle's activity and the plant's net carbon assimilation (Joo et al., 2017). The circadian rhythm also controls carbon metabolism in plants to ensure an adequate supply of carbon and energy for metabolism during the night (Graf and Smith, 2011). Disruptions in the usual diurnal changes, such as early dawn, will disrupt the carbon metabolism and lead to malnourishment (Lu, Gehan and Sharkey, 2005). CCA1 is an important gene that regulates the transcription of other clock genes under the influence of light (Green and Elaine, 2002), which makes them essential to the production of energy and the growth of plants.

Methods

Quantitative Polymerase Chain Reaction (qPCR) is used to detect the difference in gene expression of CCA1 by measuring mRNA level. Actin (a protein in cell cytoskeleton) for each sample is used for normalization because the level of expression of actin is similar among different types of cells.

To quantitatively measure the growth of Zea mays, the fresh weight and dry weight of the maize plant are measured after 30 days of growth. Fresh weight is measured after the plant is removed from the soil. Dry weight is measured after the plant is dried in an oven.

Experimental Steps



Biology & Medicine

1. Obtain 15 genetically identical Zea mays plants. Divide into 5 experimental groups, each with 3 plants. The experimental groups receive the same amount of sunlight water but are placed in environments 10 °C , 15 °C , 25 °C , 35 °C , and 45 °C respectively.
2. Gene expression of CCA1 is measured using qPCR and recorded at dawn, noon, dusk, and in the middle of the night on days 10, 20, and 30.
3. After 30 days have elapsed, the fresh weight and dry weight of each plant are measured and recorded.
4. The difference in gene expression of selected genes, fresh and dry weight of Zea mays in each group are tallied and analyzed.

Hypothesis

The optimal temperature for the growth of Zea mays is around 25 °C . (Ramirez-Cabral, Kumar and Shabani, 2017) Therefore, the fresh and dry weight of Zea mays in the experimental group grown under 25 °C are likely the highest. The Circadian rhythm of Zea mays is affected by heat stress. Therefore, it is expected that the gene expression of major clock genes is different in each experimental group.

Project Plan

Task	day 1-5	day 6-10	day 11-15	day 16-20	day 21-25	day 26-30	day 31-35	day 36-40	day 41-45	day 46-50	day 51-55	day 56-60
Literature Research												
Obtain materials for experiment												
Extract tissue from Each plant sample												
Conduct qPCR on samples												
Measure dry and fresh mass of each sample												
Organize experimental data												
Write Research Paper												

Reference

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Effects of different levels of progesterone in water on specific traits of zebrafish

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Biology & Medicine

Abstract

1. What are the research questions?

Subtitle 1 - Effects of different levels of progesterone contained in water on anxiety in zebrafish

Subtitle 2 - Effects of different levels of progesterone contained in water on reproductive ability and offspring quality of male zebrafish after natural mating with female zebrafish

2. What is your research design? (qualitative, quantitative, mixed)

This study is based on quantitative research in aquariums, light and dark box and fish tank specially designed for mating

3. What are your expectations?

The ideal goal of this study is to gain a deeper understanding of the effects of different levels of progesterone on different traits in underwater organisms

Background & Significance

In recent years, environmental hormones have attracted worldwide attention. As one of the environmental hormones, progesterone is widely used in animal husbandry and breeding to improve yield and economic benefits. However, due to the imperfect treatment of sewage treatment plants, direct excretion of animals and direct discharge of wastewater, progesterone substances remain in environmental media (such as soil, surface water, sediment and groundwater, etc.), with concentrations ranging from a few ng/L to tens of thousands of ng/L (Liang Yanqiu, 2016). Thereby, water bodies and underwater life are endangered. Yet, there are relatively few reports on the effects of different level of progesterone substances on underwater biological traits in water. Therefore, in order

to use progesterone substances more rationally, this paper took zebrafish as an experimental animal model to study the effects of different progesterone content on zebrafish characters in water.

Literature Review

Several studies have shown that certain chemicals in birth control pills can affect certain traits in zebrafish, such as fertility, offspring quality, ovulation and circadian rhythm.

In Liu Dongteng's research:

'By constructing a zebrafish Pgr knockout family, this study demonstrates for the first time that Pgr is an essential regulator of ovulation in fish. The use of this family, combined with RNA-seq, suggests that preovulatory Pgr regulates follicle cells to undergo a fate transition that is essential for ovulation..... DHP and LH cooperatively regulate the expression of ADAMTS9, possibly to make its expression level meet the requirement of ovulation and promote the occurrence of ovulation. '(2018).

Jiang Yuxia's study showed that dehydroprogesterone in contraceptives interferes with physiological functions such as sexual differentiation, reproduction and circadian rhythm in zebrafish via fatty acids (including saturated fatty acids, N-6 PUFAs and N-3 PUFAs) and purinergic signaling metabolites (2019). In one study, the number of eggs laid per day, number of eggs laid, malformation rate, hatching rate, egg diameter, membrane rupture time and hunger tolerance time were used as endpoints to evaluate the reproductive ability and offspring quality of zebrafish after exposure. The final results showed that bisphenol A had a significant inhibitory effect on zebrafish reproduction, and bisphenol A had a synergistic effect with nonylphenol. Prolonged exposure to bisphenol A can affect zebrafish reproduction and offspring quality. (Shen Wanyun, Zhou Zhongliang & Li Xiangjun, 2007)

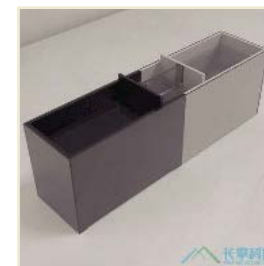
In summary, the chemicals in birth control pills have serious and long-lasting effects on underwater life at some point. So far, there are few studies on the effects of different progesterone content on specific traits of zebrafish. Therefore, this study will investigate the effects of different levels of progesterone substances on specific traits of zebrafish, so as to gain a deeper understanding of the specific effects of progesterone substances on underwater organisms.

Methods

1. Research Framework

light and dark box for zebrafish

In light and dark boxes experiment, animal like activities in the dark box, but the study of animal behavior prompted its attempt to explore the light box, however, light box to stimulate and restrain the animal inquiry activity in the box, light box experiment is a classic method of evaluation of anxiety and depression.



Pic 1 (Source: Evermountain Tech, Available at: <<https://neuronlab.cn/product-list/zebrafish-light-dark>>)

2. Research material and equipment

- experimental equipment:

- Four aquariums(each aquariums with water that meets the growth conditions of zebrafish;the temperature control of the fish house is set at 28 degrees Celsius, the water pH value is 7.5, the salinity control range is 0.25-0.75, the photoperiod is 14 hours light cycle and 10 hours dark cycle, and the light intensity of the water surface is in the range of 54-324 Lux);
- A tank specially designed for fish to mate;
- Light and dark box for zebrafish

- Experimental animal model: 80 zebrafish (Danio rerio)

3. Research steps

Subtitle 1: Effects of different levels of progesterone in polluted water on anxiety in zebrafish

Step1: Four aquariums are prepared, and the environment in each tank is in line with the growth conditions of zebrafish. Put 500ng/L progesterone in aquarium 1, 1000ng/L progesterone in aquarium 2, 5000ng/L progesterone in aquarium 3, and no progesterone in aquarium 4. All other conditions remain unchanged. Ten healthy zebrafish of the same size and quality (5 males and 5 females) were placed in each tank. The 40 zebrafish were reared for three months.

Step2: After three months, place each zebrafish in the center of the open box in the light and dark box respectively (the water in the light and dark box does not contain progesterone and meets the growth conditions of healthy zebrafish). After each test, all urine and faeces were removed and both chambers were cleaned with 70% ethanol. The retention time and movement distance of zebrafish in the light box of each group were observed and recorded. The experimental data of zebrafish in each group were averaged.

Step3: According to the principle that the higher the anxiety of zebrafish, the shorter the detention time in the light box and the smaller the movement distance in the light box, the experimental results are obtained.

Subtitle 2: Effects of different levels of progesterone in contaminated water on the reproductive ability and quality of offspring of male zebrafish after natural mating with female zebrafish

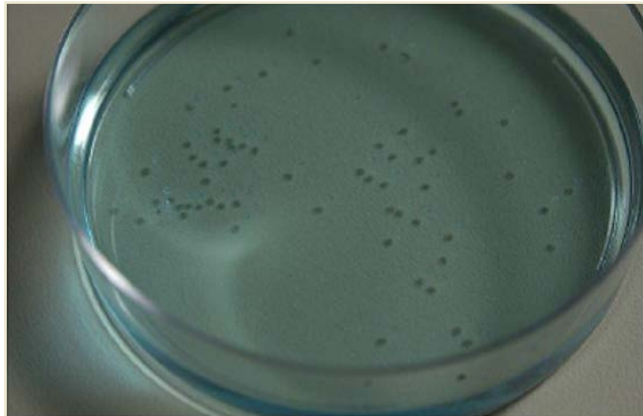
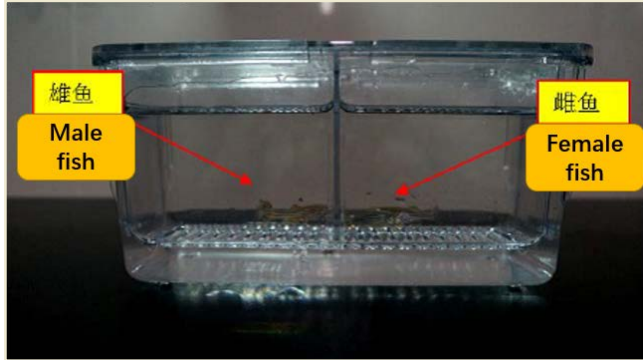
Step1: Prepare four aquariums, each with water that meets the growth conditions of zebrafish. Put 500ng/L progesterone in Aquarium 1, 1000ng/L progesterone in aquarium 2, 5000ng/L progesterone in aquarium 3, and no progesterone in aquarium 4. All other conditions remain unchanged. Ten healthy zebrafish of the same size and quality (5 males and 5 females) were placed in each tank. The 40 zebrafish were raised for three months in this experiment because

"under normal feeding conditions, zebrafish can be sexually mature and mate to produce the next generation" (Zebrafish Breeding System Construction and Breeding technology, National Zebrafish Resource Center).

Step2: Three months later, use the tank specially designed for fish to mate, insert the inner tank (with a leaky net at the bottom) into the outer tank, add about 2/3 tank of water, and place a male zebrafish and a female zebrafish from

each group of aquariums on both sides of the separator in the tank specially designed for fish to mate (Pic2).

Step3: The next morning, after the photoperiod begins, the clapboard can be pulled apart according to the time needed to allow male and female fish to mate and lay eggs. Typically, after 15 minutes, the male and female begin to mate and lay eggs. The fertilized eggs produced will leak from the bottom of the inner tank, into the outer tank, to avoid adult fish contact and eat the fertilized eggs. Each time the fertilized eggs are collected, they can be directly taken out of the inner cylinder and transferred to another outer cylinder. The fertilized eggs in the original cylinder are readily poured into the collection net and washed into the Petri dish with water (Pic3) (After each mating, all urine and faeces were removed and both chambers were cleaned with 70% ethanol.)



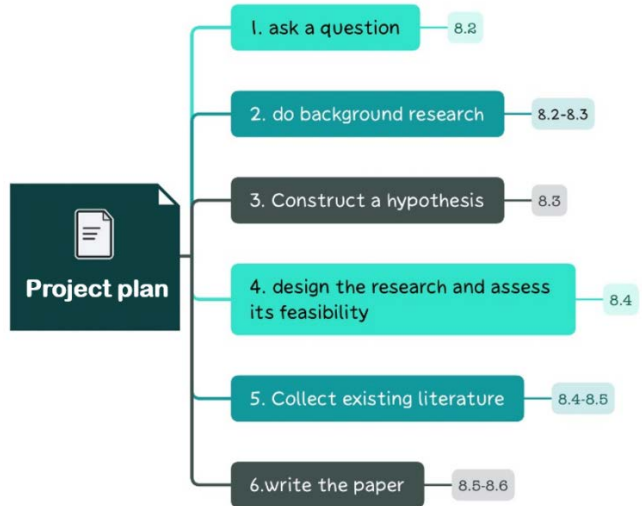
Pic2 and Pic3 - Establishing natural mating and egg collection (Source: National Zebrafish Resource Center)

Step4: Finally, the number of eggs laid per day, the number of eggs laid, the deformity rate, the hatching rate, the egg diameter, the membrane breaking time and the hunger tolerance time were used as the end points to evaluate the reproductive ability and the quality of offspring of zebrafish after exposure.

Hypothesis

After investigating the results of this study, we can use the experimental data to control the levels of hormones in birth control pills or alter their composition to make most of them harmless to underwater life.

Project Plan



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Design and Implementation of "IC Campus Second-Hand Book Market" Based on WeChat Mini Program

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Abstract

With the rapid development of the "Internet +", the public welfare industry on campus has also shown a high degree of digital innovation. After the methods of WXML, WXSS, JavaScript and environment of cloud development were applied, the program "IC Campus Second-Hand Book Market" developed by the author provides a public service platform for students in the school to deal with second-hand books and materials. The students could freely publish books and e-books, freely trade and publish information, save limited resources, and improve the utilization rate of old books. This paper introduces the design and implementation of this project

Keywords

WeChat Mini Program, Campus Second-Hand Book Market

Introduction

WeChat Mini Program is an application service that can run on WeChat, which was first officially introduced in 2017 by Tencent (Hao, et.al, 2018). In WeChat, "program" refers to a new open capability, which provides a simple and efficient application development framework and supporting components and APIs (Jiang & Li, 2021). The program can help developers develop services with native app experience that can run on WeChat. This kind of service is usually called WeChat Mini Program. This mini program doesn't need to build a website or install an app. The development cost is lower than that of APP, and its development cycle is shorter than that of APP, so it can launch application services faster (Lin, 2021).

The program "IC Campus Second-Hand Book Market" developed by the author provides a public service platform for students in the school to deal with second-hand books and e-books, in which the students could freely

trade and donate books, freely release information, recycle the old books and save limited resources, cultivate an environment-friendly and economical campus culture, and improve the utilization rate of books.

Design

2.1 Overall framework of the project

The pages are the key contents of the development and generally include an index page and a logs page, all in the pages directory. The authors designs and implements functional modules, databases and system interfaces of "IC Campus Second-Hand Book Market" program shown in figure 1.

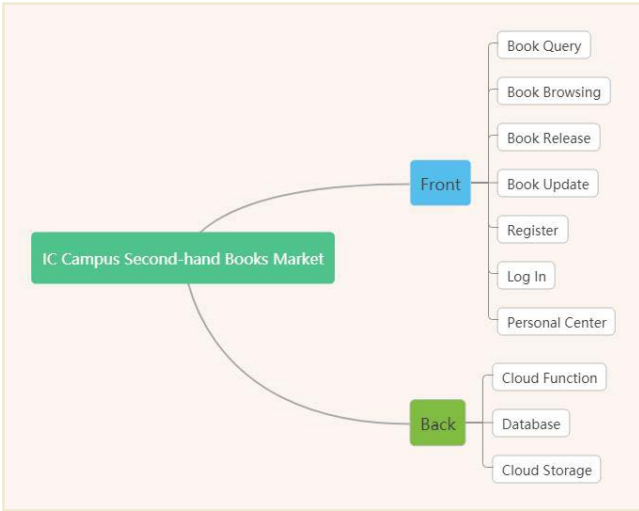


Figure 1. the Framework of the Project

Following "Mini Programs on the WeChat Official Account Platform"(Tencent, 2022), the front-end development needs JS/CSS/HTML foundation, which is completed by WXML, WXSS and JavaScript. WXML is responsible for the implementation of data binding, component style and other designs; WXSS is responsible for rendering the component styles of WXML; and JavaScript is responsible for the design of application logic layer (Wang, Wang & Zhu, 2018). The

program structure is shown in figure 2:

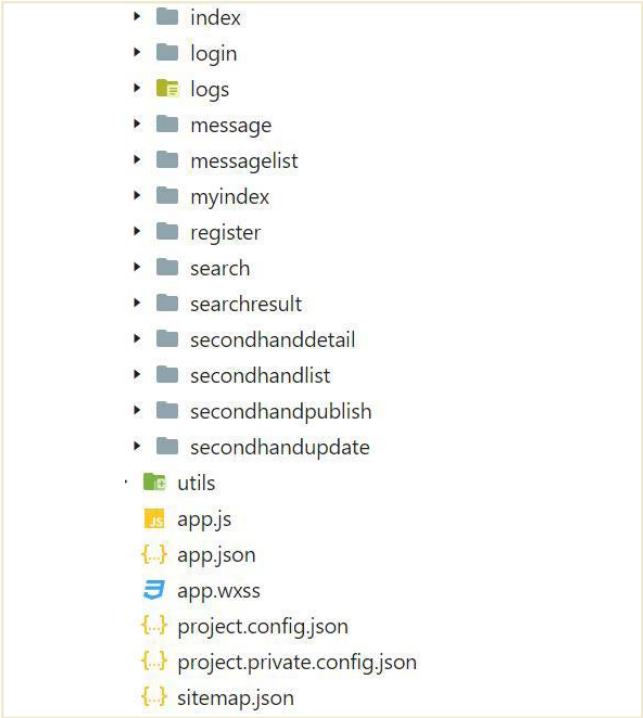


Figure 2: the Program Structure

2.2 Front-end

2.2.1 Program UI design

Interface design is in accordance with the standard of "WeChat Mini Programming Guide"(Tencent, 2022). The program uses iphone5 screen as the development and testing interface.

i. User login and interface (shown in figure 3)

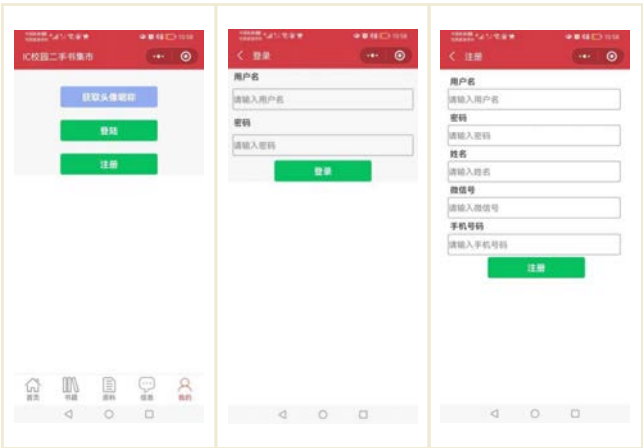


Figure 3: the Interface Design of User login and Registration

ii. Program home page interface (shown in Figure 4)

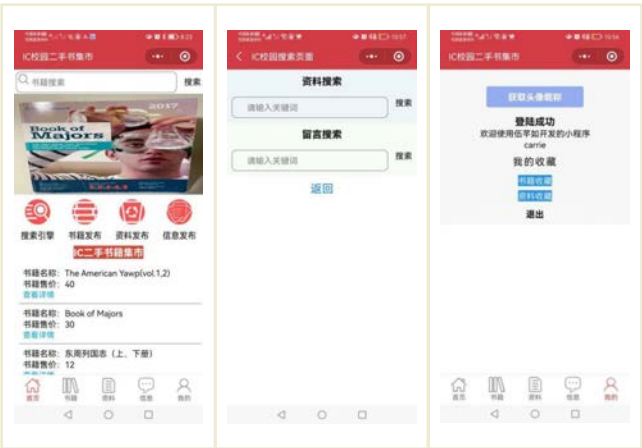


Figure 4: the Interface Design of Homepage, Search and Message Center

iii. User browse and publish page (shown in Figure 5)



Figure 5: the Interface Design of User Browsing and Publish Page

2.3 Backstage

The back-end function modules for administrators include:

2.3.1 Cloud function

The program defines eight cloud functions in Cloud Base, which respectively perform the functions of querying, deleting and updating four databases.

2.3.2 Database

Cloud Base database includes four databases: books, e-books, messages and users.

2.3.3 Cloud storage

It includes two folders of books and E-books, which are used to store uploaded data and pictures of books.

Method

This project contains 18 pages, 8 cloud functions, 4 cloud databases and 2 cloud storage files, as well as four global configuration files: app.js, app.json, app.wxss and project.config.json. At the bottom of the program's page, there are navigation buttons for quick interface switching, including five functional modules: Home, Books, E-books, Information and User, which are shown in figure 6:

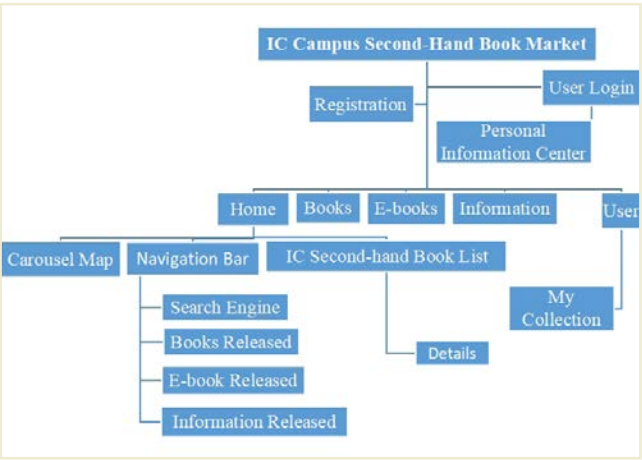


Figure 6: the Functions of Each Module

3.1 Get the user ID

Every time the developer obtains personal information through this interface.

3.2 Register the login module

It is used to judge the user's name and password entered during registration.

3.3 Home page

The home page consists of book search engine (searching the contents names and introductions that contain keywords), carousel map (showing the latest five books published by users), navigation bar (consisting of four columns: search engine, book released, e-book released and information released) and IC second-hand book list (showing the latest 20 pieces of data).

3.4 Books page

It is in the form of a list, showing thumbnails of books, book names and prices. We can click to view the book details, call the cloud function and display it in pages, with 20 pieces of data displayed on each page.

3.5 E-books page

It is in the form of a list, showing thumbnails of data, e-book names and prices.

3.6 Message page

It is in the form of a list. The latest 100 pieces of data are retrieved from the cloud database.

3.7 User page

You can view the books and e-books collected by users under "My Collection" column.

3.8 Search engine module

The search engine module designed for title and content keyword queries is on the home page. After clicking the link, it will switch to the search page.

3.9 Book (E-books, message) released module

For the publication of books and E-books, users can freely input the book name, introduction, price, mobile phone number and WeChat ID, and upload book pictures. The newly entered books can be quickly viewed in the "Second-Hand Book List" on this page. For message release, users can independently enter the title, content, publisher, mobile phone number and WeChat.

3.10 Books (E-books) updated module

Users can modify the pictures and prices that have been entered into the database themselves. The "Update Commodity" button of "Second-Hand Book List" on the page can be updated the pictures and prices of the entered books.

3.11 Details page

Users can display the pictures, names, introductions, prices, mobile phone numbers and WeChat on these pages.

3.12 Personal Center (Collection) Module

Users can view individual collection books on the page.

Conclusion

Through online testing, the "IC Campus Second-Hand Book Market" is a successful WeChat Mini Program. The graduates have successively published old books and e-book online from June 25, 2022. The freshmen have also been buying books in this public platform since July 25. The mini program can basically meet the needs of browsing, trading and publish second-hand books of over three hundred students in Beijing No.4 High School.

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Future Expectation of New Fish Skin Materials: How to process the waste fish by-product (fish skin) into biodegradable clothing materials, which can achieve the canvas texture and ensure the waterproof characteristics?

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Abstract

The purpose of this proposal/ experiment is to analyze and test whether, in the entire process from the fish skin separated from the fish body to the new biodegradable clothing material, the fish skin can ensure that the clothing raw materials made of fish skin are "safe", "reliable", "colorless and tasteless", "no harm to human body" and "canvas like" biodegradable materials with the auxiliary of a certain amount of (specific) solution and (specific) biomass materials, And also it can ensure that the waterproof characteristics of the fish skin itself are not damaged. Secondly, this study will be based on the mixed method, which originated and marked in 1959.

Background & Significance

Studies have repeatedly shown that traditional chemical waterproof coatings have been proven to cause a certain amount of damage to the environment and human body [the raw materials of common waterproof coatings] (MIT, 2021). Second, there is no canvas material on the market that can not use any form of waterproof coating; Third, the prices of non-toxic and harmless new waterproof coatings are generally on the high side. Specifically, scientists have proved that " Fish skin contains tough and flexible proteins, and agar can be used as an adhesive to bond these materials together. By combining these two organic materials, a completely biodegradable bioplastic can be formed" (Fiakos, 2020). In addition, " Fish skin itself is the early form of Gore Tex, and is also the waterproof and breathable fabric today. This material is strong and waterproof" (Hsia, 2020). Secondly, according to data statistics, " Nearly five million tons of fish are wasted every year" (GC, 2021). Therefore, the exploit of biodegradable fish skin as a new environmental protection material for clothing to a large extent ensures safety and low price. More importantly, it can protect the environment and reduce carbon emissions. At the same time, the data showed that "More than 27% of the captured

fish were either thrown away or rotted on the deck before being sold" (GC, 2021). With the increasing global population, people's demand for natural resources is also increasing, which inevitably leads to waste. Therefore, recycling the fish that are wasted every year (those that die naturally, those that die due to white pollution, those that are stranded, and those that are not eaten) is a win-win environmental protection strategy, which not only reduces the production cost but also won't receive moral condemnation. The high-end market is also consistent with the current *politically correct* marketing strategy. Second, the production of fish skin materials will reduce the emissions of carbon dioxide and greenhouse gases to a certain extent.

Literature Review

Research conclusion on characteristics of basic fish skin

ThFish is a common species that lives on the earth; The fish skin contains strong but elastic protein in this province, and the protein of the fish skin itself is very similar to that of human beings. The fish skin can also be naturally decomposed and can be degraded (Reilly, 2022).

Leather process

First of all, "tanning" is needed in the whole process of tanning, and the function of tanning is to make the (leather) elastic, soft and not easy to decay, and also to make the pores on the (leather) more compact and waterproof.

Glycerol sterilization

In addition to Pseudomonas aeruginosa and Enterobacteriaceae, GML has bactericidal effects on a variety of potential bacterial pathogens. In the presence of acidic pH and cationic chelating agent ethylenediaminetetraacetic acid, the bactericidal activity of GML against Pseudomonas aeruginosa and



Chemistry

Enterobacteriaceae was significantly enhanced (Duraism, 2016).

Methods

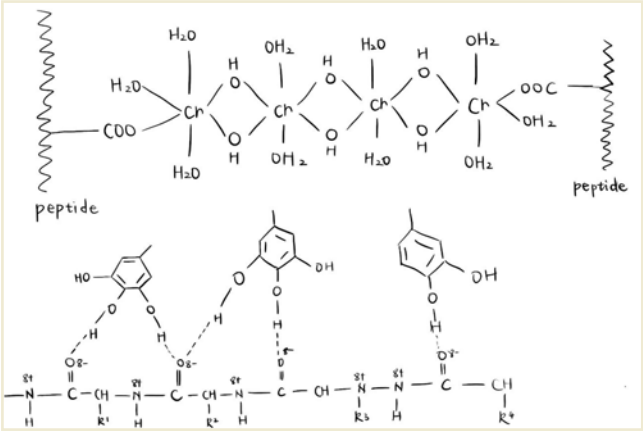
5.1 Research Framework - Experimental Principle

#1 principle of tanning: tanning is a process in which the protein produced by leather is completely stimulated by heat, enzyme biodegradation, and thermomechanical stress... The purpose is to convert the fibrin of raw skin or skin into a stable material to prevent the decay of skin or skin and make the leather suitable for a variety of final applications (Duraism, 2016).

#2 Principle of glycerol sterilization: a practical method for disinfection of glycerol by compound pharmacists can be obtained by using membrane filtration. Sterility is ensured by appropriate validation, and quality control checks must be completed before release of the injectable formulation. (McCluskey , 2008).

#3 principle of water absorption of corn starch: because corn starch is composed of a large number of glucose molecules, especially amylopectin and amylase. When starch and water are heated at the same time, starch particles expand and break, causing them to decompose and release glucose molecules into water (Buddies, 2012).

#4 hydrogen peroxide cleaning principle: hydrogen peroxide can oxidize common compounds in organic life and disinfect the surface. It dissolves proteins by decomposing and releasing water and oxygen radicals. (Schipani, 2019).



5.1 Research Framework
Figures of material protein reaction for making leather



5.1 Design Ideal Image

5.2 Research Framework - Parameters1-3

Assumption: the total area of fish skin raw materials (combined with two pieces of fish skin) is

50 cm * 50 cm = 2500 square cm = 0.25 square meter

Variable # 1: 1000ml

hydrogen peroxide volume of hydrogen peroxide: area of fish skin = 1:2.5

(# 1) 75 degree alcohol: glycerol 1:1 (24hours) 500ml: 500ml

#1 solution: fish skin area = 1:2.5

750g corn starch (yellow) corn starch (g): fish skin area (M2) = 3:1

198g protein + 2G white vinegar protein white vinegar volume: fish skin area = 0.8:1

Variable # 2: 1000ml hydrogen peroxide volume of hydrogen peroxide: area of fish skin = 1:2.5

(# 2) 100% glycerol (3hours) # 2 solution: fish skin area = 1:2.5

750g corn starch (yellow) corn starch (g): fish skin area (M2) = 3:1

200g protein + 2G white vinegar protein white vinegar volume: fish skin

area = 0.8:1

Variable # 3: 1000ml hydrogen peroxide volume of hydrogen peroxide: area of fish skin = 1:2.5

(# 3) 75 degree alcohol: glycerol 1:2.5 (24hours) 285.71:714.29

#3 solution: fish skin area = 1:2.5

750g corn starch corn starch (g): fish skin area (M2) = 3:1

200g protein + 2G vinegar protein white vinegar volume: fish skin area = 0.8:1

5.2 Experiment steps

Peel the fish skin: peel the whole fish skin from head to tail with a wooden knife. After peeling, clean the large pieces of fish meat left on the fish skin with a wooden knife

Preliminary cleaning of fish skin: put the fish skin into the liquid mixed with protein and white vinegar, rub and clean it, and then rinse it with water

Fish skin cleaning: immerse the fish skin in 1000ml hydrogen peroxide (volume of Hydrogen peroxide: area of fish skin = 1:2.5) for 12 hours

Fish skin cleaning and sterilization: put the fish skin into the solution and soak it in the solution according to the required time of different solutions

Secondary cleaning: take out the fish skin from the solution and cover it with corn starch for 24 hours

Tanning: take out the fish skin from the corn starch and put it into the measuring knife for repeated tanning for 15 minutes

Refrigerate: put the fish skin in the - 4 degree refrigerator for 24 hours

Take out the fish skin and rinse with water until it is naturally dried

The solution with the best analytical performance (# 1 # 2 # 3)

Sterilization rate checked by professional institutions

Confirm whether the material reaches canvas material

Test water resistance

Garment making

5.3 Equipments and Materials

Name of Material (English)	Name of Material (Chinese)	Where to Buy/Get	Cost
Dead fishes	死鱼	Farm products maket	0 (市场收集)
Bokuto wood cutter	木刀	Online	20
protective clothing	防护服	Online	30
scissors	剪刀	Online	10
corn flours	玉米面	Online	30*3
hydrogen dioxide	双氧水	Online	40*3
Gullotion	剃刀	Maket	120
Glycerol	甘油	Online	40*6
Alcohol	75 度酒精	Online	43*6
vacuum peckaging tape	真空包装带*20	Online	50
Container for preparing solution	调制溶液的容器*9	Online	150
Storage bottle	储存瓶	Online	200
Vinegar	白醋	Online	10
Protein	蛋白	Online	15
Tablecloth	桌布	Online	10

Hypothesis

In terms of hypothesis, first, the fish skin is cleaned with protein to remove the indicated impurities, and then hydrogen peroxide is used to clean the impurities in one step. Thirdly, the solution mixed with glycerol and alcohol is used to sterilize the fish skin material to ensure the safety of the fish skin. The fourth prediction: put the fish skin into the corn flour and cover it completely. The clean fish skin will become hard after being covered with corn flour. Fish skin is very fragile. When oil and moisture are sucked out, the skin will become firm. However, the corn flour just contains the ingredients that can dissolve the oil. Corn flour contains linoleic acid, which is miscible with dimethylformamide or oil and insoluble in water. The final product presents a canvas feeling and can replace the ordinary waterproof canvas material in real life.

Project Plan



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SILVER

A study of air quality in major cities across the country

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Abstract

The rapid growth of the population and the acceleration of the urbanization process have made environmental problems increasingly apparent, and environmental problems such as air pollution and water pollution have occurred frequently, which has aroused widespread concern in society. In this paper, cluster analysis and principal component analysis are used to analyze the air quality data of major cities in 2019, so as to solve the air quality problem more efficiently and quickly.

Methods

Clustering

The K-mean clustering method divides the air quality levels of 31 cities into 5 categories, the specifics of which are as follows: the air quality of major cities is divided into five categories according to the table above; There are 7 cities with high air quality, namely Fuzhou, Nanning, Haikou, Xining, Guiyang and Lhasa. There are 9 cities with good air quality, namely Hohhot, Changchun, Harbin, Shanghai, Nanchang, Chongqing, Lanzhou, Yinchuan and Urumqi. There are 6 cities with mild air pollution, namely Shenyang, Hangzhou, Hefei, Changsha, Guangzhou and Chengdu. There are 5 cities with moderate air pollution, namely Beijing, Tianjin, Nanjing, Wuhan and Xi'an. There are 4 cities with heavily polluted urban air, namely Shijiazhuang, Taiyuan, Jinan and Zhengzhou. Cluster analysis classifies the air quality of major cities, but we must consider many factors affecting air quality, and analyze the problem of air pollution more comprehensively and systematically, so we need to use principal component analysis to study the influencing factors of air quality in major cities.



Mathematics
& Computer
Science

categories	city
Category 1 (Excellent)	Fuzhou, Nanning, Haikou, Xining, Guiyang, Kunming, Lhasa (7 in total)
Category II (Good)	Hohhot, Changchun, Harbin, Shanghai, Nanchang, Chongqing, Lanzhou, Yinchuan, Urumqi (9 in total)
Category III (Mild Pollution)	Shenyang, Hangzhou, Hefei, Changsha, Guangzhou, Chengdu (6 in total)
Category IV (Moderate Pollution)	Beijing, Tianjin, Nanjing, Wuhan, Xi'an (5 in total)
Category 5 (Heavy Pollution)	Shijiazhuang, Taiyuan, Jinan, Zhengzhou (4 in total)

Table 1 Air quality classification results

Principal component analysis

There is a clear correlation between the variables, and if they are directly included in the analysis, they may lead to erroneous conclusions due to the influence of multivariate collinearity, so the information carried by the data needs to be condensed through principal component analysis.

From Table 2, it can be seen that $KMO=0.785>0.7$ indicates that there is a particularly perfect degree of overlap between variables, and the results obtained by principal component analysis will be relatively perfect and worth experimenting.

KMO and Bartlett test		
Number of KMO sample tangents		.785
Bartlett sphenical degree test	Approximate chi-square	221.966
	Degree of freedom	21
	Significance	.000

Table 2 KMO and Bartlett test

As can be seen from Table 3, only the first 2 feature roots are greater than 1, so SPSS only extracts the first 2 principal components. The variance of the first principal component accounts for 66.026% of the variance of all principal

components, close to one-third, while the cumulative variance contribution rate of the first two principal components reaches 86.13%, so the first two principal components are enough to describe the number of days when so2 factor and NO2 factor reach air quality and are better than secondary. The eigenvalues of the correlation coefficient matrix are $\lambda_1=4.622$, $\lambda_2=1.407$, $\lambda_3=0.374$, $\lambda_4=0.284$, $\lambda_5=0.229$, $\lambda_6=0.055$, $\lambda_7=0.029$, from which the first and second principal component expressions can be obtained:

$$F_1=0.326 \times X_1+0.784 \times X_2+1.603 \times X_3+1.541 \times X_4+1.784 \times X_5+4.121 \times X_6-5.642 \times X_7$$
$$F_2=0.406 \times X_1-0.158 \times X_2+0.448 \times X_3+1.469 \times X_4-1.575 \times X_5-1.514 \times X_6+3.337 \times X_7$$

On the first principal component, respirable particulate matter scored the highest, which indicates the increase in dust from motor vehicles driving on unpaved asphalt, cement roads, crushing and milling processes of materials, and wind-lifted dust. In terms of the second component, sulfur dioxide scored the highest, and sulfur dioxide became the main source of air pollution in major cities in China, which to a certain extent explains the harm caused by automobile exhaust and factory exhaust.

Total variance is explained						
components	Initial eigenvalue			Extract the sum of squares of the loads		
	Total	Percentage of variance	Cumulation %	Total	Percentage of variance	Cumulation %
1	4.622	66.026	66.026	4.622	66.026	66.026
2	1.407	20.104	86.130	1.407	20.104	86.130
3	.374	5.340	91.470			
4	.284	4.052	95.522			
5	.229	3.271	98.793			
6	.055	.787	99.581			
7	.029	.419	100.000			

Table 3 Total variance is explained

Looking at these factors that affect the air quality of Cities in China, we can judge that there are three main sources of air pollution in China: domestic pollution sources, industrial pollution sources, and traffic pollution sources.

Using the boids model and MassMotion to study the evacuation of a nursing house in case of an earthquake

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Abstract

This study aimed at figuring out how old people will act under terror and other external factors when an earthquake occurs through the boids model and MassMotion. The study is based on mixed data(both qualitative and quantitative) dividing the elders into several groups through their health conditions and display a model of the evacuation pattern of a nursing house.

Background & Significance

Earthquakes have caused the highest casualties among natural disasters. How to reduce the number of earthquake casualties has always been one of the main topics for professionals. According to the annual average statistics for earthquake counts by USGS, there were approximately 7088 deaths caused by earthquakes from 2016 to 2019 (USGS, 2022). This study hopes to help the government and relevant departments improve the earthquake evacuation drill by building a mathematical model.

Literature Review

1. THE BOIDS MODEL AND ITS OPTIMIZATION SCHEMES

The boids model was invented to simulate the motion pattern of a flock of birds by simulating the behavior of an individual bird through a coordinate system for each individual. Each separate individual had the trend of flying away from the center when collision between individuals were likely to occur; individuals tended to move towards the center of the flock during flying as well as attempting to maintain the velocity of itself similar to fellows surrounding it (Raynolds, 1987).

The boids model had also been improved later in the movements of fish, taking other three rules into consideration: 'following a feed; avoiding obstacles;

avoiding enemy boids' (Chen et al., 2006), which makes the moving pattern of boids became more realistic. For studies related to the data analysis, we can use non-negative matrix factorization analysis to discuss different functions related to different flocks (Maruyama, 2019).

2. MODELS AND SIMULATIONS OF CROWD EVACUATION

According to observations, people in panic situations tend to have blind actionism because of nervous (Helbing, 2002) and they start to follow what people near them do. The crowd is likely to form a pattern of 'lane formation' under normal situation, that is, the density of people on the street is approximately constant (Helbing, 1997).

Social force model was made to deal with the normal situation. Actual velocity and desired speed were both taken into account and the direction with a certain 'relaxation time' was involved in the formula for calculation. Force model was made in the project to simulate the movements of panicking pedestrians. 'Body force' which referred to the force generated by people when the body is compressed in the crowd, and 'sliding friction force' that impedes relative tangential motion. (Helbing, 2002)

The real simulation made to a particular situation was about using a model called 'ESCAPES' to model the evacuation of people at the International Terminal at Los Angeles International Airport. The ESCAPES system used 2D initially and then transformed into massive extensions in order to form a 3D model. The original reason for using a 2D model was its convenience for both human and computers. The study discussed individual travelers, family agents, and authority and security agents. Each of the crowd has his own programming because of different backgrounds and duties in the reality. (Tsai, 2011)

Methods



Mathematics & Computer Science

The study will mainly use the boids model and the force model as the base of the simulation. The codes and models that need to be made later in the project will be displayed through C++ and MassMotion.

Birds in the boids model will be replaced by people with human behaviors. Codes will be written in different ways by using 'if' in C++ under different situations. In the normal situation, individuals need to have the 'awareness' of moving fast to a safer place when collapse occurs. This will cause an increase in the pedestrian density towards safe places, thereby increasing rates of pushing or even trampling in these areas.

The simulation will include 50 nursing workers and 150 old people stand for the old in the nursing center with different health conditions, restoring the pattern of a nursing house. Codes like 'slow moving pace' , 'may stand at one spot for a long time' and 'have the possibility of fainting' will be written into the program. The simulation will also take into consideration that, in reality, half of the nursing workers in the nursing house will not protect the old when the earthquake occurs.

Also, 150 old people will be divided into different groups. Group 1 stands for old people who can take care of themselves and have independent consciousness and moving ability. Group 2 stands for old people with their own consciousness but need help from others in order to move like a healthy person. Group 3 stands for old people who rely on nursing workers completely. Different groups of people will be given different codes based on their behaviors. The old will be settled in different corners or floors in the model complying to their groups.

Hypothesis

The casualty rates in the model might be high, at about 50% or higher for reasons that about half of the nursing workers are not necessarily willing to protect them during the earthquake and old people are likely to panic. The people who escaped are more likely to be the majority of nursing workers and a small number of old people with their own consciousness and action ability.

Project Plan

Phase I ---- take 4 days to read references and previous experiments related to the topic and arrange them

Phase II ---- take 4 days to write codes and use MassMotion

to simulate

Phase III ---- take 3 days for data analysis and integration

Phase IV ---- take 2 weeks to write the final project and send the results to relevant departments

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Improving current artificial leaf with the addition of atmospheric water technologies (shortened version)

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Abstract

This paper will primarily focus on green energy, specifically, the artificial leaf technology. The paper will explore new ways to add upon existing artificial leaf technologies, through the combination with atmospheric water technologies (AWD) as well as direct atmospheric capture technologies (DAC). Due to the COVID–19 circumstances here in China, it is hard to obtain experimentation materials, and this paper will only be based on secondary research.

Background & Significance: Presently, climate change is posing one of the most severe problems the human race has faced collectively. In fact, the United Nations has called climate change 'humanity's code red warning'. And it indeed is true, climate change is exacerbating at an

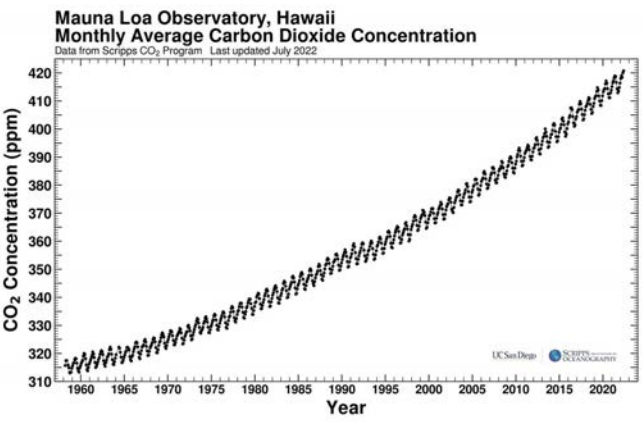


Figure 1: Measurements of atmospheric CO2 since 1958 from the Mauna Loa Observatory in Hawaii (Scripps Institute of Oceanography, 2022)

unprecedented rate – atmospheric carbon dioxide concentration has increased by one third in the past 6 decades, whilst it has increased by a half since the industrial revolution, as shown in Figure 1 and 2. The consequences are also quite tremendous – coral reef and aquatic habitat depletion, rising sea levels, increasing droughts affecting 700 million people, and 40% increase in medium and large



Chemistry

scale natural disasters just to name a few (United Nations, 2022). After acknowledging climate change's urgency and impacts, we need

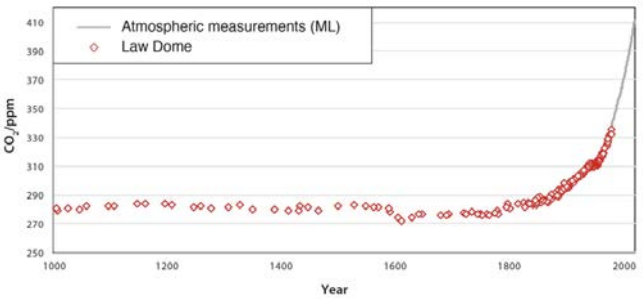


Figure 2: CO2 variations during the past 1000 years (The Royal Society)

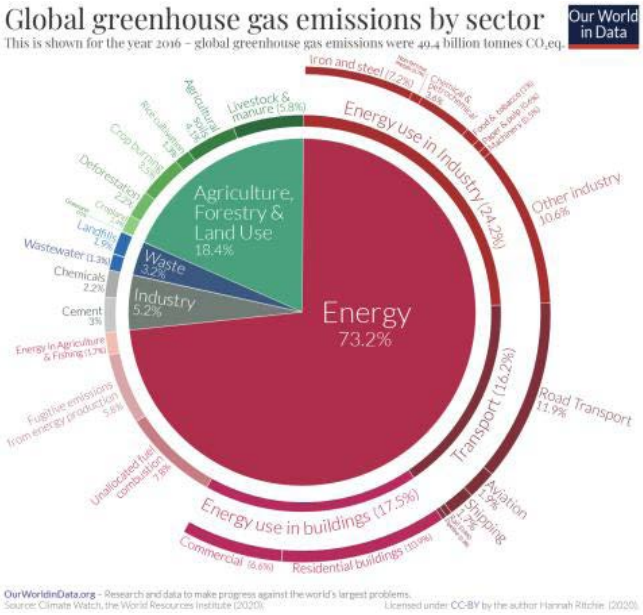


Figure 3: Global greenhouse gas emissions by sector (Ritchie and Roser ,2016)

examine potential effective solutions. As shown in Figure 3, among the greenhouse gases emitted until 2016, nearly a quarter of it comes from the energy sector. This points towards energy as the core of the issue, and solving it would require the transformation of energy type – from fossil fuel-based energy to sustainable green energy. There have been already huge efforts put into sustainable energy, however,

a new technology, the artificial leaf, may bring revolution in the sustainable energy sector. It has two benefits over the others – its end result being syngas and it not requiring much natural resoruces. This makes the technology seem very promising. In this paper particularly, it will be focusing on the sustainability side, and how the system can become less dependent on natural resources.

Literature Review

Literature Review – Nocera 2012: The artificial leaf, a technology simulating plant photosynthesis in hopes of creating clean energy, was first developed by Daniel G. Nocera in 2011 and published on the Accounts of Chemical Research, a subsidiary of the American Chemistry Society, in 2012 with the name "The Artificial Leaf" This article paved the path for all future studies on the artificial leaf. In Nocera's paper, he developed a plausible system of the artificial leaf in which solar energy is captured and used for water splitting, a technology which can produce hydrogen energy with no pollutant. The theory behind was to use silicon chips, coated with catalysts, and combined with water and solar energy, to mimic photosynthesis and split Oxygen and Hydrogen. During the process, it will create abundant Hydrogen molecules that can be used as an intermediate material for electricity. The result is clean and sustainable hydrogen energy that can be captured independent of electric grids.

Literature Review – Andrei 2019: After years of development, another exciting breakthrough in artificial leaf came. Andrei, Reuillard, and Reisner from the Christian Doppler Laboratory of University of Cambridge published their new developments on artificial leaf on Nature Materials by 2019. In this paper, Andrei and his peers introduced the production of syngas with the artificial leaf. They took a different approach than Nocera. Instead of clean hydrogen energy production through artificial photosynthesis, Andrei and his peers focused on producing syngas, short for synthesis gas, a mixture of carbon monoxide and hydrogen molecules. This technology basically uses H2O, CO2, sunlight, and catalysts to form syngas and O2.

Literature Review – EPA 2022: The United States Environmental Protection Agency, also known as the EPA, has funded research on the field of atmospheric water. The essence of atmospheric water is to produce water from the water vapors abundant in the atmosphere. Atmospheric water is thus a relatively sustainable way to produce water, as water vapors in the atmosphere is abundant for now.

Through heterotrophic plate counts, or HPC, the EPA tested the average atmospheric water. From the tests, indicators of Legionella, Mycobacteria, and fecal contamination, such as fecal coliforms and Escherichia coli, were not detected. Overall, atmospheric water has been a mature technology in producing sustainable water.

Methodology

Because of the lack of access to materials and space required to experiment, I will be instead relying on research heavily. I will be incorporating the literature research methodology to analyze existing studies, and implementing my own thoughts on altering current existing studies. In particular, I will be proposing an alteration to current models of the artificial leaf. It will also be mostly based around the artificial leaf chemical equation in the model of Andrei and his Cambridge team: CO2+H2O+H⁺ → sunlight + catalyst → CO+H2 + H⁺ and will incorporate AWD and DAC.

End Result

Andrei's team, as well as many others in the academia has proposed many of the cutting-edge catalyst and materials, however, one vacuum in the academia is the emphasis on its sustainability. Coincidentally, I have a general vision on how the artificial leaf can be circulated and self-sustained. Since the input of the artificial leaf includes water, CO2, H⁺, sunlight, and catalysts, we could possibly circulate the energy from the output to produce the input, which is why I have mentioned the EPA's AWD program, as it allows more than enough water for the artificial leaf, created through a sustainable way by utilizing abundant water vapor. For CO2, there is a widespread technology called the Direct Air Capture, or DAC, initiated by the International Environmental Agency. The DAC technology is in fact able to capture and store CO2 directly from the air, without any intermediate process, giving a feasible, though expensive, alternative for the input of CO2 for the artificial leaf (IEA 2021). For sunlight, natural sunlight may be used in sunny days, whilst artificial sunlight may be used without the sun. The energy produced, in turn, will be fueling the artificial sunlight, DAC, AWD etc. and the rest will be used and combusted, and the created CO2 will be captured again. The specifics are all shown in Figure 6, where I designed the potential cycle of the artificial leaf except for the catalyst, as the catalyst have still not yet reached consensus.

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Experimental study on flow induced noise interference between propeller and wing

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Physics & Engineering

Abstract

Propeller-type aircraft is more and more widely used in modern UAV, but the noise problem brought by it is also gradually prominent, which affects its development. Most of the noise generated by propeller aircraft is from flow induced noise. By changing the relative position of the propeller and the wing, this study explores the law of flow induced noise interference caused by the propeller and the wing. It is found in the experiment that the wind speed can affect the flow induced noise of the "propeller and wing" assembly. The higher the wind speed, the greater the flow induced noise; the relative position of the propeller wing assembly also has obvious influence on the flow induced noise. Among the 9 relative positions set in the experiment, the flow induced noise is significantly reduced when the propeller is tilted backward relative to the wing at position 9.

Background & Significance

Propeller aircraft plays a major role in modern regional aviation and most general aviation transportation fields. This kind of aircraft has the advantages of large pulling force, high propulsion efficiency and good economic performance when flying at low subsonic speed, which makes it have broad application prospects in the field of military transport aircraft and regional airliners. However, the noise problem of propeller is the main reason why it is difficult to popularize this type of aircraft. Sustainability in this field has been improved by further control and reduction of noise size

There are two main sources of propeller noise: mechanical noise and flow induced noise, of which flow induced noise is the main one. At present, research shows that there are two main methods to reduce propeller noise: one is to reduce the intensity of the sound source, and the other is based on destructive acoustic interference. The former reduces the noise by reducing the blade thickness and chord length

of the propeller, reducing the relative Mach number of the blade tip, moving the aerodynamic load of the propeller to the blade root, reducing the blade diameter, increasing the number of blades, and reducing the motor speed. The treatment of the blade tip is particularly important. Almost all the flow induced noise is generated by the blade tip. The latter uses the characteristics of sound as a wave to reduce noise by emitting a reverse wave to offset the original sound wave and make it weaken or even disappear, which has a good effect on low-frequency noise.

Literature Review

At present, there are few researches on propeller noise in the world, so the research on propeller noise mechanism is an important and emerging research direction. In foreign countries, DARPA (Defense Advanced Research Projects Agency) has found that the rotation of the propeller can be used to cancel the sound of each other, and the special blade shape of the propeller can also be used to reduce the noise.

Taking the GL-10 VTOL fixed wing developed by NASA as an example, it makes use of the self interference between the continuously distributed sound sources of the propeller blades themselves.



Fig. 1 GL-10 VTOL fixed wing developed by NASA

By optimizing the propeller design, the flow induced noise of the propeller can also be effectively reduced to meet the flight safety standard and reduce the noise pollution. At present, many researchers have carried out research on the noise generation mechanism, propeller model design and flow induced noise numerical calculation. By collecting relevant physical quantities and qualitatively analyzing the flow induced noise of the propeller, scholars have continuously improved the geometric parameters of the propeller model to achieve the purpose of noise reduction.

In recent years, many scholars at home and abroad have carried out a lot of research on low noise propeller design. Chusseau M. and Ohad Gurl analyzed the influence of the main design parameters of light aircraft on the propeller flow induced noise, but did not carry out numerical calculation and comparative verification on the propeller flow induced noise. Antonio Pagano, Marinus B G, Campos, et al. carried out multi-objective optimization design for propeller flow induced noise, but did not carry out qualitative research on physical quantities affecting flow induced noise. Pan Jieyuan and Qian Huide put forward a numerical optimization method for propeller aerodynamic design, and re-optimized the design and calculation of two existing propellers. They obtained good prediction results. However, the application of blade noise reduction optimization and the performance analysis of the blades after noise reduction were not carried out.

Methods

5.1 Experimental principle

In the measurement of propeller flow induced noise, the following parameters will be used:

(1) Advance Ratio

The advance ratio J of the propeller is defined as:

$$J = \frac{U}{n_s D} \quad (1)$$

Where, U is the incoming flow velocity, in m/s; n_s is the propeller speed, in r/s; D is the propeller diameter, in m. The advance ratio represents the efficiency of the propeller. The higher the advance ratio, the higher the efficiency of the propeller.

(2) Sound pressure level

Sound pressure level (SPL), refers to the ratio of the effective value $p(e)$ of the sound pressure to be measured,

to the reference sound pressure $p(\text{ref})$, which is taken as the common logarithm, and multiplied by 20, that is:

$$\text{SPL} = 20 \log_{10} [p(e)/p(\text{ref})] \quad (2)$$

The unit is decibel (dB).

The reference sound pressure $P(\text{ref})$ in air is generally taken as 2×10^{-5} PA, which is the sound pressure value that normal human ears can just detect the existence of 1 kHz sound, that is, the audible threshold sound pressure of 1 kHz sound. According to the national environmental noise standard, the standard limit equivalent sound pressure level of class II area (residential, commercial, industrial mixed area and commercial center area) with the largest population in the city is between 50-60dB. In this paper, the sound pressure level is used to measure the noise level.

5.2 Experimental equipment

5.2.1 Wind tunnel of flow induced noise

This test was completed in the D5 wind tunnel of Beihang University. D5 wind tunnel is 1m×1m aeroacoustic wind tunnel test room of Beihang University, which is the National Aerospace Test and Teaching Center (Fig. 2). D5 aeroacoustic wind tunnel is a low speed, low turbulence and low noise return aeroacoustic wind tunnel. The test section is square, with a width of 1.0m and a height of 1.0m; The length of the closed test section is 2.5m, the length of the open test section is 2.0m, and the length of the gas switching section is 0.5m. The test section can be used in two ways: open and closed. Around the open test section is a 7m × 6m × 6m full anechoic room, the wall of the anechoic room is made of thick CAIA-L low-frequency sound absorption and insulation board, which is used to simulate the free sound field environment, and can absorb more than 99% of the reflected sound, meeting the inverse square law



Fig. 2 D5 aeroacoustic wind tunnel of Beihang Lushijia Laboratory

of sound propagation. The low-frequency cutoff frequency of the free sound field is 200Hz. The D5 wind tunnel can carry out both conventional aerodynamic tests and acoustic tests. As shown in Figure 3, its background noise is very small, and it is one of the most advanced aeroacoustic test wind tunnels at home and abroad.

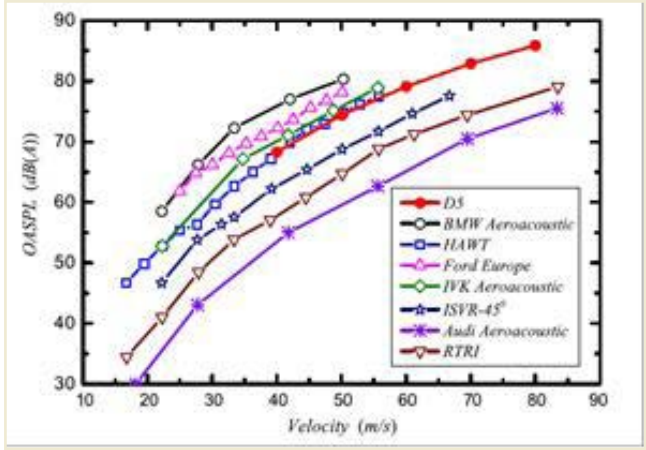


Fig. 3 Comparison of background noise of D5 wind tunnel of Beihang and other acoustic wind tunnels

5.2.2 Test model

The propeller used in the test is commercially available, with the number of blades $B = 6$ and the blade radius $R = 0.3\text{m}$. The propeller is shown in Fig. 4.



Fig.4 Propeller model

5.2.3 Interference test platform of propeller and wing

The test platform used is shown in Figure 5-6. The propeller-wing interference test platform is composed of propeller, servo motor, wing, rotatable disk, far-field microphone support, etc. Taking this as a reference, the three-dimensional experimental platform for propeller aerodynamic performance and flow induced noise is designed according to the actual situation of the D5 aeroacoustic wind tunnel of Beihang, as shown in Figure 5. The propeller test-bed is composed of servo motor, motor support and far-field microphone support, wherein the height of motor support is $H = 1800\text{mm}$, the distance between the propeller disk and the nozzle, and the distance between the tail of servo motor and the air collector. In terms of experimental details, the flow induced noise experiment requires to reduce the interference of all background noise as much as possible. Therefore, in the flow induced noise experiment platform, we wrap the servo motor with sound-absorbing cotton to prevent the propagation of servo motor noise; At the same time, the ground is also covered with sound-absorbing cotton to avoid the ground reflection of noise; The motor support

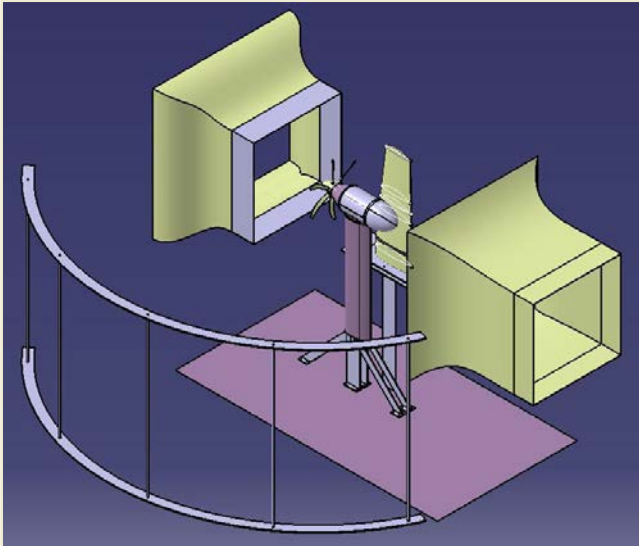


Fig. 5 Schematic diagram of test bench

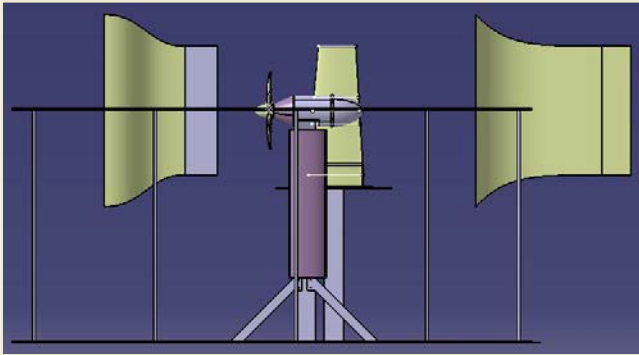


Fig. 6 Side view of test bench

and the far-field microphone support are also wrapped with sound-absorbing cotton to avoid the wall reflection of noise.

5.3 Test method

The schematic diagram of the propeller-wing assembly test bench is shown in the following figure:



Fig. 7 Schematic diagram of propeller-wing assembly test bench

The experiment of the propeller-wing assembly includes the relative positions of the prototype propeller, the optimized propeller and the wing, and also the front and rear positions of the propeller and the wing, the upper and lower positions of the propeller and the wing (the specific relative positions may be adjusted according to the actual situation of the test bench); The specific test conditions are as follows:

Items	Front and rear position of propeller	upper and lower position of propeller	Installation angle of propeller	Section of wing
1	Original position	Original position	0°	MA700
2	Move forward 150mm	Original position	0°	MA700
3	Move back 150mm	Original position	0°	MA700
4	Original position	Move up 20%	0°	MA700
5	Move forward 150mm	Move up 20%	0°	MA700
6	Move back 150mm	Move up 20%	0°	MA700
7	Original position	Move down 20%	0°	MA700
8	Move forward 150mm	Move down 20%	0°	MA700
9	Move back 150mm	Move down 20%	0°	MA700

Table 1 List of test contents

Hypothesis

1. The wind speed has a certain influence on the sound pressure level of the propeller-wing assembly. The higher the wind speed, the greater the noise.
2. The relative position of the propeller and the wing also affects the noise.

Project Plan

Phase I (2 days) - theoretical analysis and design the experiment;

Phase II (5 days) - data collection;

Phase III (3 days) - The time slightly coincides with the second stage. On the basis of sorting out the data and learning to use array sound source localization, noise spectrum diagram and noise directivity for analysis.

Test results and analysis

8.1 The sound source location array

Fig. 8 shows the sound source location array diagram of the propeller-wing assembly when the wind speed is 30m/s. When at this wind speed, the relative positions of the propeller and the wing are different, which will affect the sound source location and sound source size at the same time.



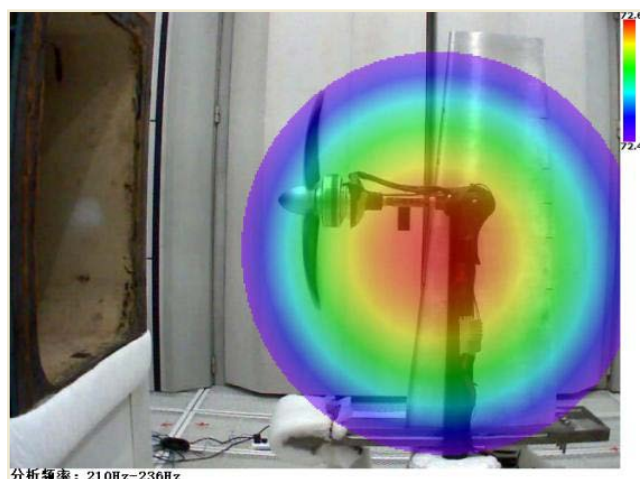


Fig. 8 Sound source location at different relative positions at wind speed of 30m/s

Figure 9 shows the sound source location array diagram of the propeller-wing assembly when the wind speed is 50m/s. It can be seen from the figure that the sound source is mainly at the root of the wing when the wing and propeller are combined. The relative position of propeller and wing is different, which has little effect on sound source location, and mainly affects the size of sound source.

8.2 Noise spectrum diagram

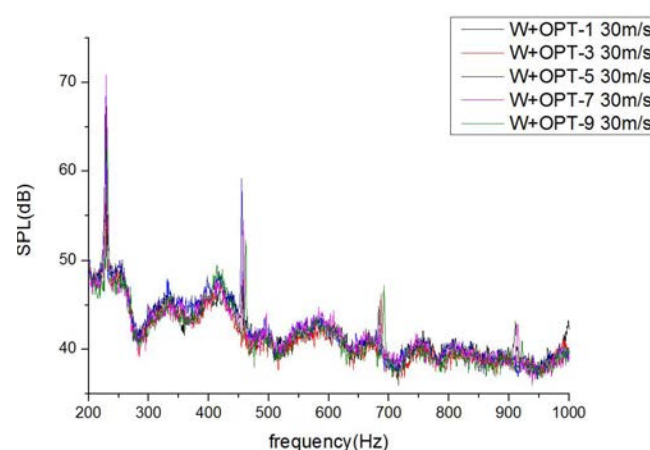


Fig. 10 Noise spectrum at different relative positions when the wind speed is 30m/s and the rotation speed is 2300rpm

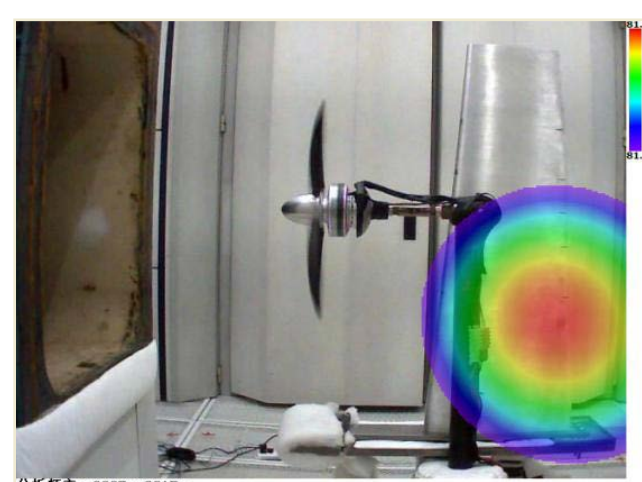
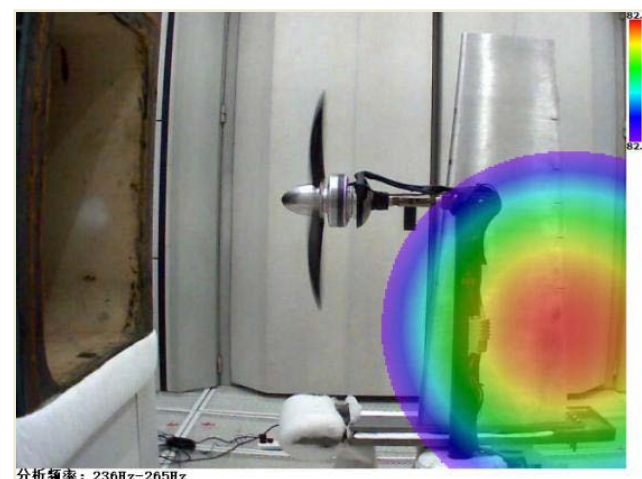


Fig. 9 Sound source location at different relative positions at wind speed of 50 m/s

Fig. 10 shows the noise spectrum of different relative positions when the wind speed is 30m/s and the rotation speed is 2300rpm. It can be seen from the noise spectrum that the noise generated by the propeller-wing assembly is composed of discrete noise and broadband noise, and the propeller frequency doubling peak is obvious.

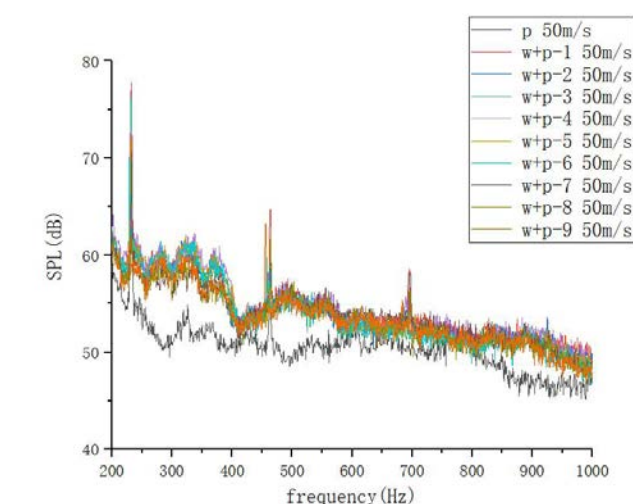


Fig. 11 Noise spectrum at different relative positions when the wind speed is 50m/s and the rotation speed is 2300rpm

Fig. 11 shows the noise spectrum of different relative positions when the wind speed is 50m/s and the rotation speed is 2300rpm. Compared with 30 m/s, the sound pressure level has increased. It can be seen from the noise spectrum that the overall sound pressure level of the propeller-wing assembly is higher than that of the single propeller. The noise generated by the propeller-wing assembly is also composed of discrete noise and broadband noise, and the propeller frequency doubling peak is obvious.

8.3 Noise directivity

Fig. 12 shows the noise directivity at different relative positions when the wind speed is 30 m/s and the rotation speed is 2300rpm. It can be seen from the figure that the noise of the propeller wing assembly at positions 9 and 7 is relatively small.

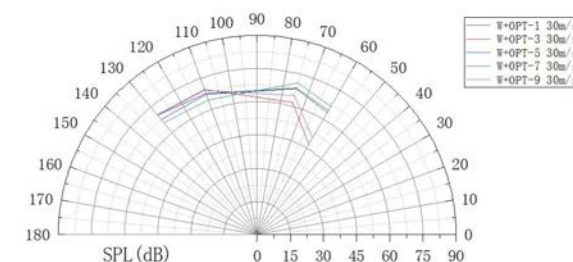


Fig. 12 Noise directivity at different relative positions at wind speed of 30 m/s and rotation speed of 2300rpm

It can be seen from the noise directivity that the directivity of different relative positions is obviously different. The noise at the 9 relative positions is relatively small and the noise reduction effect is obvious.

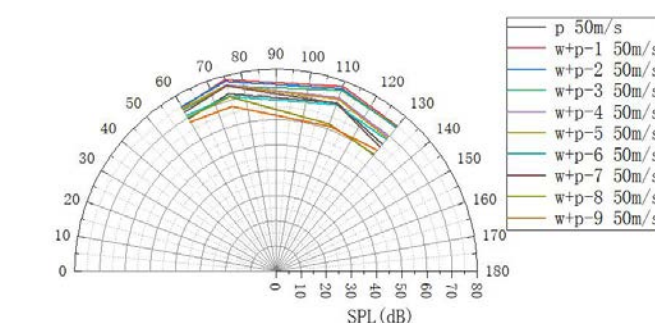


Fig. 14 Noise directivity at different relative positions at wind speed of 50m/s and rotation speed of 2300rpm

Conclusion

In this paper, the D5 aeroacoustic wind tunnel of Beihang University is used to investigate the flow induced noise of propeller and wing assembly. The flow induced noise of different wind speeds is measured by changing the relative position of propeller and wing. The following conclusions

can be obtained through the experiment:

1. The wind speed affects the sound position and size of the propeller-wing assembly. When the wind speed is 30m/s, the sound source is near the propeller. When the wind speed increases to 50m/s, the sound source moves to the root of the wing;
2. The wind speed has a certain impact on the sound pressure level of the propeller-wing assembly. The higher the wind speed, the greater the noise.
3. The relative position of the propeller and the wing also has an impact on the noise. In the relative position 9, the noise is small.

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Identification and Research into a Wild Parasitic Fungus and its Biological Characteristics

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Abstract

A parasitic fungus is a macrofungus that parasitizes the fruiting bodies of mushrooms, though its parasitic mechanism has never been clearly documented. In this study, fruiting bodies of a parasitic fungus were collected from the field, with strains obtained by classical taxonomy, marker-assisted identification and tissue isolation. A phylogenetic tree was then constructed. A single factor test was conducted to investigate the effect of different macrofungi on their growth status in the seed bottle. The results showed that the parasitic fungus was *Asterophora lycoperdoides* Bull. In the biological characteristic test, this particular fungus achieved the most significant growth in a culture with powdered fruiting bodies of *Russula*, while its growth was inhibited in one containing *Hericium erinaceus*. The results indicated that *Russula* plays a role in promoting the growth of *Asterophora lycoperdoides* Bull. to a certain extent. This study can provide a theoretical basis for further study into the parasitic mechanism of parasitic fungi.

Keywords

Parasitic fungus, parasitic mechanism, biological characteristics

Background & Significance

Macrofungi are a type of fungus containing fruiting bodies that are visible to the naked eye. As an important group of fungi, they play a critical role in stabilizing ecological balance and have numerous applications (Tolgor Bau, 2010). Research shows that there are around 1.5 million species of fungi in the world, about 14,000 of which are described as macrofungi (Li Yu, 2015). Therefore, macrofungal resources are in urgent need of further development. Parasitic fungi, forming part of the *Tricholomataceae*, *Agaricales*, *Hymenomycetes*, and *Basidiomycota* families, are distributed throughout most parts of China. It has

been recorded that parasitic mushrooms are a specialized form of parasitic fungi, though recent research has focused primarily on strain identification and taxonomic phylogeny, and there have been no studies on the factors affecting their parasitic mechanism. On the basis of optimizing the culture medium of a parasitic fungus at the early stage, specimens acquired in the wild were identified in this study to investigate the factors affecting their parasitic mechanism, in order to provide a basis for further development and utilization.

Literature Review

Macrofungi can be divided into three ecological types based on their ecological habits; these include saprophytic macrofungi, symbiotic macrofungi, and parasitic macrofungi (Lin Chao, 2005). With regard to parasitic fungus research, there is presently only one known type, i.e., *Asterophora lycoperdoides* Bull., that grows fast and is widely found (Sharma, 2007). Most studies on *Asterophora lycoperdoides* Bull. are focused on strain molecule identification, physiological activity (Koller, 1985), optimization of its biological activity (Koller, 1985), and medium prescription optimization. Research into this last aspect (Wang Jiandong, 2004) shows that, for *Asterophora lycoperdoides* Bull., its hyphae grow best in an HSVA medium, and exhibit good alkali tolerance. Regarding the factors affecting their growth (Homma, 2006), certain substances present in *Russula nigricans*, such as mannitol, or even *Russula nigricans* itself, can be used to promote the growth of hyphae. It is therefore believed that the composition of *Russula nigricans* may contribute to the host specificity of *Asterophora lycoperdoides* Bull. In conclusion, there are presently no clear research findings on how the composition of *Asterophora lycoperdoides* Bull., a type of parasitic fungus, affects its parasitic mechanism, though there is a clearly identified optimal medium for its growth.



Biology & Medicine

Research Methodology: Specialized Theoretical Framework

5.1 Experimental materials

The fruiting bodies of the parasitic fungus were collected from the field, and strains were obtained by means of tissue isolation.

PDA medium: 200 g of potato, 20 g of glucose, 20 g of agar, 1 L of water;

HSVA medium: 1 g of yeast extract powder, 2 g of glucose, 0.1 g of NH₄Cl, 0.1 g of KCl, 1mg of VB₁, 16 g of agar, 1 L of water.

5.2 Experimental methods

5.2.1 Morphology and marker-assisted identification

The cap and stipe sizes of wild *Asterophora lycoperdoides* Bull. were measured, and a description given on whether the color, shape and cap edge extended outwards. Fresh gills were cut away for temporary slide production. The basidiospore was observed under a scanning electron microscope, and its size measured. An improved CTAB method was then used to extract the DNA, and its ITS sequences were PCR-amplified for clone sequencing. For the sequences obtained, their peak charts were viewed using the BioEdit software. The results were analyzed and compared by BLAST in Genbank to see whether the studied strain was homologous with the target species already present in Genbank.

5.2.2 Phylogenetic tree building

序号 Sample	种名 Species	标本号 Specimen No.	Genbank 号 Genbank accession No. ITS	来源地 Locality
01	<i>Asterophora lycoperdoides</i>	BTM86719		Henan, China
02	<i>Asterophora lycoperdoides</i>		KP192566	France
03	<i>Asterophora lycoperdoides</i>		LN714522	Czech Republic
04	<i>Asterophora lycoperdoides</i>	LSXB0826		
05	<i>Tricholoma imbricatum</i>		DQ822836	USA
06	<i>Tricholoma terreum</i>		EU653301	Beijing, China
07	<i>Tricholoma terreum</i>		EU653300	Beijing, China
08	<i>Singerocybe humilis</i>		JX514131	Beijing, China
09	<i>Lepista irina</i>		HM237136	New Zealand
10	<i>Lepista irina</i>		KJ194172	Pakistan
11	<i>Lepista panaeolus</i>		MK642902	Beijing, China
12	<i>Laccaria amethystea</i>		MT568580	Guizhou, China
13	<i>Laccaria laccata</i>		JX679363	Czech Republic
14	<i>Oudemansiella radicata</i>		AY534119	Korea
15	<i>Oudemansiella canarii</i>		AF321479	USA
16	<i>Oudemansiella canarii</i>		OK446689	Philippines
17	<i>Melanoleuca melaleuca</i>		MT270918	Czech Republic
18	<i>Melanoleuca melaleuca</i>		HM622269	Italy
19	<i>Melanoleuca excisssa</i>		LT594132	Czech Republic
20	<i>Melanoleuca excisssa</i>		LT594131	Czech Republic
21	<i>Cortinarius bulliardii</i>		OM867745	Sichuan China

Tab.1 Newly generated sequences for phylogenetic analysis

Related species were taken from the fungi index database, and 2 ampliconic ITS sequences of the parasitic fungus were selected. In addition, 20 species of *Leucoagaricus* fungi, with a total of 18 sequences, were selected from the same family but not the same genus (*Asterophora*, *Tricholoma*, *Lepista*, *Laccaria*, *Oudemansiella*, and *Melanoleuca*) as reference sequences; *Cortinarius bulliardii* (Pers.) Fr. was selected as an outgroup for tree building and analysis. The Neighbor-joining (NJ) method was used to construct the tree.

5.2.3 Biological characteristics test

Using the HSVA medium, the powdered fruiting bodies of *Russula*, *Pleurotus eryngii*, *Hericium erinaceus*, and *Ganoderma lucidum* with different content gradients (0, 0.5, 1.0, 1.5, 2.0 g/L) were added to the tissue culture vessel under aseptic conditions. Parasitic fungus tissue masses of the same size were taken and inoculated at the center of the seed bottle, which was then placed in a constant temperature incubator at 25°C. Hypha growth and fruiting were observed and analyzed every other day. Pictures were taken, and recording was stopped when the same batch of hyphae overgrew the bottom of the seed bottle. Each test was repeated 3 times.

Hypothesis

6.1 Fungal identification results

The morphological characteristics of the fruiting bodies of wild *Asterophora lycoperdoides* Bull. are shown in Figure 1. The cap was subsphaeroidal in shape when young, before becoming more hemispherical, and covered with a thick layer of white powder. The context looked white or off-white. There were rare gills, which were white and straight



Figure 1 Photo of *Asterophora lycoperdoides* Bull.



raw. The stipe was white, cylindrical, and internally solid, with white villi at the base. Most spores of *Asterophora lycoperdoides* Bull. are chlamydospores, whose microscopic characteristics are shown in Figure 2. Being irregularly star-shaped, they also feature many spikes. It is thus speculated that the fancy shape of the spores might be related to the parasitic mechanism of the fungus.

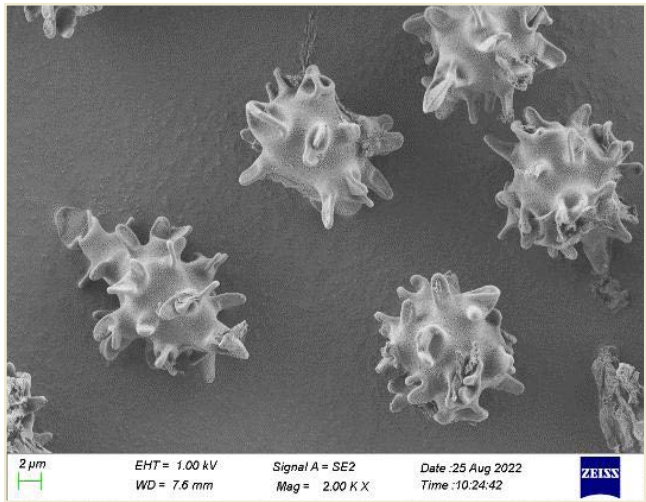


Figure 2 Spores under SEM taken in an ecological environment

6.2 Analysis of phylogenetic results

The parasitic mushroom species was clustered into one branch of the phylogenetic tree, where it is closely related to *Tricholoma*. The two were clustered into a single large branch, remotely related to *Melanoleuca* Pat., though belonging to different branches. The self-testing sequences of the parasitic fungus were clustered into one branch with the sequences downloaded from Genebank, supporting the results of traditional morphological identification. (Figure 3)

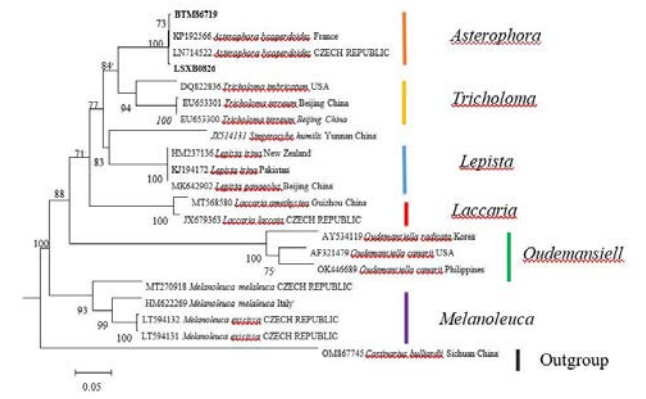


Fig. 3 Molecular phylogenetic tree constructed by the neighbor-joining method based on ITS

6.3 Results of biological characteristics test

According to the test results, *Asterophora lycoperdoides* Bull. grew steadily in the culture medium containing

Russula (Figure 4), and grew more slowly in the medium containing *Hericium erinaceus* (Figure 5). It is speculated that certain substances present in *Russula* might be able to promote the growth of *Asterophora lycoperdoides* Bull. *Hericium erinaceus*, being a wood-rotting fungus, may competitively inhibit its propagation. Furthermore, the fruiting bodies of both *Pleurotus eryngii* and *Ganoderma lucidum* promoted the growth of *Asterophora lycoperdoides* Bull., but not so significantly (Figure 7).



Figure 4 Growth of *Asterophora lycoperdoides* Bull. in a medium containing *Russula*



Figure 5 Growth of *Asterophora lycoperdoides* Bull. in a medium containing *Hericium erinaceus* (The concentration of *Russula* and *Hericium erinaceus* added is 0.5, 1.0, 1.5, and 2.0 g/L from left to right)



Figure 6 Growth of *Asterophora lycoperdoides* Bull. without powdered fruiting bodies of a macrofungus

6.4 Conclusions and Discussion

In this experiment, a parasitic fungus was identified and its biological characteristics studied. The conclusions show that the parasitic fungus was *Asterophora lycoperdoides*

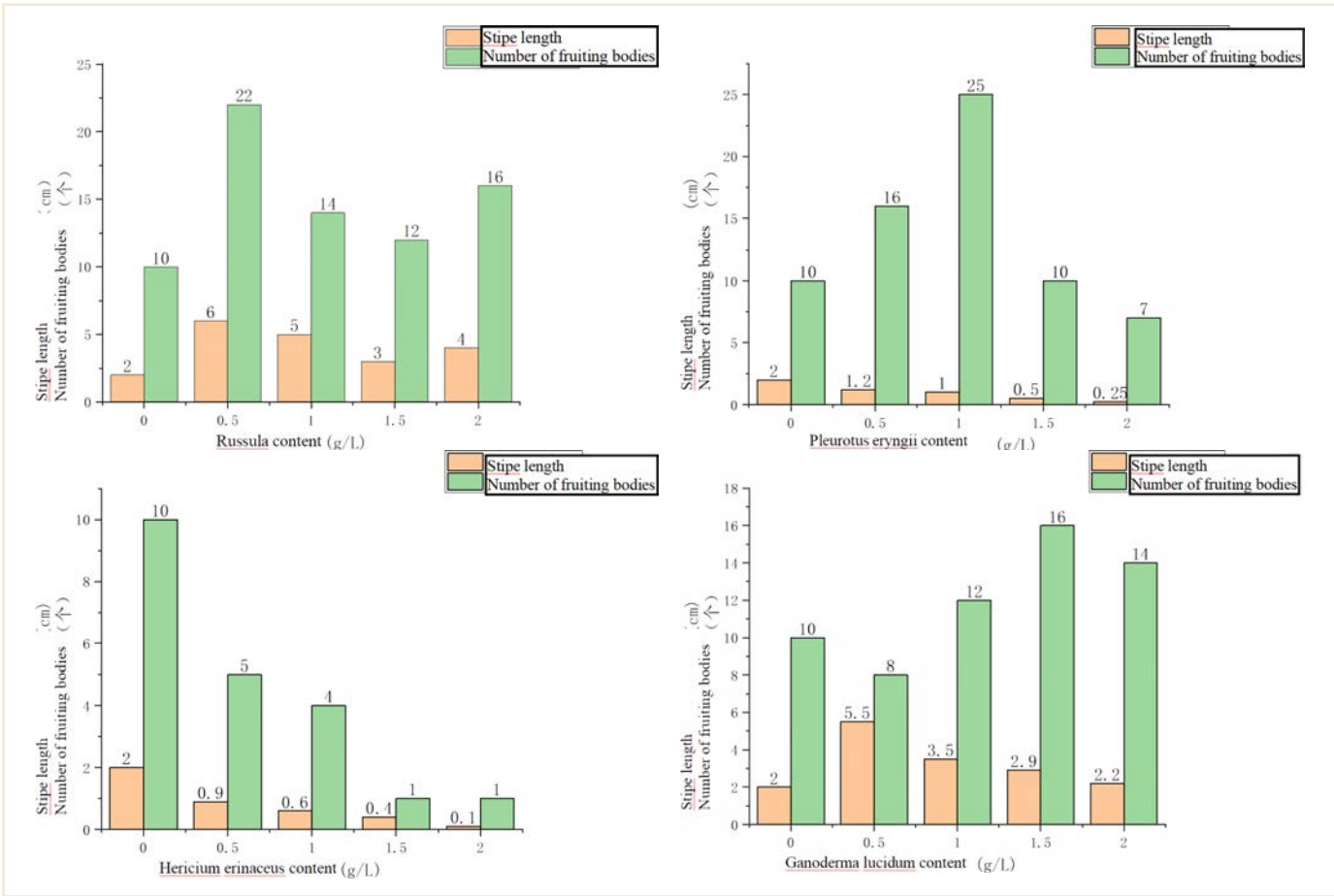


Figure 7 Effects of different macrofungi on the growth of *Asterophora lycoperdoides* Bull.

Bull., and that, when added to the culture medium, *Russula* could significantly promote its growth. However, the experiment also had certain limitations. For example, when a single-factor test was designed, a proper content gradient should be selected, since the dosage of different macrofungi has different effects on the growth of *Asterophora lycoperdoides* Bull. Edible fungi are an important part of a healthy diet consisting of "one meat dish - one vegetable dish - one mushroom dish" as recommended by the Food and Agriculture Organization (FAO). *Asterophora lycoperdoides* Bull. is a fungus that has not yet been used as an edible or a medical resource. Its nutritional activity and pharmacological efficacy can thus be further investigated, in order to better understand its suitability for human health and food safety.

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Analyzation of Ocean Energy in Tropical Seas: How to minimize disturbance to benthic ecosystems

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Abstract

Ocean Energy is a reusable resource which could provide humans with needed energy. The technologies that are needed for the harvesting of this resource is mostly developed. However, the impact of these technologies on ecosystems around them is still being explored. Under many factors that makes ocean unpredictable, these studies are crucial before this technology can be used worldwide. This article is an analyzation on Ocean Energy and related effects on tropical marine life. The study is based on mixed methods which is done by several different Oceanographic researchers in Brazil. The goal of this study is to provide a thorough plan on how to generate demanded energy from the tropical oceans, while protecting local marine ecosystems.

Key Words

Ocean Energy, Tropical Ocean, Benthic, Renewable Resources

Background & Significance

The ocean covers 71% of Earth and is ever changing. There are differences in the salinity, temperature, tides, and depth in different parts of the ocean, and can be used to produce large amount of energy to meet our demands. Thus, from economic and social perspective, Ocean energy has great potential and value as a source of renewable energy. The technology to produce this energy is already in use around the world. There are two main types of generators that were commonly used: First type is a tidal generator, which uses a buoy, and a spar connected spar connected to the seabed that secures the buoy in place. There is a piston inside the spar that generates the up-and-down movements of the buoy into electricity. Second type is a tidal current generator, which acts like a wind turbine. It is powered by the currents underwater that moves the turbine in

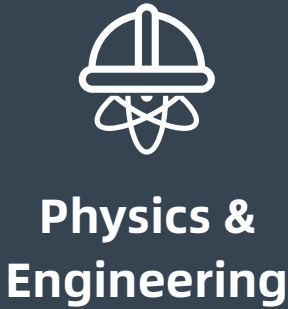
circular movements to generate electricity (Martínez et al., 2021, p. 4). However, much research is still needed for this renewable energy to be used all around the ocean globally, as devices may be costly to maintain and install, may cause harm to native environment if distributed and designed poorly, and may lose energy through underwater wire nettings (Uihlein & Magagna, 2016).

Tropical regions have complex climate conditions, through a more hostile ENSO effect. Although the ENSO effect happens around the world, it effects tropical areas the most, causing extreme climates. ENSO effect is caused by the distribution of jet streams and temperature changes of the air, thus reacts with and changes currents in the ocean (NOAA, 2021a). Also, Tropical Oceans have complex geomorphic structures: coral reefs and ecosystems that are still being explored. Coral reefs are essential to ecosystems on the benthos, they contain nutrients for bacteria, which acts as the bases of the food chain in the marine ecosystem (Rädecker & Pogoreutz, 2019, p.2, p5). An estimation has been made where coral reefs contain one fourth of known marine animals ((Rädecker & Pogoreutz, 2019, p.2). Thus, these oceans provide a complex ambience which should be protected. Before we can advance Ocean Energy technologies into Tropical Seas, we must understand the interrelationship between human activities, the geomorphological/ ecological systems and climate change.

Literature Review

2.1 Geomorphological Structures

Different studies had been looking at the geomorphological structures of tropical oceans. Geomorphological structures are directly related to reef structures, which provides and contains different ecosystems within them, thus these are important studies that is fundamental for further Oceanographic studies. These studies are conducted near the coast of Brazil, in the South Atlantic Ocean, by the



Structures		Depth						
		Area (km ²)	Area (%)	Min. (m)	Max. (m)	Mean (m)	Range	STD
01	Flat Plains	44.78	49.22	−19.31	0.33	−8.48	19.64	5.63
02	Depressions	14.65	16.10	−19.86	−2.64	−12.07	17.21	4.29
03	Gentle Slopes	7.79	8.56	−19.26	0.23	−9.06	19.48	4.13
04	Steep Slopes	4.58	5.03	−19.28	0.32	−9.30	19.60	3.91
05	Flat Ridge Tops	5.28	5.80	−14.88	0.29	−3.39	15.17	2.87
06	Rock Outcrop Highs	9.08	9.98	−16.34	0.43	−4.79	16.78	3.69
07	Local Pinnacles in Depressions	0.01	0.01	−8.74	−2.80	−3.57	5.94	1.05
08	Local Pinnacles on Broad Flat	4.81	5.29	−18.23	0.44	−9.81	18.67	4.66

Table 1: Depth related description of the geomorphological classification and the percentage of occurrence (Goes et al., 2019, p. 6)

University of Pernambuco.

The main method that allowed the researchers to identify and classify the Geomorphological structures is by using multi-beam echosounders. They are placed parallel to the equator, 200 meters apart from each other, to collect samples in a raster of 10- meter cells (Goes et al., 2019, p. 2). This method is called Bathymetric Data, and by modeling the Bathymetric Data into the Benthic Terrain Modeler (BTM) (Goes et al., 2019, p. 3), researchers were able to classify 8 types of geomorphological structures.

2.2 Reef Structures

The method of Benthic Community sampling is done using photo-quadrats, which is used to understand reef structures (Biscaia zamoner et al., 2021, p. 3). In research conducted by the University of Santa Catarina, sites are selected at different depths and different parts of the coastal oceans, in which most of the selected sites have depth no more than 12 meters deep (Biscaia zamoner et al.,

2021, p. 3). The sampling process is throughout seven years, all taking in the month of October, with up to 1,040 images each year (Biscaia zamoner et al., 2021, p. 3). By selecting random photos from different points, the photo-quadrats were processed visually, identifying different organisms at each point, and then classifying them into recognized reef systems (Biscaia zamoner et al., 2021, p. 4). This process estimated the benthic groups' coverage each sample year (Figure 1)

It is seen from the study that large amount of Cyanobacteria has been found in the data collected in 2019. Cyanobacteria, which is also known as Cyanotoxin, is a sign that shows the negative effect climate change has to marine ecosystems (Cyanobacteria).

2.3 Possible Negative Effects of Ocean Energy on Marine Life

There are several aspects of negative effects between Ocean Energy and Marine life. Since there isn't any existing large scaled Ocean Energy stations (in terms of coverage of devices), negatives effects are mostly hypothesized. The negative effects could be categorized into a few sections: effects on reproduction and feeding, hydrology, noise, and electromagnetic fields. Different devices will have greater or less effects on local Marine life (Frid et al., 2012, p. 1).

- Effects on reproduction and feeding is related to how the structures are distributed. To produce most energy, it will be required that the turbines be placed facing currents. However, marine life relies heavily on the ocean currents to move around, thus wave energy farm is defiantly have negative effect on marine life (Frid et al., 2012, p. 4). However, tidal energy farm doesn't have much negative effects on feeding and reproduction of marine life. Despite the possible harm of wave energy farm, most smaller fishes will swim faster than

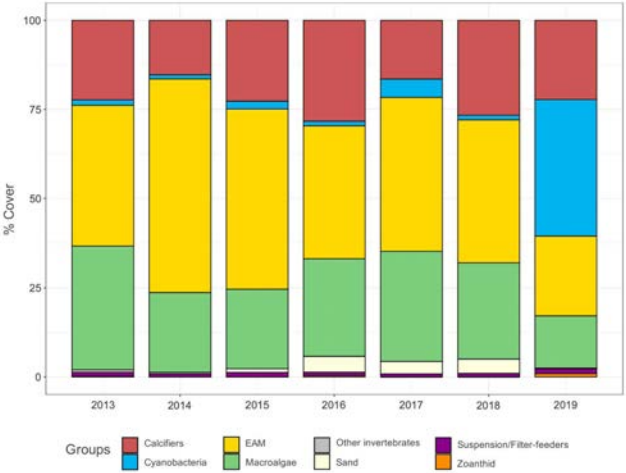


Figure 1: Yearly benthic community structure. Stacked barplot illustrating the yearly substrate cover pooled during the 7-year monitoring in Fernando de Noronha Archipelago in terms of major benthic groups and sand mean percentage cover (Biscaia zamoner et al., 2021, p. 7).



- the turbines, giving them opportunities to evade the spinning turbines (Frid et al., 2012, p. 4).
2. Devices have direct effect on hydrology, which may also directly affect marine life negatively. Wave energy farm may act as wave breakers, ending the currents (Frid et al., 2012, p. 5). This may pose problems as mentioned before. While causing negative affect to marine life, it could also change benthic terrain, as currents have great impact on the rate of erosion (Frid et al., 2012, p. 5). Tidal energy farm also poses possibilities to change hydrology, as engines may affect the salinity of the surrounding waters, however, not much information have proven that tidal energy farm effects the velocity of the currents (Frid et al., 2012, p. 5).
3. Noise is a major issue of all types of generators, as different species reacts differently under noise. It may harm sensitive or sensory tissues, or cause species to behave abnormally (Frid et al., 2012, p. 5). There is very little studies that have proven the noise level of Tidal and Wave farming techniques will produce noise that’s over the threshold of noise that protects the marine species (Frid et al., 2012, p. 5).
4. Although it is necessary to analyze where the electric webs are distributed, there are studies that have shown that most marine species won’t be affected by exposure to electric magnetic fields (Frid et al., 2012, p. 5). The ability to detect changes in magnetic field, however, is crucial to sharks as they are shown to depend on magnetic field for navigation (Meyer et al., 2004, p. 1).

2.4 Summarization of current studies

To summarize this section, since there is still so much unknown about our ocean, there is also much unknown about the effect of Ocean Energy on marine and benthic ecosystems, and the future potential of Ocean Energy. Since this technology is not yet to a commercial stage, much other data is invalid now, such as how are marine life effected by the noise produced by the devices. Despite the lack of data on a broader range, there are other data that already can be provided, such as the geomorphological and reef structures. Since this is a broad topic that requires studies from all aspects, different methods and models must be used at the right place and with right algorithms.

Methods

3.1 Bathymetric Data and Related Models

Data relating to the physical structures and movements of the ocean can be collected by Bathymetric Data. Bathymetric Data is very valuable as, when it is put into different models, it could provide researchers with information regarding the currents, tides, temperature, salinity, and geomorphological structures (components and classification), thus providing almost all information needed (NOAA, 2021a). Bathymetric Data is collected by echosounders, which sends out waves at 200kHz. There are two types of echosounders: Single Beam Echosounder (SBE) and Multi Beam Echosounder (MBE). Studies have shown that the accuracy of MBE could be 7 percent higher than that of a SME, thus for the purpose of accuracy of the data, MBE is suggested to be used (Goes et al., 2019, p. 2). The collection of Bathymetric Data should be conducted within cells of 10 meters, any data collected with broader ranges are proven to be less effective (Goes et al., 2019, p. 2). To produce the right results from the Bathymetric Data collected, right models must be used the right way. For example, the study by the University of Pernambuco used the Benthic Terrain Modeler (BTM) as a GIS approach. By combining the different scales of Bathymetric Positioning Index (BPI) and the slope, accurate models of benthic structures, mean depth, and depth range is created (Goes et al., 2019, p. 3). Slope is a fundamental attribute to the study of benthic structures, as it in influences the rate of erosion and currents and allowing adjustments of distribution of ecosystems (Goes et al., 2019, p. 3). BPI is a measurement of the relative elevation of the landscape. When the index is identified as 0, areas can be lower or higher than the index (-1 or +1) (Goes et al., 2019, p. 3). The slope (measured in degrees), which expresses the gradient toward the maximum slope of the ocean floor, is measured (Goes et al., 2019, p. 3).

3.2 Photo-Quadrats

On simple terms, Photo-Quadrats is the process of taking photos. At different points, Divers takes photos with specialized cameras at sample areas, then the photos were analysed visually. In the research conducted by the University of Santa Catarina, data were analysed by first identifying and classifying the photos, then the rate in terms of coverage area and type of corals structures covered is identified (Biscaia zamoner et al., 2021, p. 5).

3.3 Behavioural Conditioning

Behavioural Conditioning studies how animals will act under altering conditions. The best example is a study on

sharks’ reactions to changing magnetic fields conducted by JR Soc, which used captured sharks that were put into a study area that has an artificial magnetic field (Meyer et al., 2004, p. 1). The experiment was set up with food as the target. Observations are made as to how the sharks’ ability to reach the food was affected by the change of artificial magnetic fields (Meyer et al., 2004, p. 1). Many trials were conducted, and the course’s setup remained to be a control (Meyer et al., 2004, p. 1). However, behavioural change was seen in how the sharks reached their food as the magnetic fields changed (Meyer et al., 2004, p. 1). Experiments could be designed like this study, on different marine animals and how they are affected by noise, artificial structures, and magnetic fields.

Procedure

May: Test Devices and equipment mounted and prepared

-15 days: Multi Beam Echosounders

-15 days: Test Generators and artificial magnetic field set up

June: Bathymetric Data Gathering (30 days)

-Three times every day, once in the morning, once at noon, once at evening

-Sample time (5 minutes, 3 samples every second)

July: Bathymetric Data Analysis / Behavioural Conducting (30 days)

Analysis:

-Final review of collected Data (4 days)

-Terrain Model (3 days)

-Current Model (3 days)

-Tidal Model (3 days)

-Recheck Model and final adjustments (5 days)

Behavioural Conducting:

-Course setups recheck (2 days)

-Controlled experiments (10 days)

August: Photo-quadrats collecting/analysis (30days)

-Photo taking (20 – 25 days)

-Photo Analyzation (5 – 10 days)

September: Overall analyzation (5-7 days)

Repeat steps throughout the course of 3 years, evaluation of changes.

Expected Results

In terms of Hypothesis, firstly, we expected significant difference in terms of negative effects on benthic ecosystems between Wave Farms and Tidal Farms. We hypothesised that Tidal Farms would have fewer negative effects on benthic ecosystems.

Secondly, we expected difference in terms of where the devices are placed (according to geomorphological structures) and what components they are placed on. Since any failing of these devices may cause further harm to benthic ecosystems, we hypothesised that devices should be placed on flat plains (areas with a BPI close to 0), with components of mainly mud and rock.

Thirdly, we expected behavioural abnormalities when animals are under long contact with artificial devices and electromagnetic fields. We hypothesised that devices should be placed in more remote areas in terms of bio-density of an area.



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Chemistry

A study on the threat from sunscreen to the marine and aquatic ecosystem – the contamination from sunscreen, and ways people can do to minimize its threat when wearing sunscreen

Ruiyang Xie

Abstract

2.1 What are the research questions?

2.2 What is your research design? (qualitative,quantitative,mixed)

2.3 What are your expectations?

This study aims to look at the marine contamination from the popular and commonly-used sunscreens, analyze and discuss the factors that influence the hierarchy of contamination from sunscreen, and suggest ways to reduce sunscreen contamination. The study would be based on a questionnaire, a review and an experiment using COD (Chemical Oxygen Demand) tests and CDOM (Chromophoric Dissolved Organic Matter) level tests. The ultimate goal of the study is to gain understanding and social awareness of threat from sunscreen to the ocean, and find possible ways to reduce the threat.

In this study, the following questions are aimed to be answered:

- 1. What sunscreen types (spray or cream) brands do people usually use when they go to beach? What are the chemical components of these popular sunscreens? Among these components, which would be harmful to the ocean?
- 2. What are the differences of chemical components between sunscreen spray and sunscreen cream? Do they cause different hierarchy of marine contamination?
- 3. Considering the solution of harmful components, how to reduce the contamination from sunscreen? What factors may influence the hierarchy of contamination?

- Does sunscreen spray and cream have different hierarchy of effect to sea creature?

- Does the duration the skin soaks in sea water effects the contamination?

- Does the duration between putting on the sunscreen and getting into sea water effects the contamination?

- Does different brands of sunscreen cause different hierarchy of contamination?

By finding out the answers to the questions above, what advice can be given to reduce sunscreen contamination?

-Does 'water-proof' sunscreen have less solubility thus less effect to water?

Background & Significance

3.1 Reason for choosing the project

3.2 Significance

Marine ecology have become a globally-concerned issue. In recent years, with policies and legislation focuses on plastic and oil pollution of the protected areas, less concern has been given to an ordinary-looking human activity – the global habit of using sunscreen when going to the beach. In fact, some popular sunscreen may contain harmful chemical components, such as oxybenzone, which can put the coral reef to death (Downs et al., 2021). However, it is impossible to advise people to stop using sunscreen as it is crucial to our skin health (Matthew and Wyatt, 2018). Now, scientist are looking for new approaches to reduce the pollution (Pandika, 2018; Downs, Cruz and Remengesau, 2022). As a high school student, my study aims to find the sunscreen products that people mostly consume, analyze their chemical components which may be hazardous and find factors that may influence the hierarchy of contamination, hopefully raising public awareness of sunscreen contamination and suggesting what people can do to reduce it.

Literature Review

List related research question that scholars proposed, what research methods they have used and what findings they have obtained,etc.

Sunscreen pollution can be a symptom of unsustainable tourism and coastal development, impacting marine and aquatic resources. When introduced into marine and freshwater ecosystems, sunscreen pollution can cause a cascade of insults to the ecological structure, from impacting primary production to reducing wildlife reproductive viability and fecundity. Without intervention, tourism and its associated development in these coastal areas may become self-destructive, ultimately degrading or destroying the natural resources that initially attract the tourists (Downs, Cruz and Remengesau, 2022). According to CasasBeltrán (2021), the second largest reef system globally, Mesoamerican Barrier Reef System, as well as inland aquatic ecosystems, are at risk of contamination due to the intensive use of sunscreen by the tourists in Mexican Caribbean.

These hazards are caused by the harmful chemical components that most sunscreen products contain. Matthew and Wyatt (2018) have found strong evidence that some sunscreen ingredients, especially oxybenzone, are harmful to corals if the concentration in water is high. They have noticed concentrations of these harmful ingredients far exceed the levels shown to be harmful to corals in some areas, primarily related to the number of swimmers and the geography of the shoreline. Researchers in Hawaii found evidences that oxybenzone could cause coral bleaching even at very low concentrations (Downs et al., 2021). According to Hansel (2022), oxybenzone-based sunscreens are increasing the mortality rates of stressed corals at present. And Graham (2022) even described sunscreen as a coral killer.

Besides, some ingredients may also be harmful to the fish. UV filters such as 4-methylbenzylidene camphor, oxybenzone, octocrylene, and octinoxate have been identified in various species of fish worldwide, which has possible consequences for the food chain (Samantha and Henry, 2019).

Moreover, it is concerned that the untreated sewage containing sunscreen would ultimately cause marine and aquatic pollution. According to Samantha and Henry (2019), UV filters such as oxybenzone, octocrylene, octinoxate, and ethylhexyl salicylate have been identified in almost all water sources around the world. The amount of these ingredients

would be significantly greater in beach spots. According to the estimation by CasasBeltrán’s team (2021), 229.76 tons of sunscreens are used annually in Mexican Caribbean areas. The harmful residues from these sunscreens are threatening the health of the marine and freshwater aquatic ecosystems as well as the local residents.

Unfortunately, not only the current techniques but also the current policies may not be of help to prevent sunscreen contamination. All these filters are not easily removed by common wastewater treatment plant techniques (Samantha and Henry, 2019). And the regulation and management of sunscreens are inconsistent at present. Most policies and legislation focused on the protected marine areas while little current focus is on the inland aquatic ecosystems (CasasBeltrán et al., 2021).

Though scientists have found strong evidence of sunscreen pollution, it is impossible to advise people to stop consuming and using it. As Matthew and Wyatt (2018) concerned, people cannot simply stop using sunscreen to avoid pollution because of the crucial role that sunscreen plays in preventing sunburns, photo-aging, and skin cancer. In fact, due to the increasing awareness regarding skin health, more and more people are using sunscreen products worldwide (Samantha and Henry, 2019).

Scientists are now looking for new approaches to reduce hazard. According to Downs, Cruz and Remengesau (2022), safer sunscreen products and a precautionary approach to governance, as well as ecologically and culturally cognizant branding and education, may contribute to effectively promotes environmentally sustainable tourism. As a case study, the Republic of Palau has already implemented a precautionary governance policy to tourism that conserves and protects its marine and aquatic resources from known harmful chemical components that contribute to sunscreen and cosmetic product. Moreover, researchers are also looking for photoprotective compounds derived from algae and other marine and aquatic organisms, with the hope of producing new sunscreens that are less hazardous (Pandika, 2018).

Methods

5.1 Research Framework

5.2 Research material and equipment

5.3 Research steps

The online questionnaire collecting public preference of sunscreen would be released through a questionnaire platform surveymonkey.com as well as put on two social platforms, thestudentroom.co.uk and Weibo.

Then the components of these most popular sunscreens would be searched, and past research on sunscreen contamination would be reviewed online.

There would be a qualitative experiment measuring the COD values and CDOM levels of sample solutions to show the hierarchy of contamination.

COD test: one of the most popular measurement of aquatic pollution (Kumar and Kumar, 2022)

CDOM level test: CDOM absorbs ultraviolet light and decomposes to release tannin, which lowers the pH of water and causes the water to turn murky, influencing the living environment for aquatic and marine organisms. The CDOM levels can be measured using electrical optical sensors that use fluorometers and sapphire lens. (Kumar and Kumar, 2022)

Materials: artificial saltwater (known concentration), three most popular sunscreen creams (marked as cream A/B/C) and three most popular sunscreen sprays (marked as spray D/E/F), among these, cream C and spray F are known as 'water-proof'.

Samples:

Group	500g saltwater with	The way to add
a	0.1g cream A	Put on clean hand and immediately soak the hand in saltwater for 15 seconds
b	0.1g cream B	Put on clean hand and immediately soak the hand in saltwater for 15 seconds
c	0.1g cream C	Put on clean hand and immediately soak the hand in saltwater for 15 seconds
d	0.1g spray D	Put on clean hand and immediately soak the hand in saltwater for 15 seconds
e	0.1g spray E	Put on clean hand and immediately soak the hand in saltwater for 15 seconds
f	0.1g spray F	Put on clean hand and immediately soak the hand in saltwater for 15 seconds
g	0.1g cream A	Put on clean hand and immediately soak the hand in saltwater for 1 minutes
h	0.1g cream A	Put on clean hand and immediately soak the hand in saltwater for 3 minutes
i	0.1g cream A	Put on clean hand, wait for 3 minutes, then soak the hand in saltwater for 1 minutes
j	0.1g cream A	Put on clean hand, wait for 9 minutes, then soak the hand in saltwater for 1 minutes
k	0.1g cream A	Put on clean hand, wait for 15 minutes, then soak the hand in saltwater for 1 minutes
l	0.1g spray D	Put on clean hand and immediately soak the hand in saltwater for 1 minutes

m	0.1g spray D	Put on clean hand and immediately soak the hand in saltwater for 3 minutes
n	0.1g spray D	Put on clean hand, wait for 3 minutes, then soak the hand in saltwater for 1 minutes
o	0.1g spray D	Put on clean hand, wait for 9 minutes, then soak the hand in saltwater for 1 minutes
p	0.1g spray D	Put on clean hand, wait for 15 minutes, then soak the hand in saltwater for 1 minutes

By comparing a-f, it is expected to be found the difference of hierarchy of contamination caused by different types and brands. Whether 'water-proof' sunscreen has less effect to water would also be found out.

By comparing a, g and h, and comparing d, l and m, it is expected to be found the correlation between duration of soaking and hierarchy of contamination.

By comparing g, i, j and k, and comparing l, n, o and p, it is expected to be found the correlation between the hierarchy of contamination and duration between putting on the sunscreen and soaking the skin in water.

Hypothesis

Anticipated outcome and value of the project

Certain organic and inorganic compounds that are harmful to the ocean are supposed to be found by searching for literature.

It is expected that some popular sunscreen products may contain components that are toxic to alga, fish or coral.

It is assumed that the particles of sunscreen spray are smaller than the particles of sunscreen cream. Thus, when putting the same amount of spray and cream on skin and soaking the skin in water, the spray may dissolve more and faster, therefore causing higher hierarchy of contamination (higher COD and CDOM value).

It is assumed that the 'water-proof' sunscreen would have less effect to water compared to those without the mark of 'water-proof'.

It is expected that the longer the skin with sunscreen soaks in water, the higher hierarchy of contamination (higher COD and CDOM value) would be caused.

It is assumed that the earlier the sunscreen is put on before soaking the skin in water, the lower hierarchy of contamination (shown by COD and CDOM value) would be caused.



Project Plan

- 2 days:** releasing the questionnaire and collecting public preference of sunscreen types and brands
- 5 days:** preparing the experiment material (artificial saltwater, the most popular sunscreens, beakers and tanks) and booking COD and CDOM tests (FuDa Technology Co.,Ltd.)
- 1 week:** performing the experiment, collecting and analysing the data
- 1 week:** discussing the results and suggesting possible ways to reduce sunscreen contamination, compiling the findings and writing a project report
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Reference

Protein Folding Structure Prediction using Reinforcement Learning with Application to 2D and 3D Environments

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Abstract

Proteins are critical for lives. They not only build 10%–35% of our body tissues, but also can be used to understand the structures of different viruses, and then help us to explore effective vaccines. Hence, predicting new protein structures is very important for human health. However, the structure of protein is complicated. Exploration using human experiments is cost-consuming. Recently, artificial intelligence (AI) technology, such as imitation learning and reinforcement learning (RL), has been rapidly developed and significantly improved the efficiency in many different domains. In this project, we will try to use RL to solve the protein folding structure prediction problem.

This study aimed to predict protein folding structure using reinforcement learning. First, we adopted the PH structure as a relatively simple representation of the protein structure, where different peptides can be categorized into two types: P(hydrophilic) and H(hydrophobic). The goal of the protein folding is to try to make more H pairs during the folding process. We then formulated the protein folding problem as a reinforcement learning process. If a new H pair is generated during folding, we collect −1 reward. Such RL reward is designed based on the protein dataset (Protein Data Bank). Finally, we implemented three RL algorithms: 1) Q-learning, 2) Deep Q-learning, and 3) Double Deep Q-learning (DDQN).

Background and Significance

As technology advances, scientists crave to reveal the basis of lives. As the fundamental building blocks of every living creature, proteins play a crucial role for lives. Proteins involve in a variety of tasks including building up tissues, enzymatic reactions, immune system, cell replication etc. Proteins are important for not only human being but also virus. For example, coronavirus, caused more than 500 million cases including 6 million deaths so far,

is an RNA virus coated with protein. The structure of a protein is the determinant of its function. Learning the structure of proteins in coronavirus can help investigate the functions of coronavirus, prognosis possible mutations, provide appropriate drug targets, and develop useful vaccines (WHO, 2022). In addition, the applications of protein structures also include genetic engineering, QSAR techniques, etc (Breda et al., 2007).

Literature Review

Recently, the usage of artificial intelligence has proven efficient in Protein Folding Problem. As the currently most advanced model, AlphaFold, has demonstrated a high accuracy in predicting protein structure. As presented in last year, AlphaFold was the first model that reached an accuracy close to experimental accuracy in most cases. In CASP14 assessment, AlphaFold structures had a median accuracy of 1.5 Å r.m.s.d.95 similar to the width of a carbon atom (1.4Å) which means AlphaFold could already predict most structures with the range of error of the width of a carbon atom.

As one of the most advanced algorithm, AlphaFold has proved the availability of artificial intelligence in protein structure prediction. However, AlphaFold architecture is only able to train using supervised learning with labelled data (Jumper et al., 2021, p.583–589).

RoseTTAFold is a fast and accurate protein structure prediction platform. When a protein sequence is inputted into, a deep neural network is used to generate the distance and orientations within the structure. Then, with the help of these information, the trRosetta will predict the 3D structure with the lowest energy. Currently, the trRosetta server has been one of the most popular website platform for protein structure prediction with over 60 thousand submissions and over 7 thousand users from more than 80 countries.



Biology & Medicine

To summarize, RoseTTaFold had the similar structure with AlphaFold which they both implemented a deep neural network to predict the inter-residue and then predict the structure based on the lowest possible energy. However, with the release of AlphaFold2 which implemented a novel attention-based neural network, the efficiency and accuracy of AlphaFold2 had surpassed RoseTTaFold (Du et al., 2021, p.5634–5641).

Tfold is an algorithm developed to predict RNA secondary structures. T-fold takes the primary protein structure as an input. Then, a set of sequences will then be used as the homologous sequences. T-fold will then pick a set of best sequences to predict the secondary structure of the target structure. Finally, T-fold will generate a set of possible structures for the user.

Tfold was tested on a bunch of RNAs. Its performance was compared with several other algorithms including Mfold, RNAalifold, etc. The result showed that Tfold was always one of the best performed algorithms (Engelen and Tahi, 2010, p.2453–2466).

FALCON@home is another protein structure prediction server. It mainly focuses on remote homologue identification (Wang et al., 2016, p462–464).

These approaches have solidly proved the efficiency of the application of artificial intelligence in Protein Folding Problem.

Problem Formulation and Methodology

Proteins include several levels of structures: 1) the primary structure of a protein can be transformed into a sequence of H nodes and P nodes in according to the hydrophilicity of each amino acid; 2) secondary and tietary structures are the folding of those sequence (Breda et al., 2007). In this work, we aim to predict such folding structures. During the folding process, the P nodes tend to interact with the environment consisting of polar components such as water molecules. The entropic effect drives the P nodes to locate on the surface with H nodes left in the interior (Gunther, Mobius, and Schreiber, 2017, p.639–649). Therefore, the HP protein structure prediction model explains the Protein Folding Protein as to connect as more H nodes that are not adjacent in the primary structure to each other as possible.

Q-learning

Q-learning is a model-free and value-based reinforcement

learning algorithm. Q-learning is an extension to the traditional value iteration. Q-learning computes the values of every (state, action) pair called \$Q-values\$. The \$Q-value\$ of a (s,a) pair is defined as the optimal value that can be reached by taking action \$a\$ at state \$s\$ and taking optimal actions afterwards.

Deep Q-learning

Q-learning is a great approach so far, however, when the State Space is large, it will be not feasible to store and compute all Q values. For this reason, the idea of Deep Q-learning came as a function approximator to predict the Q values for each state and action pair.

Double Deep Q-learning

Double Deep Q learning is a modified version of Deep Q learning. The major difference between Double Deep Q learning and Deep Q learning is that Double Deep Q learning utilizes two identical neural networks: \$Q\phi_1\$ and \$Q\phi_2\$ instead of only one neural network.

Hypothesis

Our hypothesis include:

- Yes, it is possible to design/ find new protein folding structures using RL approaches.
- Using RL to solve the protein folding exploration is more efficient compared to traditional human-based experiments.
- Using deeper network can help us further improve both the accuracy and efficiency.

Project Plan

Deep reading of reference paper, understand the main concept.

Change different network structures of the reference code and explore the training process.

Searching for public dataset for RNA and protein.

Run the changed code from the reference version, and debug to make it able to run

Experiment design:

- What experiments we will need to include?
- What to be changed in each experiment?

- What variables we need to measure in each experiment?
- What hypotheses we have for each experiment?

Run the experiments, and collect results.

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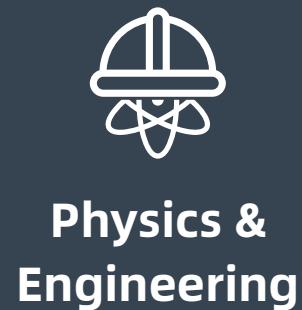
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Design of Intelligent Temperature Controlling and Automatic Turn on/off Energy-saving Electric Fan

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Abstract

2.1 What are the research questions?

At present, household electric fans only have a single function of turning off at the regulated time, and fail to meet different wind speed requirements with temperature changes. Not only does it waste electric energy, but also causes people to catch cold easily at night due to temperature drop. Therefore, this project aims to design an intelligent temperature controlling and automatic turning on/off for electric fans, to realize energy saving and improve people's comfortability.

2.2 What is the research design?

The system diagram was designed as shown in Figure 1. The AT89C51 microcomputer used as the core of the control structure. The algorithm was designed with C programming language.

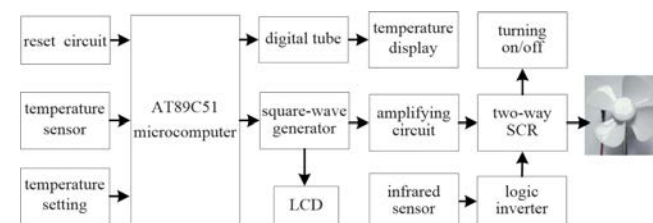


Figure 1. The system diagram of intelligent temperature controlling fan.

An intelligent temperature controlling system was built in this research using AT89C51 as a microcomputer. DS18B20 sensor is used to real-time measure ambient temperature, and then continually sent detected signals to the AT89C51 chip. By programmatically calculated, the control system output different duty ratio into square wave generator (SWG) which generates corresponding pulse-width modulation (PWM) wave to real-time regulate the revolving speed of motor.

Meanwhile, RCWL-0516 infrared pyroelectric sensor is

used to detect if there are any people around the fan. A bidirectional silicon controlling circuit is connected to the motor drive circuit to control on-off, and the gate is connected to the output of the infrared pyroelectric sensor. The motor circuit will be switched on only when people are close to it. The fan realized automatic turning on/off.

2.3 What are the expectations?

Through this project, intelligent temperature controlling will be achieved by real-time regulating speed of fan according to ambient temperature. Meanwhile, users can also manually set duty ratio through the manual adjustment key. Automatic mode or manual mode can be switched at will. Real-time duty ratio data are synchronously displayed on the LCD, so users are able to know the real-time speed conveniently and intuitively. Automatic turning on/off is realized. If a person is close to the fan, it will turn on automatically. Conversely, if a person leaves the fan, it will automatically turn off.

If ambient temperature is greater than 36 °C , microcomputer outputs 99% duty ratio. If ambient temperature is lower than 26 °C , microcomputer outputs 0% duty ratio to turn the motor off. If ambient temperature from 26 °C to 36 °C , then core algorithm of main program accurately calculates the optimal duty ratio according to functional relationship among four variables of real-time ambient temperature, set temperature, duty ratio and motor speed. The intelligent fan will achieve precisely adjust fan speed. Real-time temperature and duty ratio are display on the fan. The infrared pyroelectric sensor can accurately react within range of 1m.

Background & Significance

3.1 Reason for choosing the project

Beyond the immediate impact on health, the current crisis has major implications for global economies, energy uses

and CO₂ emissions. Global carbon emissions are set to jump by 1.5 billion tonnes in 2021 (Global Energy Review 2021).

Although numerous urban families install air-conditioning systems, rural areas where lives the majority of population in the globe still use electric fan to cool by high wind speed and large air flow (Wu T. B. et al. 2016). Household fans only has a single function of turning off at the regulated time so fail to meet different wind speed requirements with temperature changes. Users easily to catch cold in the night due to temperature drop. Meanwhile, it can't realize automatic turning on/off. Many people forget to turn the fan off when they leave. This has resulted in the increase of the electricity bill and 5-10% of electricity consumed is wasted (Kaiwen C. et al. 2016).

Therefore, it is necessary to develop a new intelligent energy-saving fan with temperature adjustable system consisting of automatic speed control, and automatic turning on/off by infrared pyroelectric sensor. This proposal will better achieve energy saving and improve comfortability for people.

3.2 Significance

This designed intelligent fan can automatically adjust motor speed from 26 °C to 36 °C with high precision. The infrared pyroelectric sensor can accurately and automatically turn on/off within the range of 1m. Each fan saves about 20% energy.

The population is more than 1.413 billion in China, and more than 500 million people live in rural areas. If three people use one fan in rural areas, there will be 170 million fans. The average power of each fan is about 50W, so the power consumption is about 1 kWh for 20 hours. This designed intelligent fan can save about 0.2 kWh electricity per day. China can save about 2.2 billion kWh in a summer, which is a staggering number.

Meanwhile, this designed fan also improves people's comfortability. It helps people to avoid catching cold due to temperature drop at night. The automatic mode or manual mode can be switched at will to set the duty ratio or adjust the temperature setpoint. Users have more choices. It is convenient for the old and children to use this fan.

Through innovating electric fan intelligent design, this proposal will contribute to save energy and improve sustainable development for human society and natural environment.

Literature Review

Traditional electric fan is used more mechanical approach to control. So, it can't according to environment temperature change timely adjustment motor speed. Sometimes user leave the room but fan is still operated because people forget to turn the fan off. Obviously, energy waste is serious in fan.

How to make an intelligent fan to save energy? More and more researchers devote to develop automatic fan. Dong C. X. (2014) introduced C8051 F005 MCU as energy-saving governor, using temperature and humidity sensor to test ambient temperature and humidity, to realization to fan for speed control. But there no test in his paper, so it can't reveal effect of saving energy.

Wu T. B. et al. (2016) designed an intelligent temperature-controlling, speed-regulating electric fan by using a temperature sensor DS18B20 and a non-contact measuring transducer for surface temperature. Speed of fan was set based on fuzzy expert rules. However, the fuzzy rationale isn't constantly exact. So, outcomes are dependent on suspicions and may not be generally acknowledged.

Mohebbi J. and Soleimani A. (2016) designed a neuro-fuzzy fan speed controller estimates the minimum required fan speed that holds the temperature close to the desired temperature with the aim of saving power. The test results demonstrate that the designed fan reduce the average of power consumption approximately 30% with increasing of average temperature by 9% (4.7 °C) compared to the traditional fan controller. Now and again, fuzzy control is neither stable nor precise because the fuzzy rationale is mistaken for likelihood hypothesis. They should take a true model and comprehend the working of this rationale.

Dai S. W. and Li Y. L. (2011) used AT89S52 SCM as a main controller and six modules to developed an intelligent temperature-controlled speed adjustable motor in radiator fan..In this paper, the infrared data receiving uses an infrared receiving head HS0038 which integrates with the functions of infrared receiving, data acquisition and decoding. As lack of infrared pyroelectric sensor, it can't realize automatic turn on/off.

Cui R. X. et al. (2013) designed a smart electric fan with PSoC as the main chip, to change the speed fast or slow, and adjust natural wind. The PSoC achieves many functions, like switch between manual control and temperature control, natural wind and other functions. This design is much more

valuable to develop smart home, but not has advantage in energy saving.

Keeratiburt K. (2018) used ESP8266 as a microcontroller, DHT22 and HC-SR04 are used to measure temperature for speed control and detect the user for automatic on/off respectively. But ultrasonic sensor detect human in one direction, so the fan easily turning OFF when users falling asleep. In his research, NodeMCU itself broke down very easily during the testing process. Meanwhile, there no test results to prove saving energy in his paper.

Ishrat T. et al. (2014) used ultrasonic sensor to detect human in one direction. If the object stays still within the infrared signal for a period of time, the sensor will understand that there is nothing within the range because there is no movement anymore. Therefore, the fan easy wrongly turn off during users falling asleep.

Mishra R. et al. (2013) used infrared signal to detect human in a museum. Using PIC16F887A as microcontroller, it was not described whether the fan continued to operate if a person is standing still or not in this paper. However, the prototype in this research is guaranteed to be working as long as a person is still there even when the person is sleeping.

Li J. W. and Cheng Y. M. (2020) taken STC89C51 as the core data processing module, design and implementation of voice-controlled intelligent fan system based on machine learning. In this research, KMSKNN and NaiveBayes algorithm used to realize speech recognition. The training set is obtained from the KMSKNN and NaiveBayes classification algorithm to get the template library. It is too complex easily to lead troublesome undertaking.

From the literature review, the outstanding difference in this research is core algorithm of main program precisely calculates the optimal duty ratio according to the function to achieve accurately adjust the motor speed. In this proposal, the results show there are more potential in intelligent, energy-saving, comfortability.

Methods

5.1 Research Framework

In this project, the equivalent circuit of the single-phase electric fan motor includes three components: resistance, inductance, and back voltage. According to the energy conservation and conversion law, the rotational kinetic

energy of electric fan can be expressed as (Shi Y.J. and Yu X.M. 2013):

$$\frac{dE_k}{dt} = P_m - P_{out} \quad (1)$$

where E_k is rotational kinetic energy of fan, constant P_{in} is input power, P_{out} is output power including wind energy and all kinds of energy losses.

The output power model is approximately a linear function as follow:

$$P_{out} = P_{out}(E_k) \approx c_0 + c_1 E_k \quad (2)$$

where C_0 and C_1 are coefficients of linear equation, respectively, which are determined by the structure of electric fan.

Thus, combining equation (1) with equation (2), rotational kinetic energy of fan can be written as:

$$\frac{dE_k}{dt} = P_m - (c_0 + c_1 E_k) \quad (3)$$

Meanwhile, equation (1) can be rewritten as:

$$\int_0^{E_k} \frac{-c_1 dE_k}{(P_m - c_0) - c_1 E_k} = \int_0^t -c_1 dt \quad (4)$$

According integro-differential theory, equation (4) can be rewritten as

$$\ln \frac{(P_m - c_0) - c_1 E_k}{(P_m - c_0)} = -c_1 t \quad (5)$$

Thus, rotational kinetic energy E_k can be expressed as:

$$E_k = \frac{(P_m - c_0)}{c_1} (1 - e^{-c_1 t}) \quad (6)$$

According to the blade rotates fixed on the axis, so rotational energy of the blade equal to the sum of kinetic energies of particles, i.e

$$E_k = \sum_i \frac{1}{2} m_i v_i^2 = \frac{1}{2} \left(\sum_i m_i r_i^2 \right) \omega^2 = \frac{1}{2} J \omega^2 \quad (7)$$

where J is moment of inertia of blade, and $J = \sum_i m_i r_i^2$

J is constant which is determined by the electric fan.

Equation (7) indicates that energy consumption of fan is proportional to square of the rotation speed. Faster rotational speed is greater energy consumption. Conversely, slower rotational speed is lower energy consumption.

Therefore, this proposal devotes intelligent temperature controlling to real-time regulate the revolving speed of motor to achieve energy saving.

5.2 Research material and equipment

System hardware design and constructed needs components as: PCB electric board, AT89C51 microcomputer, power switch, temperature sensor, display digital tube, square wave generator, LCD, adjust buttons, two-way SCR, infrared pyroelectric sensor, temperature set button.

System software and algorithm was designed using C programming language. So, C language software was downloaded and installed in my computer.

In the experimental test process, the signal of output duty ratio and rotational speed were acquired using NI data acquisition equipment, which is borrowed from one lab. The experimental results analysis and interpretation were finished by using the data analysis tools in Excel.

5.3 Research steps

5.3.1 System hardware design

The intelligent system consists of three main logical hardware parts, the intelligent temperature controlling

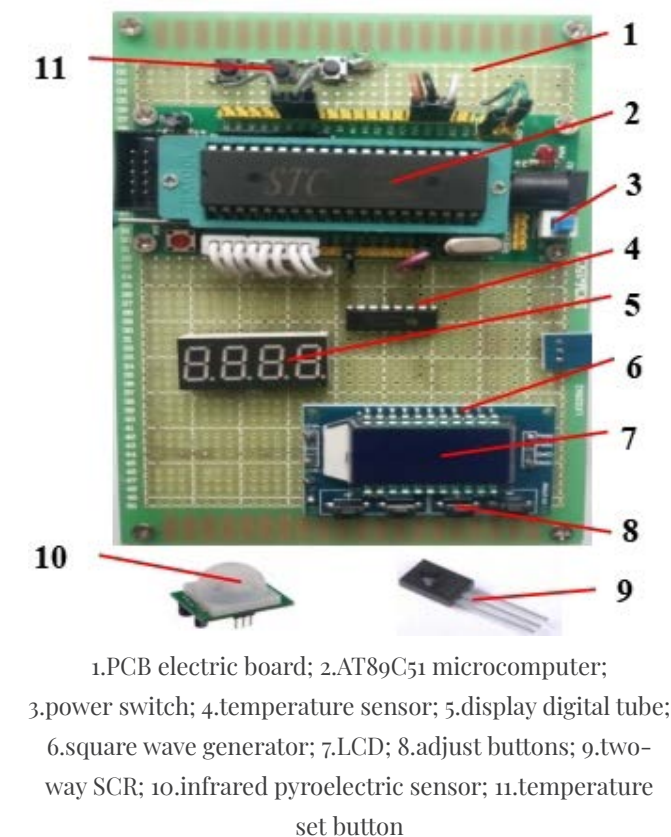


Figure 2. The system hardware structure.

module, speed regulating of motor module, automatic turning on/off module. The hardware structure is shown in Figure 2. All the hardware components were layout designed in PCB.

The new intelligent temperature-controlling built with an AT89C51 microcomputer, power switch, temperature sensor, display digital tube, square wave generator, LCD, adjust buttons, two-way SCR, infrared pyroelectric sensor and temperature set button.

The AT89C51 is an 8-bit microcomputer., which are respectively connected to temperature sensor, square wave generator and infrared pyroelectric sensor. The AT89C51 reads the real-time data from the temperature sensor, and compares it to the setpoint. Based on ambient real-time temperature, the duty ratio of PWM is calculated by program. The processed duty ratio displays on LED and will be synchronously input to the square wave generator, which generates the corresponding duty ratio PWM wave to real-time regulate the revolving speed of motor in different temperature range, achieving energy saving.

Infrared pyroelectric sensor is used to detect if there are people around the fan, which contains two adjustable potentiometers. When people close to the sensor, the output end of the sensor is high level. A bidirectional silicon controlling circuit is connected to the motor drive circuit to control on-off, and the gate is connected to the output of the infrared pyroelectric sensor. The motor circuit will be switched on only when people are close to it. The fan realized automatic turning on/off.

5.3.2 System software design

In this design, all the program codes were used programming language C. Figure 3 shows the main program flow chart. Each module will be initialized.

Temperature reading and display, intelligent temperature controlling and motor speed regulated are achieved by main program. First, the user sets the temperature range. If K1 put, lower limit of temperature will plus 1. If K3 put, maximum temperature will plus 1. If K2 put, temperature sensor measures ambient temperature and deliver into AT89C51 microcomputer. The real-time duty ratio of PWM wave was calculated by program, and sent it to the square wave generator. The PWM wave output by the square wave generator drives the motor through the amplifier circuit to regulate speed of fan. This project will contribute to save energy and improve comfort level of fan.

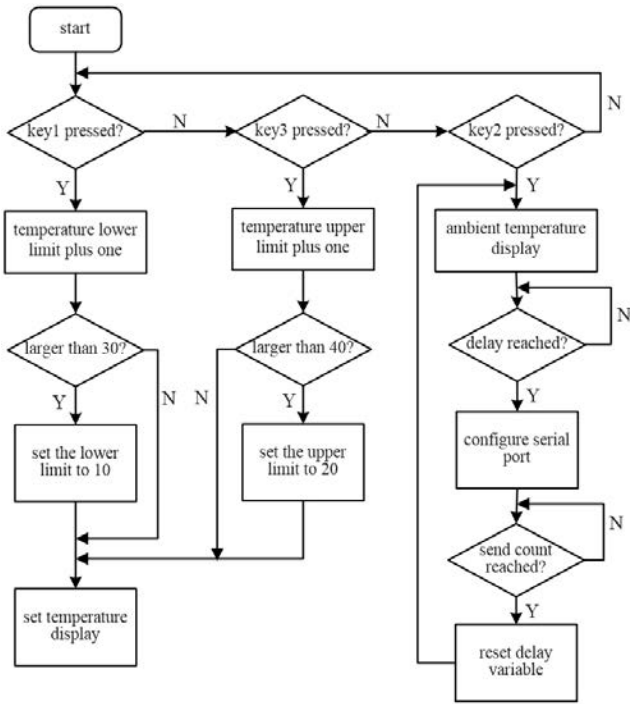


Figure 3. The main program flow chart.

5.3.3 Duty ratio calculation

The flow chart of duty ratio calculation is shown in Figure 4.

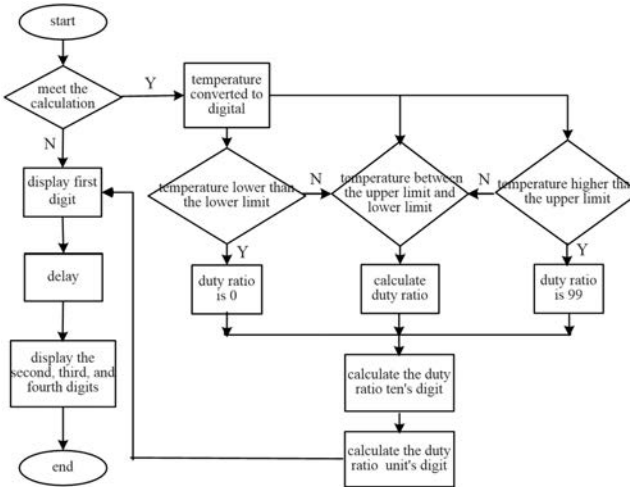


Figure 4. Duty ratio calculation flow chart.

By programmatically calculated, the AT89C51 microcomputer output different duty ratio of PWM wave to real-time regulate the revolving speed of motor. If ambient temperature is greater than the setpoint, then the SWG outputs PWM wave with 99% duty ratio to drive motor revolves rapidly. If ambient temperature is lower than the setpoint, then the SWG outputs PWM wave with 0% duty ratio to turn motor off. If ambient temperature is between the setpoint then the core algorithm of main program accurately calculates optimal duty ratio according to the functional relationship among four variables of real-time ambient temperature, set temperature, duty ratio

and motor speed. The functional relationship is obtained through experiments in 5.3.4 section. Thus, ambient temperature accurately adjusted by regulating the speed of motor, and achieving energy saving.

5.3.4 Experimental test

Experimental test was achieved in a room. The ambient temperature was changed from 26℃ to 36℃. The aim, the program setpoint of temperature was 23℃. DS18B20 sensor was used to measure ambient temperature. The experimental results of ambient temperature, duty ratio and motor speed are shown in Table 1. Duty ratio D% and

Ambient temperature (°C)	Setpoint (°C)	Duty ratio %	Motor speed r/min
35.92	23	76	1182
35.75	23	75	1169
35.58	23	74	1162
35.41	23	73	1149
35.24	23	72	1143
35.07	23	71	1130
34.9	23	70	1123
34.73	23	69	1110
34.56	23	68	1097
34.39	23	67	1091
34.22	23	66	1084
34.05	23	65	1071
33.88	23	64	1062
33.71	23	63	1052
33.54	23	62	1042
33.37	23	61	1032
33.2	23	60	1019
33.03	23	59	1006
32.86	23	58	994
32.69	23	57	987
32.52	23	56	968
32.35	23	55	955
32.18	23	54	935
32.01	23	53	922
31.84	23	52	916
31.67	23	51	903
31.5	23	50	883
31.33	23	49	864
31.16	23	48	844
30.99	23	47	831
30.82	23	46	818
30.65	23	45	805
30.48	23	44	773
30.31	23	43	760
30.14	23	42	747
29.97	23	41	727
29.8	23	40	708
29.63	23	39	688
29.46	23	38	662
29.29	23	37	649
29.12	23	36	617
28.95	23	35	604
28.78	23	34	571
28.61	23	33	552
28.44	23	32	519
28.27	23	31	494
28.1	23	30	468
27.93	23	29	442
27.76	23	28	416
27.59	23	27	396
27.42	23	26	364
27.25	23	25	344
27.08	23	24	318
26.91	23	23	286
26.74	23	22	253
26.57	23	21	240
26.4	23	20	214
26.23	23	19	175
26.06	23	18	136

Table 1. The experimental results of ambient temperature, duty ratio and motor speed.

motor speed ω are trunks, respectively. The results show that if ambient temperature increases, then the fan speed increases. Otherwise, if ambient temperature drops, then fan speed automatically decreases.

Figure 5 shows the relationship between duty ratio and ambient temperature approximate to nonlinear function as $D=0.0001T^4 - 0.01857T^3 + 0.8584T^2 - 11.75T$, where D% is duty ratio, T is ambient temperature, the curve fitting correlation coefficient R^2 approximate to 1. As shown in Figure 5, the results indicate duty ratio D% nonlinear adjust from 76% to 18% when ambient temperature change from 35.92℃ to 26.06℃.

Similarly, Figure 6 indicates the relationship between motor speed and duty ratio. The relationship approximates to nonlinear function as $\omega = 0.0001D^4 - 0.0274D^3 + 1.5785D^2 - 11.177D$, where D% is duty ratio, ω is motor speed r/min, the curve fitting correlation coefficient R^2 approximate to 0.9994.

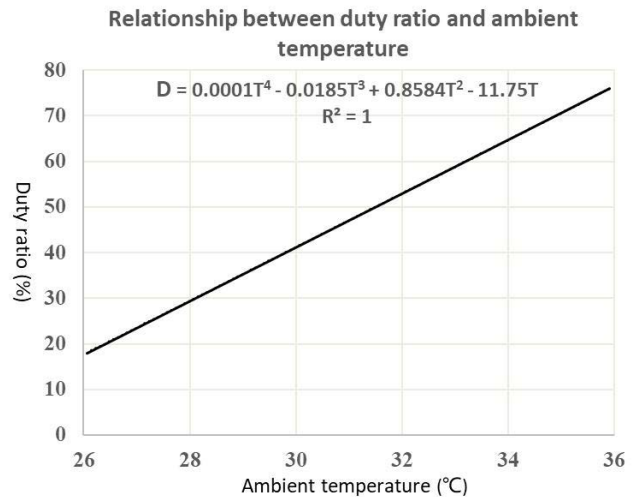


Figure 5. Relationship between duty ratio and ambient temperature.

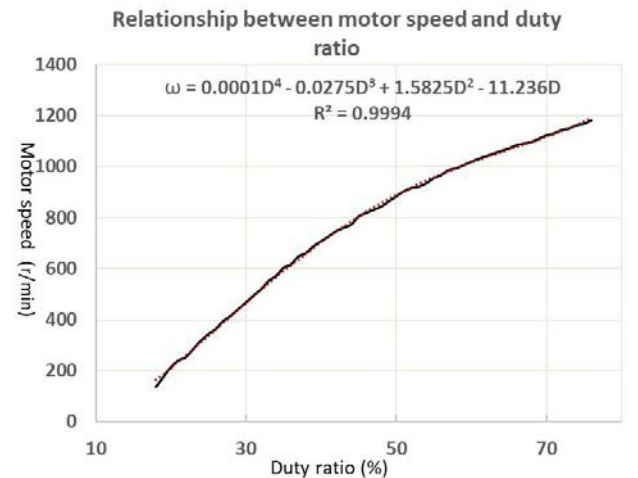


Figure 6. Relationship between motor speed and duty ratio.

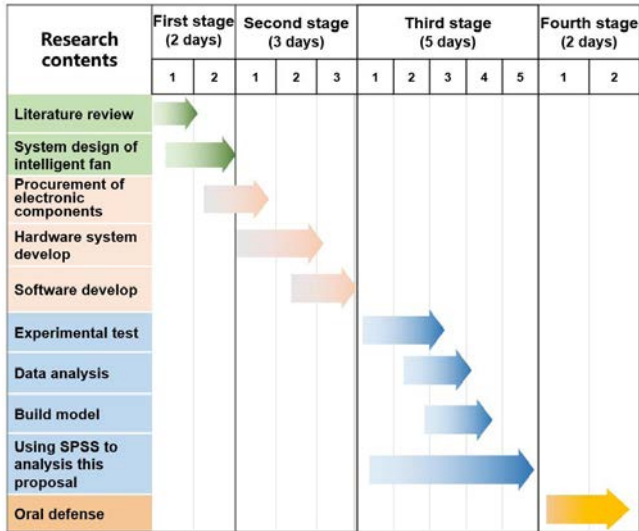
Hypothesis

In terms of hypotheses, we firstly expect that the proposal applied to our life. For example, power consumption of 50W-fan is about 1 KWH for 20 hours. If using this designed intelligent fan can save about 0.2 KWH electricity per day.

Secondly, we expect to cooperate with enterprises and put the design into production, through mass produce to reduce the cost. The population is more than 1.413 billion in China, and more than 500 million people live in rural areas. If three people use one fan in rural areas, there will be 170 million fans. China can save about 2.2 billion KWH in a summer.

Thirdly, we expect that the design thinking is to be improved and applied to other household electrics or plant equipment. China is the world's largest consumer of electricity, using over 5.934 trillion kWh in 2017. People apply intelligence to realize saving energy, improve sustainable development for human society and natural environment.

Project Plan



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The Future Expectation of China's "Double Carbon Goal" from a Mathematical Perspective.

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Mathematics
& Computer
Science

Abstract

In this research, three questions will be fully considered:

1. What does the "Double Carbon Goal" actually mean?
2. How do these factors relate to reaching targets?
3. What are the future expectations of the "Double Carbon Goal"?

This research is designed to use a mixed method to combine qualitative and quantitative statements together, to reach a final result. Pieces of literature will be analyzed and evaluated to conclude the current situation; found factors are going to be tested to find out whether it's closely related to the targets; mathematical models also will be applied to plenty of data to construct predictions.

Background & Significance

Nowadays, environmental issues are becoming increasingly critical for not only poor countries, but obviously all nations. Increased statistics are published to warn governments and all of the humankind about the urgency of paying high attention and effort to this problem. China functions as the world's largest emitter of CO₂, which weighs 30% worldwide(Liu, Li, and Wang, 2021), facing the most crucial situation and goals when trying to reach a carbon peak in 2030 and carbon neutrality in 2060(Yu & Wang, 2022).

This research can offer a reliable conclusion towards China's "double carbon" targets, based on authorized mathematical models, results are like whether it's feasible to reach or further effort is needed. By investigating these, it could be helpful to the final result of the control of carbon emissions. As a result, China can make its own contribution to the work of alleviating climate change and global warming worldwide. And China's plan will also serve as a model for those countries that are also in the stage of economic development.

Literature Review

3.1 The Current Situation in China

First, China is still the world's largest emitter, releasing over 9.8 billion carbons. Carbon emission per unit GDP is 0.69kg, 1.77 times the world average(Jiao, 2021).

Jiao (2021) mentioned that 'In 2019, China's carbon dioxide emissions per unit of GDP were reduced by about 18.2% and 48.1% from 2015 and 2005 levels respectively. This has exceeded China's international commitment to a 40-45 percent reduction by 2020 and basically reversed the rapid growth of greenhouse gas emissions.'

China's carbon financial market opened on July 16th, 2021, it's the largest carbon market all over the world, the primary aims are to offer enough incentives and funds for public and private firms to reduce their carbon emissions, this market was highly anticipated at the very beginning phase.

However, this system has many problems that need to be solved properly for its good operation in the future. To deal with them, the Chinese government needs to clarify the definition of carbon finance further, increase the total allocation of financial resources, continuously optimize the structure of the carbon financial system, and develop diversified and personalized carbon financial products. (Lu, 2021).

3.2 Challenges

To begin with, Zhuang (2021) deems that our country's industries with high input, high energy consumption, and high pollution but low efficiency are occupying a relatively high proportion. It needs an extensive and profound social and economic change that will indeed affect everyone's life. Industries that use clean energy should be further praised and subsidies should be given to avoid any possible popular trend of using traditional resources.

Secondly, the remaining time is also tight. We only have 30 years from carbon peak to carbon neutrality. However, it took 71 years for the European Union to reach carbon neutrality, and 43 years for the United States for their carbon peaks respectively. In addition, developed countries such as Europe countries and the United States both chose to begin their carbon transition after their countries' per capita GDP reached \$20,000. That means when they transited from carbon peak to carbon neutrality, they had decoupled economic development from carbon emissions, with applied less pressure on all aspects of the country. China, however, is still a developing country, which leads to a new dilemma about how to balance economic development and carbon targets(Liu, Li, and Wang, 2021).

3.3 Opportunities

Even though we are facing many obstacles on the way to being carbon neutral, this may also provide possible opportunities to bring society new vitality. It may offer an equal position for China compared with some other developed countries, and let China has the ability to actively change its composition of energy, industry, and also social attitudes. (Bai, Lu, and Li, 2021).

Furthermore, it can bring us a new creative business mode. During the process of being carbon neutral, the application of new technologies such as big data, blockchain, and artificial intelligence has driven the rapid green development of the digital economy and may bring inspiration to new development (Fu & Meng, 2021).

Methodology

I would like to gather a variety of data and visualize them in charts. These charts can provide a basic relationship between factors and targets. Then, using these data to apply correlation tests to analyze their correlation with the target reach which is the number of carbon emissions. Are those factors indeed affecting the ultimate consequences of the "double carbon" target? Doing this process can effectively show the result of the third question.

The primary purpose of using the covariance test for the testing factor and quantity of carbon emission is to find out what are the most decisive factors while affecting whether we could finish the plan to reach carbon neutrality in 2060.

Furthermore, a multivariable linear regression will be conducted to predict the future trends, and I would like to choose those influential factors obtained in the covariance

test to form the function and do further calculations later. This could be efficient and effective to answer question 2 and telling whether our current effort is enough. This regression method is able to take several factors into the consideration at the same time, which could offer us a more comprehensive view of China's "Double Carbon" targets.

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Evaluating Which of the Three Fibres Used in Composites is More Suitable to Reduce the Weight of Electric Vehicles

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Abstract

Since one of the biggest causes of global warming is carbon emission by transport, society is promoting electric vehicles to achieve cleaner transportation (Canals Casals et al., 2016). This research aims to evaluate which of the three materials (flax fibre, carbon fibre, and innegra) is more suitable to reduce the weight of electric vehicles. This study qualitatively analyses the problem through principles concluded by previous researchers and quantitatively contrasts how using different materials to produce the frames may affect six qualities of the electric vehicle. This study expects to conquer the weight problem in electric vehicles and find out which composite is more suitable for specific situations. The ultimate goal is to promote electric vehicles and thus reduce carbon emissions.

Literature Review

Part 1. The Weight Issue of Electric Vehicles

Producers need to reduce the overall weight of electric vehicles to increase range. Electric vehicles are heavy because lithium batteries have a low specific energy of only 0.5MJ/kg, while gasoline is 45.8MJ/kg (Rodrigue, 2020). Thus, to supply enough energy, producers use larger batteries, making the weight of electric vehicles about 300kg heavier than gasoline vehicles. Building the frame with new materials is a possible way to reduce weight.

Part 2. Different Types of Fibres

Carbon fibre is a kind of synthetic fibre known for its lightness and strength. The density of carbon fibre is about 1.75-1.93 g/cc (Gulgunje et al., 2015), way lower than that of steel (7.85 g/cm3). Filaments in carbon fibre typically have a diameter of 5-8 μm and form rows with more than 5000 of them (Hollaway, 2010), so carbon fibre is very strong. Thus, carbon fibre reinforced composite is an appreciable material for building frames. Companies like Tesla had

already utilized it for over a decade. However, the cost of carbon fibre is very high, and it has poor resistance to impacts.

Flax fibre is a kind of natural fibre. It is well-liked for environmental factors, good damping behaviour, lightness, and cost-effectiveness (More, 2022). European car manufacturers have been using it in the production of door panels, headliners, and package trays for several years (Holbery and Houston, 2006). Also, company Bcomp applied its flax fibre reinforcement fabric ampliTex and powerRibs on Porsche 718 Cayman GT4 racing car's interior (Porsche, 2022) recently, and that worked well. However, flax fibre composite is not widely used, because the surface treatment is relatively complicated and it's weaker compared to carbon fibre.

Innegra is a kind of synthetic fibre created by the company Innegra Technologies. Since Innegra is new and not that popular, using innegra composites to build vehicle frames is a relatively innovative approach. This research sees potential in it because it's the lightest commercial fibre available, with a density of 0.84g/cc (Zande, 2019). This can significantly reduce the weight of electric vehicles. Moreover, innegra has a high impact resistance compared to carbon fibre.

Research Principle

(This experiment is not actually performed due to the limit of materials.)

All composites used in this research are polymer-matrix composites, and the matrix is epoxy resin. It will combine with fibre, which acts as a reinforcement. To limit the cost, this research will make the composites into laminates and test their properties.

Research Framework



Chemistry

Part 1. Variables

- Independent Variables: laminate’s fibre type (carbon fibre, flax fibre, innegra)
- Dependent Variables and Their Significance:
 - Weight: Lower weight makes energy usage more effective.
 - Stiffness: Stiff vehicles can endure loads and possible crashes.
 - Flexural Loads: Flexural load shows safety.
 - Failure Mode: It reveals how the vehicle will behave after accidents.
 - Sustainability: This study aims to limit pollution.
 - Cost: This is important to achieve commercial successes.
- Controlled Variables: laminates sizes, the orientation of fibre, amount of fibre in composite, resin type, process method that combines resin and fibre

Part 2. Methods

- Weight will be measured through the mass balance.
- Stiffness, Flexural Loads, and Failure Mode:
 - First, the laminates will be made using the wet layup method.

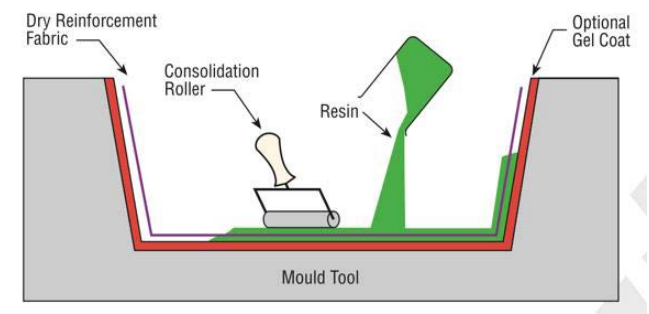


Fig.1 Wet Layup (Gurit Guild to Composites)

- Then, this study will perform a three-point bend test. The machine will apply a force on the laminate, causing it to bent and finally break. The study will record the deformation in percentage as force is exerted and when the specimen break.
- Conduct a graph (deformation vs stress) using excel based on the data. Steeper slopes indicate greater stiffness. The maximum stress laminates



Fig. 2 Three-Point Bend Test (Instron)

can endure before cracking is the flexural load. The trend after the flexural load indicates the failure mode. The following graph should be filled after the experiment.

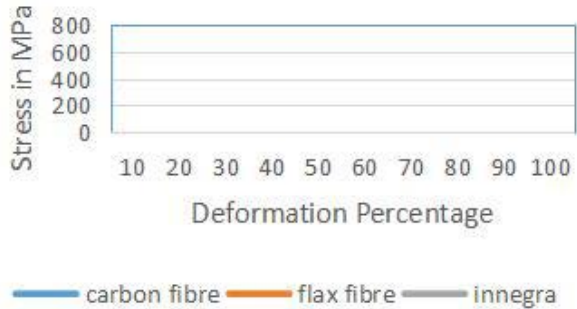


Fig. 3 Deformation Percentage of Laminates as Stress is Applied

- Sustainability will be analysed qualitatively through the source of fibres and the manufacturing process.
- The cost of each type of fibre in its top five brands will be used to calculate the average cost.

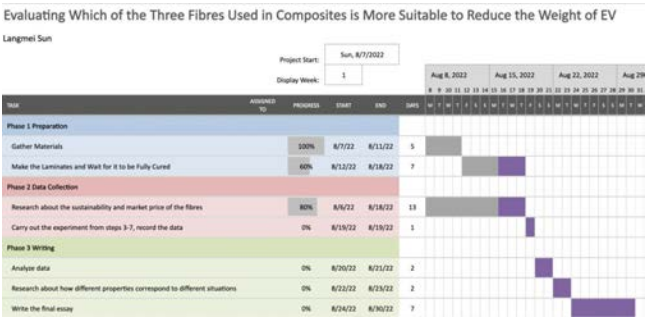
Part 3. Research Materials and Equipment

- 0.2L epoxy resin
- 50cm³ of carbon fibre, flax fibre, and innegra in woven fabric form.
- Nine mould tools (10cm*3cm*0.5cm)
- Three consolidation rollers
- One 50mL beaker
- One Mass balance
- One universal testing machine with a three-point fixture
- Excel

Part 4. Experiment Procedures

- Make 3 laminates using moulds, resin, and rollers for each type of fibres.
- Measure each of their weight.
- Put one laminate on the universal testing machine to test and record the flexural load and failure mode.
- Repeat step 3 for 9 times using different laminates.
- Conduct the deformation vs stress graph to get the stiffness.
- Research about the sustainability and cost of these composites.
- Summarize data and description into a chart.

Project Plan



Future Improvements

The adhesiveness of resin to fibres and the stiffness of resin are important in judging the stiffness of the composite (Gurit Guild to Composites). Considering that different types of fibre may be more adapted to different types of resin, future research could be conducted on choosing different resins for fibres to provide a more comprehensive evaluation.

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A study of algorithmic bias and how it affects our society

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Mathematics & Computer Science

Abstract

This study aims to analyse and understand the origins of algorithmic bias, and its implications onto society in various areas. The study would be based mostly qualitative research, but also some quantitative research from algorithms and models used in real life that has impacted society. The ultimate goal of this study is to provide a deeper understanding of the concept of algorithmic bias, and also hypothesise ways to prevent it from evolving into a medium of discrimination.

Background & Significance

As technology and science advances, traces of technology can be seen almost everywhere in our society. Its prevalence has reached the extent to which all of us take our mobile phones, TVs and computers for granted and never think too much about it. This carelessness also extends to algorithms such as facial recognition and artificial intelligence, leading to people placing excessive trust and faith into these algorithms: a recent study showed that people are more inclined to rely on an algorithm instead of people (Bogert, Schechter, Watson, 2021). This influence has impacted other areas of society as well, including but not limited to education, health systems, the internet and much more.

Literature Review

Algorithm bias is the mimicry and exaggeration of bias that exist in the real world by AI systems and algorithms. An example of algorithm bias would be search engines. A google search displays an exaggeration of existing bias, preferring to display female nurses and male programmers. Data is merely a reflection of existing bias.

Secondly, machine learning requires lots of data for training, and sometimes the data may not be adequate for certain classes to arrive at a useful conclusion. Therefore,

the algorithm's results are heavily biased towards the small amount of training data given.

Thirdly, some qualitative data cannot be easily quantified, and therefore are difficult to introduce to an algorithm, so shortcuts are used to simplify the data, which introduces bias.

Fourthly, a positive feedback loop enhances the bias in the algorithm. The output for some specific data would be fed back into the algorithm, which would cause the algorithm to favour the same output for similar data.

And lastly, algorithmic systems are vulnerable to malicious attempts of manipulations. By introducing enough biased data sets, the system would start favouring these biased data sets and be manipulated.

Joy Buolamwini is a software engineer who found out that facial recognition software could not recognise her face, due to a lack in variety of skin tones and facial structures given to the algorithm as training data, so the algorithm would be biased and be unable to recognise certain faces. Machine intelligence are susceptible to blocking out a class of people with specific traits in the long run, which contradicts with the original goal of an unbiased, rationalised prediction (Tufekci, 2016). Bias is also difficult to remove after implementation. After skewed data enters the training data of machine systems, they are used to change an algorithm's prediction, and it is very difficult to remove (Hauser, 2017)

The study mentioned in the introduction suggests that people have increased appreciation with difficult intellectual tasks, which show an increased reliance on computers instead of humans (Bogert, Schechter, Watson, 2021). Another study found evidence within literature review to show that data analytics and AI systems are very biased, or even discriminatory to specific individuals, originating from training data containing existing prejudices. (Kordzadeh, Ghasemaghaei, 2021). AI systems used in education are also

vulnerable to such bias, as "fairness" is a quality that is both vague and impossible to quantify. So, no system can be completely fair with respect to essay scoring and predicting students' success in college applications (Kizilcec, Lee, 2021).

Methods

The primary method of information gathering for this study is through researching secondary data through the internet in the form of research papers, talks and lectures given by experts in the field and videos. Most of the data is useful, as they can all lead to effective and interesting conclusions about the implications and origins of algorithmic bias. The reliability of the secondary data is also not an issue, as the sources for all the data are of high authority. The purpose of data collected in these studies are for investigating algorithmic bias, and to inform the general public about their findings, which makes secondary data suitable.

Hypothesis

This study hypothesises an incline for people to prefer algorithmic suggestions over human/crowd advice. This study also expects people to be unaware of social implications of such bias, to the extent of trusting unfair judgments by these algorithms.

Project Plan

Phase 1: confirm specific topic.

Phase 2: data collection, by finding research paper, videos, talks and websites (3–5 days)

Phase 3: data analysis

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Effect of Bifidobacterium longum on core symptoms in children with autism

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Biology & Medicine

Abstract

Autism in children, first reported and named by American psychiatrist Kanner in 1943, is a mental developmental disorder characterized by impaired social interaction, impaired verbal communication, repetitive stereotyped behaviors, and narrow interests. In recent years, the global incidence of autism in children has been increasing dramatically, and the incidence of autism in China is also rising rapidly. The absolute number of autistic patients is increasing and poses a serious social problem. The etiology and pathogenesis of autism are not yet clear, and most scholars believe that it is the result of a combination of genetic and environmental factors. It has been found that autistic patients have prominent gastrointestinal symptoms and altered intestinal microorganisms, and it is speculated that intestinal flora has some association with gastrointestinal symptoms in autistic patients, and probiotics may have some therapeutic effect. Bifidobacterium longum is one of the important probiotics known to contribute to a healthy gut by modulating the intestinal surface, blocking pathogenic bacteria adhesion, and improving the mask barrier function, as well as having beneficial effects on the improvement of host mental health and maintenance of psychological balance and brain learning and memory functions. In this study, 60 young children aged 2–6 years diagnosed with autism were selected to participate in a randomized double-blind trial of Bifidobacterium longum for four consecutive weeks. All enrolled children were assessed before and after the experiment using the Gesell scale and WPPSI for children with ASD to understand the pre- and post-changes in core symptoms of autism, to explore individualized intervention programs for children with autism, and to provide a valid biological basis for nutritional intervention in autism.

Research background and significance

Autism Spectrum Disorder (ASD) is a pervasive

developmental-behavioral disorder of childhood that is characterized by impaired language development, impaired social communication, narrow interests, and stereotypic behavior. Some children show symptoms of autism from 6 to 24 months of age, while others develop normally in the early stages of development and then show regressive changes and loss of language and social skills by 2–3 years of age. 2020 latest Centers for Disease Control and Prevention reported the prevalence of ASD as 1 in 45 in the United States, (2.8–30.4) per 10,000 in mainland China, and (7.3–30.4) per 10,000 in Hong Kong and Taiwan. The absolute number of children with ASD is increasing and poses a serious social problem. 38% of children with autism cannot live independently and require lifelong care, creating a heavy burden on families and society.

The etiology and pathogenesis of autism are not yet clear, and most scholars believe that it is the result of a combination of genetic and environmental factors. Currently, the identified monogenic genetic disorders with autism include fragile X syndrome, Rett syndrome, Angelman syndrome, and tuberous sclerosis, all of which have causative genes associated with autism. Molecular genetic studies have also yielded a series of loci and candidate genes associated with autism. Nevertheless, only 6–15% of ASD cases can be identified with a causative genetic factor, so its development may also be associated with viral infections, immune abnormalities, and metabolic disorders at the same time.

Cognitive and behavioral abnormalities in ASD are thought to be due to central nervous system dysfunction; however, in addition to this, patients with ASD still exhibit many non-central nervous system physiological abnormalities, i.e., in addition to the symptom spectrum indicated by the diagnostic criteria, patients with ASD also exhibit a variety of comorbidities, of which partial eating, picky eating, and a narrow food spectrum are common manifestations of autism. The incidence of gastrointestinal symptoms

in children with ASD is 60–80%, and common symptoms include constipation, diarrhea, bloating, abdominal cramps, and gastroesophageal reflux. The common symptoms include constipation, diarrhea, bloating, abdominal cramps, and GERD. Studies suggest that there is an association between gastrointestinal problems and the manifestation of symptoms in children with ASD. For children with ASD, those with frequent abdominal pain, bloating, diarrhea, constipation, or painful bowel movements scored worse in irritability, social withdrawal, stereotypic behavior, and hyperactivity compared to children without corresponding gastrointestinal symptoms. Alterations in gastrointestinal physiology and diet can affect gut microbes. It has been found that the gut microbes of autistic patients are altered, mainly in the form of translocation of intestinal bacteria and a significant increase in the variety and number of anaerobic Clostridium perfringens, which can cause not only imbalance in gastrointestinal tract function but also release toxins.

Children with ASD autism have poor social adaptation, self-care, and verbal and non-verbal communication skills, and some even cannot return to society for life, which is a heavy burden to individuals, families, and society. Therefore, clarifying the pathogenesis of ASD and exploring intervention modalities to alleviate core symptoms and concomitant symptoms are urgent issues. Existing studies have found that there is an association between gastrointestinal problems and symptom expression in children with ASD, and the alteration of gastrointestinal physiology and diet will affect the intestinal microorganisms, causing the alteration of intestinal microorganisms in ASD patients. It is speculated that probiotics may have a role in alleviating core symptoms and concomitant symptoms in ASD patients, but there are more phenotypes of autism, and the relationship between different phenotypes and intestinal flora and intestinal phenotypes is not clear, and different The relationship between the gastrointestinal symptoms and the behavioral characteristics and genotypic characteristics of ASD, as well as the neurobiological mechanism of the gut-brain connection, is also unclear, which hinders the in-depth study of probiotic intervention therapy for ASD. Therefore, to explore the relationship between different phenotypes of autism and the intestinal flora and intestinal phenotypes, as well as between different intestinal symptoms and the behavioral characteristics and genotypic characteristics of ASD, to provide a basis for the intervention probiotic strain selection and dose of the intervention probiotic.

Literature Review

Analysis of domestic and international research status and development trend.

Studies have found that the intestinal microorganisms of autistic patients are altered, mainly in the form of intestinal bacterial translocation, with a significant increase in the species and number of anaerobic Clostridium tetani, and mostly pathogenic bacteria of such microorganisms, such as Clostridium difficile and C. tetani, releasing toxins and causing a functional imbalance in the gastrointestinal tract. It has been suggested that autism may be due to long-term subacute C. tetani infection, and that neurotoxins released after gastrointestinal infection with C. tetani are transmitted to the CNS through the vagus nerve, inhibiting the release of neurotransmitters and thus causing various behavioral manifestations of autism, and that anti-clostridium intestinal treatment may reduce the symptoms of autism. One study also found that metabolites of gut microbes, such as propionic acid, caused autism in rats. These findings suggest an alteration in the intestinal flora of autistic patients, particularly in the Clostridium species. Whether gut microbes cause autism or autism causes alterations in gut flora is always a matter of controversy. Probiotics, on the other hand, promote the balance of the intestinal flora, inhibit the growth of Clostridium difficile, and reduce the toxic substances produced by harmful bacteria. In a recent study, researchers treated a mouse model with both autism and intestinal dysfunction with the commonly used probiotic B. fragilis, which not only normalized the intestinal wall with increased permeability but also altered autistic behaviors in the mice, such as reduced anxiety and repetitive stereotyped behaviors. This result suggests that gastrointestinal problems can indeed trigger some of the symptoms of autism. Current studies most often use a mixture of Bifidobacterium longum and various Lactobacillus species. No improvement in core symptoms in children with ASD has been documented with Bifidobacterium longum alone. Therefore, the changes in autism symptoms that accompany the use of Bifidobacterium longum alone deserve greater attention.

Research Methodology

The details of this study are as follows.

1. Source of the sample

A total of 60 cases of children with autism who were

diagnosed as eligible from the hospital were planned for this study.

2. Subject population and selection

(1) Inclusion criteria

- Children aged 2–6 years
- Autism Diagnostic Observational Scale (ADOS): assessment of positive children
- Autism Diagnostic Interview Scale (Revised) (ADI–R): assessment of positive children
- Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM–V) diagnostic criteria were met
- Childhood Autism Rating Scale (CARS) ≥ 30
- The child is unable to receive appropriate rehabilitation treatment after diagnosis
- Signed informed consent form

(2) Exclusion criteria.

- abnormal liver and kidney function
- History of sulfa drug allergy
- Abnormal electrocardiogram
- Genetically related autism disorders, such as fragile X syndrome, Rett syndrome
- Children with neurological disorders (e.g., epilepsy, schizophrenia, etc.)
- Are using melatonin for sleep disorders or have been off the medication for less than 3 weeks

3. Study procedure

Bifidobacterium longum was administered for four consecutive weeks, and an assessment questionnaire was completed by a physician before and after the experiment for assessing changes in autism-related behavioral symptoms.

4. Data analysis

SAS statistical software was used for statistical analysis, and statistical methods such as ANOVA with repeated measures were mainly used for symptom scores at different time points.

Research Hypothesis

To explore the ability of Bifidobacterium longum to improve social interaction deficits in autism.

Research Plan

Recall of children with confirmed ASD – Inclusion and exclusion criteria – ASD questionnaire assessment – Medication use for four weeks – ASD reassessment – Statistical analysis.

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Developing an artificial intelligent self-assessment strategy for internet addiction

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Abstract

Internet addiction has been recognized as a new worldwide problem by the World Health Organization. The addiction may cause serious health and social symptoms such as mood disorders, anxiety, withdrawal from friends and family, sleep deprivation, etc. especially in adolescents and young adults. Due to the limitation of time and relevant knowledge, not every family can guide the potential addicts with diagnosis and the subsequent multidimensional family therapy and psychotherapy. Moreover, patients’ self-awareness is crucial to the efficacy of therapy. So far, there is a lack of reliable self-assessment methods for this addiction. With the increasing implication of artificial intelligence (AI) in clinics, it may provide a novel means for this problem. Therefore I propose to develop an effective AI self-diagnosis strategy for internet addiction. Through machine learning, characteristic facial expression and voice of internet addicts will be established. Based on this, an APP can be developed as a self-assessment tool for internet addiction which can benefit those who are vulnerable to internet addiction..

Background & Significance

Nowadays, the internet and electronic devices are used much more widely and for longer time than before. As of December 2021, the number of internet users in China reached 1.032 billion with the internet availability rate of 73%. The average time people use the internet was 28.5 hours per week (CNNIC 2022). Statistics also showed that 78% Americans aged 18–24 use internet and electronic devices multiple times on a daily bases (Smith, Anderson 2018). Long period of device and internet using may cause addiction. During the COVID–19 pandemic, this phenomenon has become more prevalent and serious, especially for adolescents and young adults. Therefore, internet addiction, considered as powerful “new drug”, was recognized by the World Health Organization (WHO) as a

world–wide problem in 2020. Internet addiction not only cause health and psychology problems, but also cause social problems such as conflict between couples and between parents and their children.

Internet addiction can be assessed by clinicians and managed through pharmacotherapy and psychotherapy (Shaw, Black 2008). However, the accurate assessment and effective intervention require self-awareness and cooperation of addicts. Thus, the lack of relevant knowledge hampers the diagnosis and treatment of internet addiction.

This proposal aim to develop a self-assessment strategy for internet addiction, which will help vulnerable people to make an initial assessment on the problem and its severity. It also can be used as a supplementary monitoring strategy during the clinical management.

Literature Review

Internet addiction can be assessed, but the criteria are still on a debate. Sometime It can be hard to use the general screening questionnaire regarding how a person feels about his using internet to distinguish addiction from normal use (Shaw, Black 2008). Thus, a number of screening methods have been developed, including the 46–item assessment instrument developed by Egger and Rauterberg (1996), the 32–item Internet Addictive Behavior Inventory (IRABI) questionnaire developed by Brenner (1997), and the 20–item Internet Addiction Test (ITA) developed by Young (1998). Although ITA appears to be valid and reliable (Widyanto, McMurrans 2004), more objective criteria are needed for more accurate diagnosis.

Facial expression involving activity of muscles of the eyes, nose and mouth reflects emotional status, thus, it can be used as an important indicator in the study of emotions (Ge, Zhong, & Luo 2017). With the advancement of artificial intelligence (AI) and machine learning, there have been increasing implications in clinics including mental health.

Depressive disorder, which affects about 5% of adults worldwide, has been become one of the major causes of the global burden of diseases (World Health Organization 2021). Facial expression providing critical information can be used in the assessment of depression. Through fast region–based convolutional neural networks (R–CNN) deep learning, facial expression associated with depressive emotions can be recognized. Lee and Park thus developed the system that could recognize facial expression using smartphone camera and KakaoTalk’s chatbot platform (Lee, Park 2022). Studies like this suggest that AI–based self–assessment may be used for internet addiction, too.

Methods

The two functions offered by the App will include:

1. Self-assess whether the user has screen and internet addiction:

The App will show specific pictures and drawings and use the camera to record the users’ facial expression. Also, it will ask the user to say some sentences and record the change of the users’ voice. Through the AI analysis, the difference between normal people and the addicts can be distinguished. Moreover, the App would monitor how long users spend on their electronic device and every specific App. Combination of these results will show whether the user are addicted or not and how serious it is.

The AI will be developed to learn the traits of the facial expression and voice of internet addicts. Machine learning is actually the process of machines to know how to summarize the difference through the data and results input to the AI. To obtain initial data, we will recruit volunteers of normal

people and internet addicts with different severity, and then record their facial reaction when seeing specific pictures and their voice. Then manual judgement on whether they are addicted to screen and internet and the severity will be made by psychologists . At last, these data will be given to the machine to summarize the traits.

2. Monitor the efficacy of therapy:

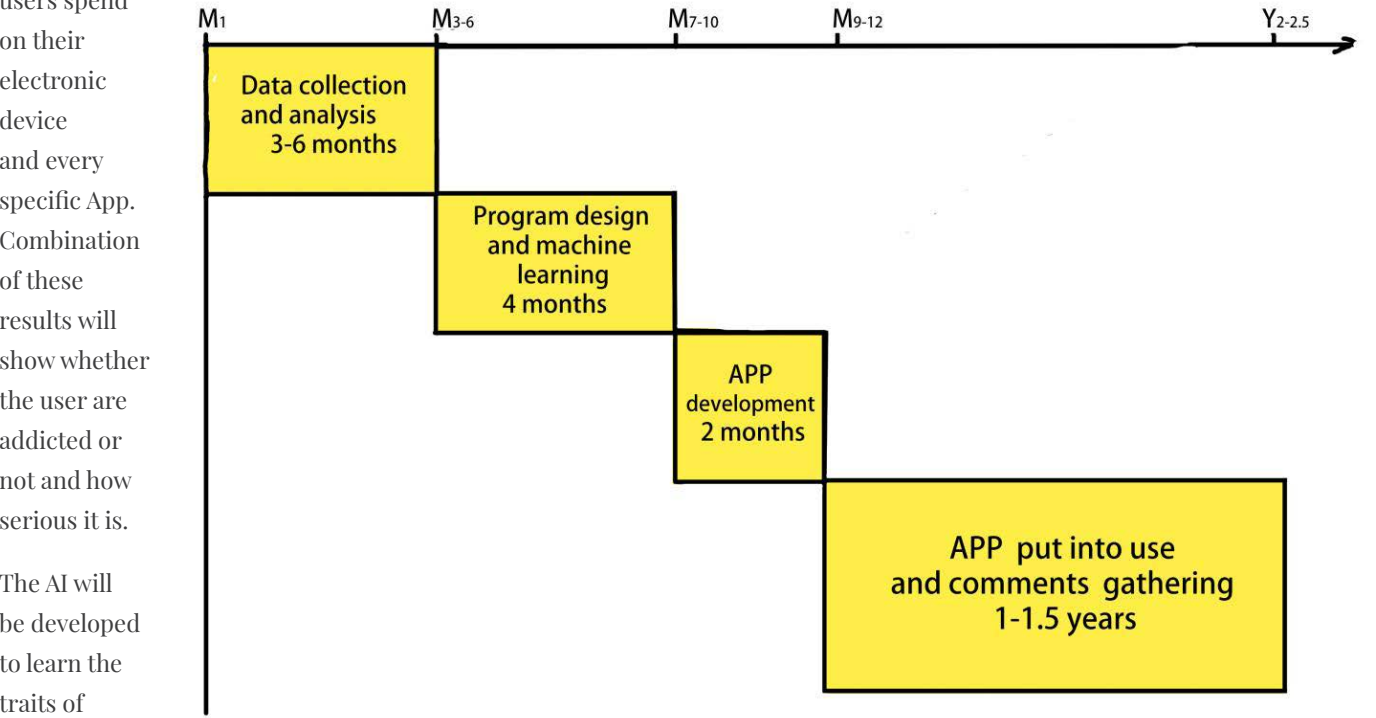
After the patients receive therapy, the App can help monitor their changes and the time they spend on screens. Through analyzing these parameters, the patients can assess their condition and decide what to do next.

The users will be asked for feedback, grading and comments after use, which can be used to judge if the app is useful and what kind of improvement it needs.

Hypothesis

The App we will develop can be used to self-assess whether a person is addicted to screens and internet as well as severity through analyzing his/her facial expression and voice detected by the App.

Project Plan



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A Survey of SiO shown by the Gigahertz Spectrum of Sagittarius B2

Jacky Wang

Abstract

As the observation methods flourished Astrophysicists can use multiple waves to look at any area in the sky. By using microwaves, Astrochemists can understand an area' s chemical composition. In this paper, I will focus on Sagittarius B2's SiO dense and discuss the emitting spectrum of two Hot Cores and Molecular Gas around. By calculating the difference between emitting and absorption lines, we can get the relativity velocity of the molecular gas and the hot core. In addition, this result can prove the theory of the formation of new stars.

Background & Significance

Astronomy is a subject that originated from the deep desire of seeking the truth of the universe. As the observation techniques are highly improved, Astronomers can declare more hidden truths about the universe. In 1842, in the paper "On the Colored Light of Double Stars", Doppler discussed the effect of the frequency of sound and light when it's moving toward or away from the observer. However, this theory failed to describe the light shifting because it' s based on Classical Physics, and the result will have a real difference if you use Relativity when the speed is fast enough, such as the speed of light. In relativity, Einstein made a modifier formula of the Doppler Effect.

I think it's possible to use these ideas to describe how the newborn star was formed. People used to prove the idea of how the stars were born by observing the near stars. In Kant's book "General History of Nature and Theory of the Heavens", he suggested that the stars were formed by nebulae in 1755. In 1901, this theory was finally been proved by J. H., who is an English Astronomer, Physicist, and Mathematician. He observed the nebulae nearby and conclude that they form stars. In this paper, the nebula Sagittarius B2 is too far to directly look at, so I'd like to use the Doppler Effect to prove that the Gas around the Core is

attracted by the Hot Core. Furthermore, it is correct that the stars were formed in this way.

Literature Review

SEDIGISM: Structure, excitation, and dynamics of the inner Galactic interstellar medium

This paper is about the Hot Core and Molecular Cloud in Sagittarius B2, so some Microwave multiple waves data is required. Luckily, I found some data from the ALMA(Atacama Large Millimeter/submillimeter Array)'s official website (Schuller et al., 2021).

ALMA Observations of Massive Clouds in the Central Molecular Zone: Ubiquitous Protostellar Outflows

In this paper, I get this information: there ' s a SiO emitting/ absorption line on "f=217.1050 GHz" (Xing Lu et al., 2021) (Schuller et al., 2021).

Methods

Doppler Effect on Emitting lines

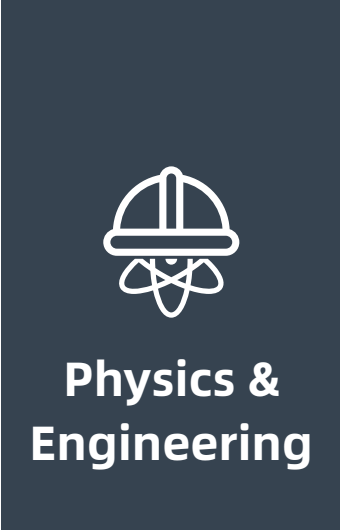
The Classical Physics version of the Doppler Effect is written in equation (1):

f' = (u ± v_o / (u ∓ v_s)) f (1)

Where u means the velocity of the wave, v_o means the velocity of the observer, v_s means the velocity of the light source, f means the frequency of the original wave, and f' means the frequency of the wave observed.

However, after we consider the relativity, equation (1) cannot be used anymore. Instead, after Lorentz transformation, equation (2) formed:

f' = (sqrt(c^2 - v^2) / (c - v cos (θ))) f (2)



Where c means the speed of light, which is approximate 3×10^8 m/s, v means the relative velocity between the observer and the light source, and θ means the angle between the direction of the movement of the light source and the direction of the observer.

Hot Core and Molecular Cloud

By plotting the average light density of each area (both Hot Core and Molecular Cloud areas), we get these diagrams:

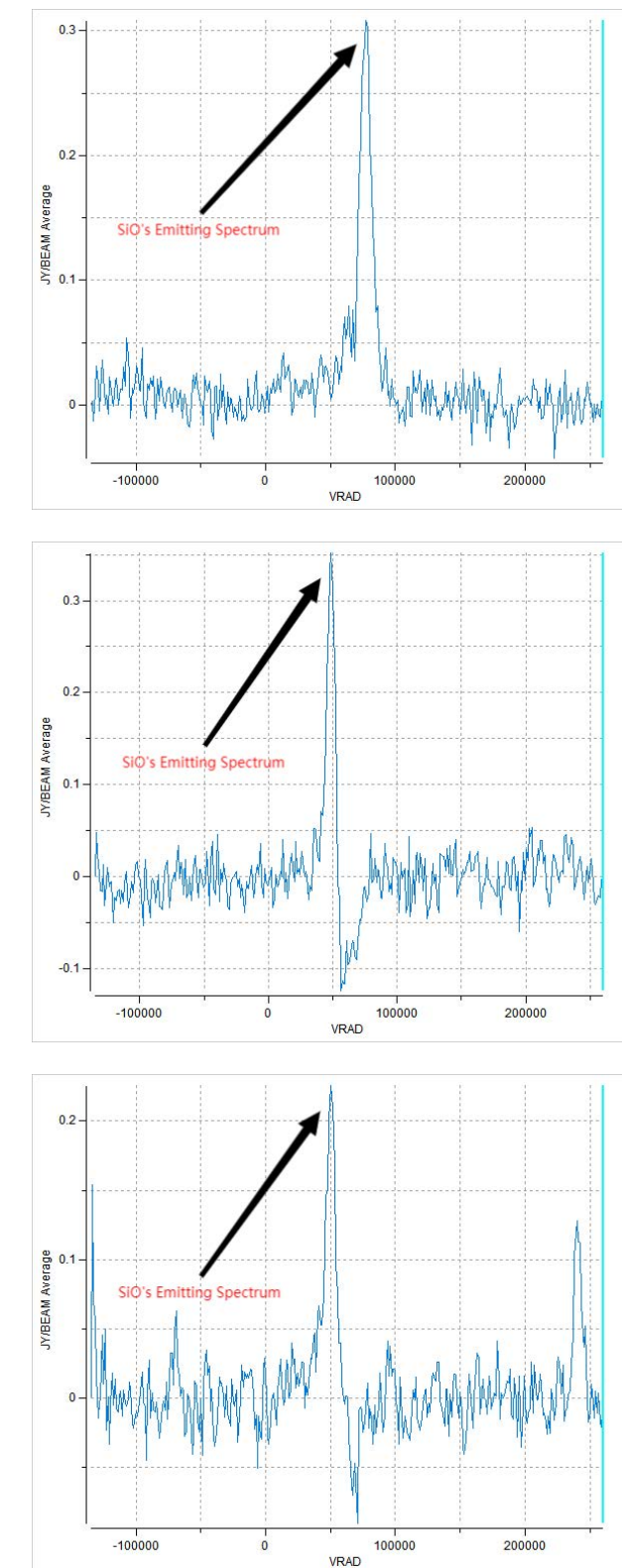
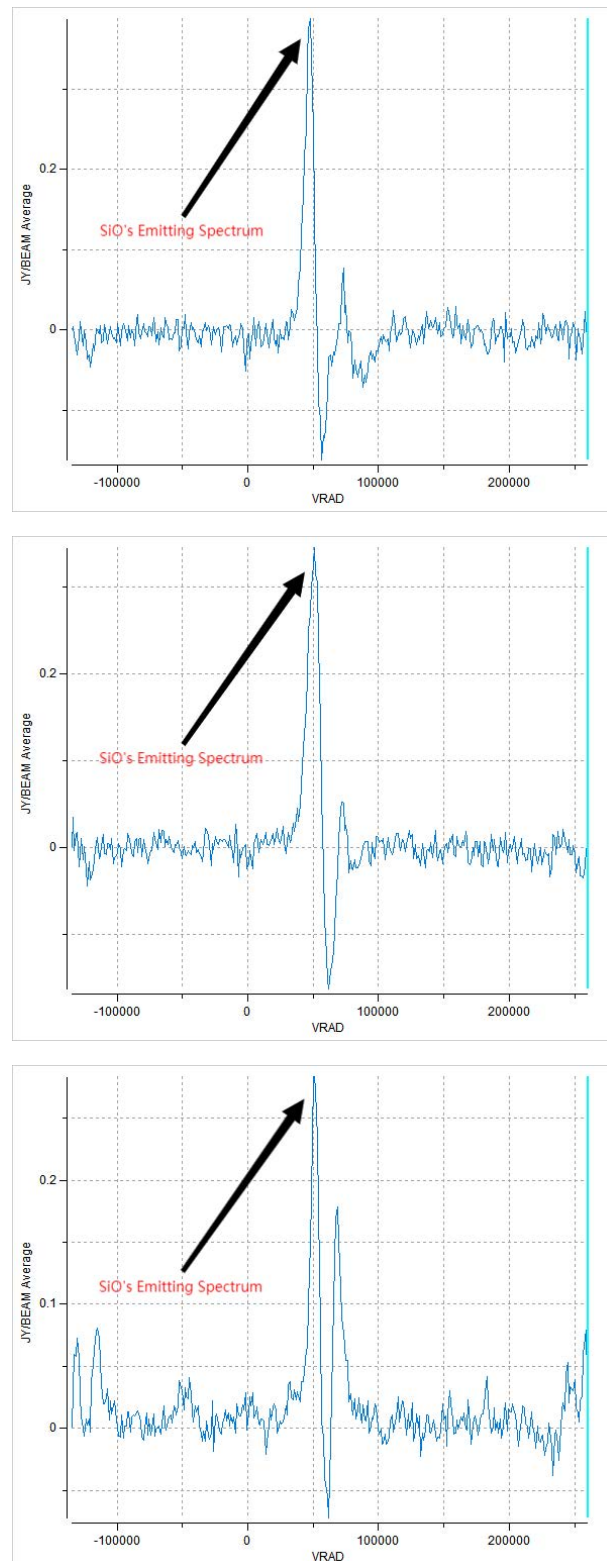


Fig. C1, C2, C3, C4, C5 & C6: The Emitting Spectrum of six Molecular Cloud. (Fig. C1 shows Molecular Cloud 1, Fig. C2 shows Molecular Cloud 2, and so on)

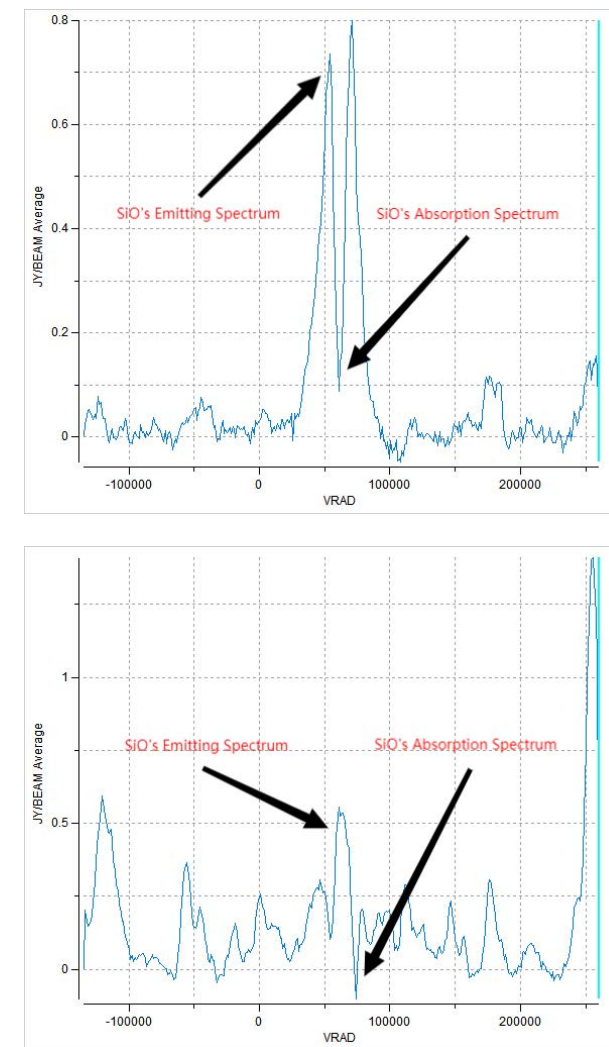


Fig. D1 & D2: The Emitting and Absorption Spectrum of two Hot Cores.

(Fig. D1 shows Hot Core 1 and Fig. D2 shows Hot Core 2)

We find that the Emitting Spectrum and the Absorption Spectrum didn't overlap, so we can conclude that there are some Molecular Cloud that shares a similar chemical formation structure, and they have a relative speed which makes the Emitting Spectrum and the Absorption Spectrum of the same compound don't overlap due to the Doppler Effect.

We find that the Molecular Clouds have an Emitting line, and some of them but not all of them have an Absorption line. The Emitting line is formed by some hot Molecular Cloud and the Hot Core which contains SiO, the Absorption line means there's some cold Molecular Cloud that contains the same compound. For instance, Fig. C4 doesn't have an obvious Absorption line, which means it's a very hot Molecular Gas. In contrast, Fig. C1, C2, and C3 have an obvious Absorption line, which means there's some cold Molecular Gas in front of it.

We also know that Hot Cores always have an Absorption

line, so there's an invisible cold Molecular Cloud in front of that area and absorbing their Spectrum.

Astrophotic and Astromechanics

In the desire to know the truth of the universe, I want to calculate the relative velocity between the invisible cold Molecular Cloud and the Hot Cores which generated it.

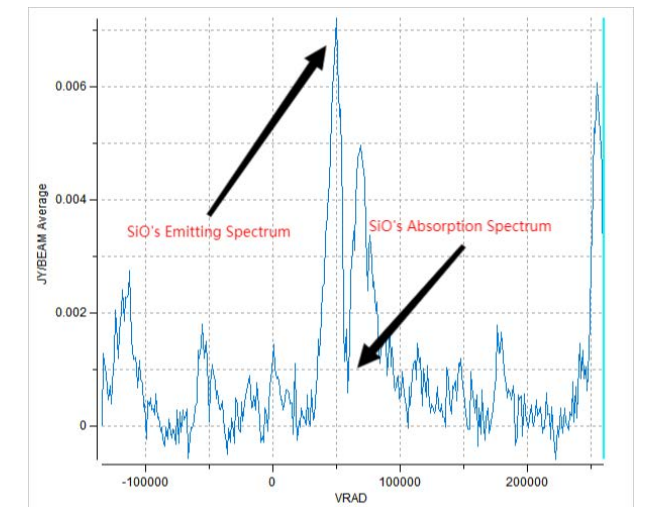


Fig. E: The Emitting and Absorption Spectrum of the overall area.

At the lowest point, the Absorption frequency is represented by f_a , and at the highest, Emitting frequency is represented by f_c . From the data, we get the information (3) and (4):

$$f_a = 217.0625 \text{ GHz} \quad (3)$$

$$f_c = 217.0689 \text{ GHz} \quad (4)$$

After some simple rearranging of equation (2), we can get the formula (5) to find the relative velocity between object and observer (the angle θ 's value is π because the direction of movement and the direction of the observer is the same direction):

$$v = \frac{f^2 - (f')^2}{f^2 + (f')^2} c \quad (5)$$

Substitute the f as the frequency of SiO emitting/absorption lines, we can get the relative speed of the invisible Molecular Clouds and the Hot Cores by using Absorption frequency and Emitting frequency. The relative speed between us and the invisible Molecular Gas Clouds and the Hot Cores are shown in (6) and (7):

$$v_a = 58733.1 \text{ m/s} \quad (6)$$

$$v_e = 49887.8 \text{ m/s} \quad (7)$$

Now we can calculate the speed between them, by the

Relativity speed difference formula, the calculation is simple, so I just leave the result here as (8) shows:

$$\Delta v = -8845.2 \text{ m/s} \quad (8)$$

Hypothesis

The value of is negative means the Molecular Cloud is moving to the Hot Core. The Hot Core is the unborn star, it needs the mass and the energy in the Molecular Gas Cloud to grow to a star. The present Hot Core has some initiated mass and it attracts more mass from the Molecular Gas to join it due to gravity.

The expected result of this paper is that there's an Emitting line on the left followed by an Absorption line on the right. The other frequency should mainly be noise. Nevertheless, The theory in this paper cannot explain the result of the Emitting line which happens to stand on the right hand of the Absorption line. This might be an observation error since I only have the SiO line to observe.

Project Plan

The Molecular Clouds 1, 2, and 3 are chosen too close to the Hot Cores, so they have a similar error line. Thus, adding more lines to observe might have a better result. By observing more lines, we can reduce the error. We can get a further result if some compounds have both Emitting and Absorption lines and other compounds only have Emitting. This shows the difference in chemical formation structure between the cold Molecular Cloud and the Hot Core.

Reference

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