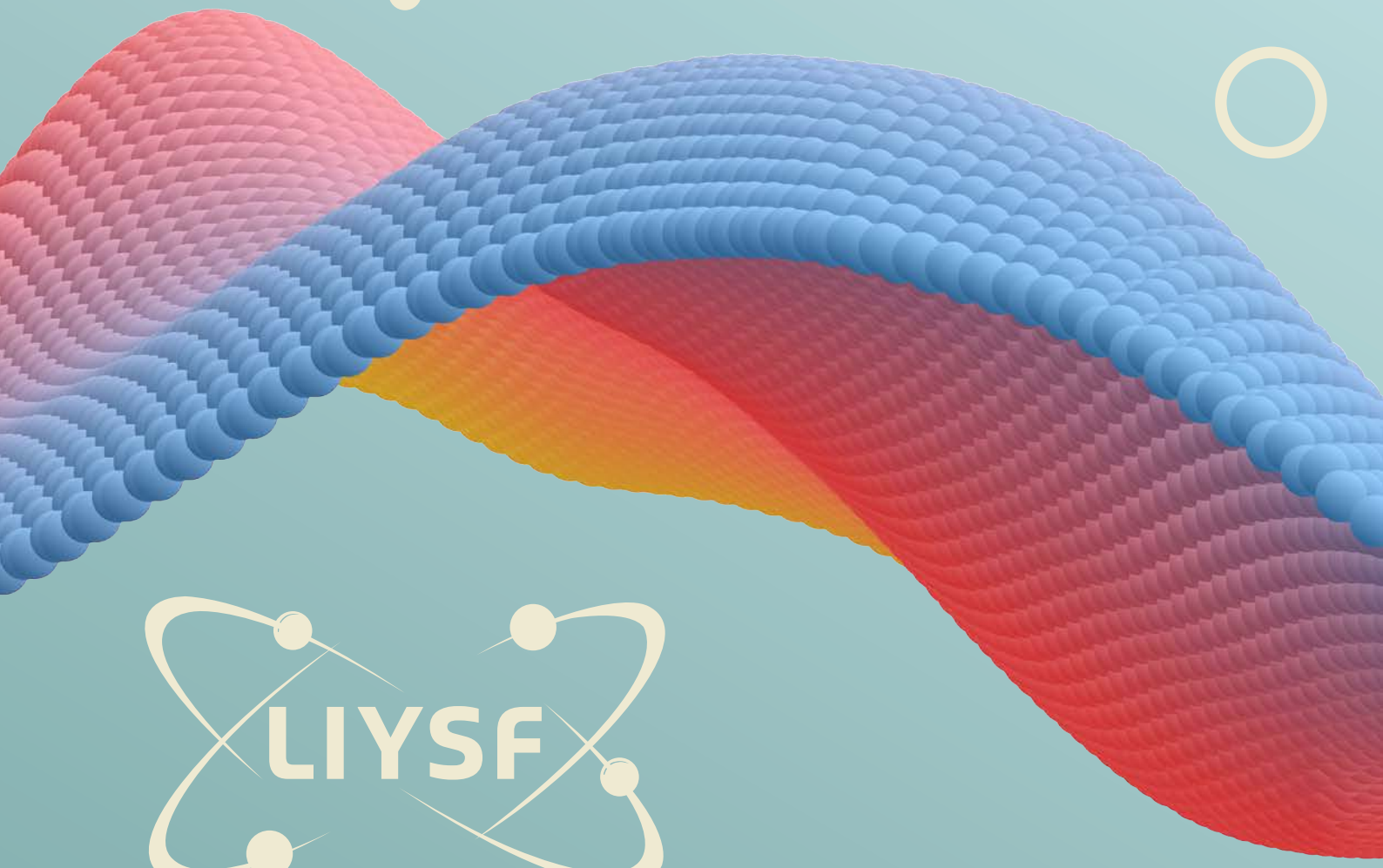

LIYSF

62nd London International Youth Science Forum (China)

SCIENCE Collection

ASDAN China 阿思丹

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 group home to home 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 and, following the belief that 'out of like interests the strongest friendships grow. 'They based the programme on science. 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 2021 China, as the first-ever attempt for the past 62 years to invite participants from China and fulfill the vision of "a community of shared future for science and art without borders".

The 62nd London International Youth Science Forum (China) was held at Shanghai, China. From 29th July to 10th Aug 2021, 221 students attended this forum, with their enthusiasm and inspiration, experiencing a remarkable science journey. 196 students attended the Research Bazaar with their research portfolio while 60 students were awarded for their extraordinary works. To demonstrate their passion for science, this collection includes the brilliant research ideas of 18 students.

Table of CONTENT

GOLD

Explore the Influence of the Size of Filters of Simple Convolutional Neural Network (CNN) on the Accuracy of Image Recognition

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ICT

Abstract: Convolution Neural Networks (CNNs) are becoming more and more popular due to their ability to learn deeper relationships in the dimension of data comparing with other methods. In this paper, different sizes of the filters were used with CNN to determine their effect on the accuracy of image recognition. This work has been done through series of experiments; in each experiment, different filter sizes have been applied, and other condition does not change. The result has shown that higher accuracy is gained with the first layer's filter size between 3 and one-third of the sample's resolution, second layer's filter size around half of the resolution of the sample. The best performance is gained with a filter size of 6 in the first convolutional layer, filter size of 10 or 14 in the second convolutional layer.

INTRODUCTION

CNN has been used for several areas including text, image, sound and video processing, and the results have proved that CNNs gain a significant advantage in such fields. In most research, people have paid most of their attention to the general structure of a CNN and optimize its performance from the aspect of optimizers, activation functions instead of details such as the size of filters. As a result, only a limited number of papers and theories can be used as a reference to deduce the initial sizes of filters. Therefore, time and resources can be wasted to adjust these super parameters. If any reliable methods can be used to predict a suitable filter size, a considerable amount of time and resources can be saved. This research is aiming at finding a rule that can be used when setting the filter sizes of a convolutional neural network, that can produce a higher accuracy.

METHOD

1. Convolution Neural Networks (CNN) and Optimizer

CNN is one of the most popular structures used in image recognition. In this experiment, five layers are used in total (Figure A.): two of them are the Convolutional layer and followed by two affine layers. In each layer, Rectified Linear Unit (ReLU) is used as an activation function. In the last layer, a SoftMax with cross-entropy error is used to generate the result and loss as well.

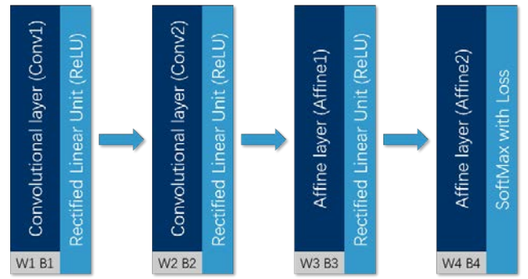

Figure A. The structure of the neural network

1.1 Convolutional layer and Affine layer

Different filter sizes are used in every model, ranged from 1 to 27 to test the effect of accuracy. The shape of the filter is square. A total number of 30 filters is used in each Convolutional layer. In each Affine layer, 100 nodes are used.

1.2 SoftMax with cross-entropy error

A SoftMax layer is used to classify the image and generate the result into 10 different types: from 0 to 9. A Cross-Entropy error is used with correct results to gain the loss of the result generated by the neural network.

2. Training the model

The CNN has been training for 2 epochs, by set the value of batch size = 100, learning rate = 0.001, momentum = 0.9 and decay = 0.999. In every epoch, 10 batches of data have been trained, by using the data randomly selected from the training dataset.

3. Data Processing and MNIST Dataset

The whole experiment is based on the MNIST database of handwritten digits, which is an open-source and light training dataset. All the image in this dataset is black-and-white, with a resolution of 27x27 pixels, tagged with the correct answer that can be used to calculate the loss.

RESULTS AND ASSUMPTION

A total number of 378 models are trained, and the final accuracy of the models are recoded, drawing into a heatmap (Figure B.). The result has shown that with the size of filters in convolutional layer 1 between 4 and 9, and the size of filters in convolutional layer 2 between 8 and 15, the model has a better performance. Also, the best results are gained with 6 for filter size in the first convolutional layer, 10 or 14 for filter size in the second convolutional layer.

Since then, an assumption can be made: to gain a higher accuracy, the size of filters in convolutional layer 1 should be smaller than the size of filters in convolutional layer 2. Also, the filter size in convolutional layer 1 is better between 3 and one-third of the resolution of the sample, and the filter size in convolutional layer 2 is better around half of the resolution of the sample.

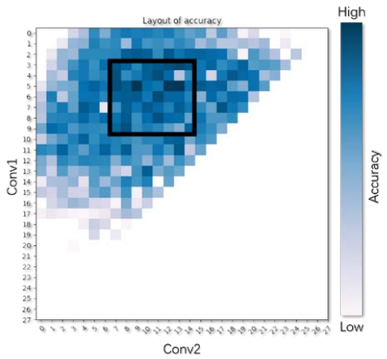

Figure B. The accuracy of models

FUTURE IMPROVEMENT

The experiment still has many problems that need to be solved and areas that can be improved. There should be more epochs when training error and should repeat the experiment several times to minimize the random. In addition, the code should be written with an advanced library to shorten the time used when training the model and maximize the usage of computational sources.

The assumption needs to be verified on more databases and experiments, and a more precise conclusion needs to be determined by trying more structures, varying more parameters of the neural network.

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Why is the Ball Hard to Throw into the Basket? The Design Evaluates Potential Improvements.

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Physics

Abstract: Studying why the ball can fall into the basket and the elements that influence the process provides a broader perspective on this motion. We describe the shape, mass, latitude, emit Angle, and wind direction and discuss how these elements can influence the result. The study concludes that these elements can affect the outcome to different degrees.

Keywords: motion, shape, mass

Introduction

A large amount of paper discussed the motion of throwing the ball and elements that affect the motion. However, no one has combined these results and improved the inner structure yet. Ball's internal structure is essential in our life. Industries can enhance transport efficiency if we remake the ball's internal structure. How these elements influence the motion simultaneously is unknown. So, my research attempts to determine how these elements affect the motion when several element effects simultaneously and design a better inner structure. In the first stage, I will simplify several experiences and get results. The approach uses the model to simulate the different situations, and the result will record as several trajectories. Then, I will use statistics to analyze the effect of each element and get a complete result. In the second stage, these results will use to redesign the inner structure of the balls. Finally, A new design will give in the effect.

Method

First is the research material and equipment.

We need to prepare several balls with different shapes and mass, a computer is to record the trajectories, and MATLAB is to build several models.

The plasticine ball is treated externally, including cylindrical, conical, and spherical balls—the details of these balls show below.

Three cylindrical balls with a radius of 3.0cm and a length of 4.0cm. It has a mass of about 6.0 grams

Three cylindrical balls are with a radius of 3.0cm and a height of 6.0cm. The mass is about 8.0 grams.

Three conical balls are with a radius of 3.0cm and a length of 4.0cm. The mass is about 2.0 grams.

Three conical balls are with a radius of 3.0cm and a length of 6.0cm. The mass is about 2.7 grams.

Three balls (spheres) make for a 3.0cm radius.

The first experiment tests how the shape (air resistance) affects the ball's motion. Use the ideal modeling to solve this.

- It assumes that the balls of different shapes move in the absence of gravity, and there is standard air. The balls are only affected by air resistance.
- I was shooting in a straight line and initial speed at a constant 10m/s.

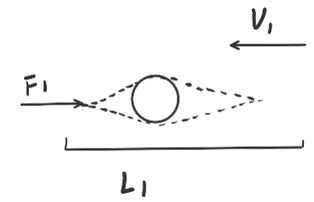

Figure 1

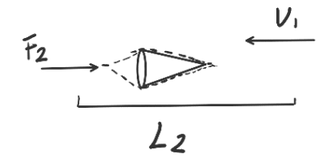

Figure 2

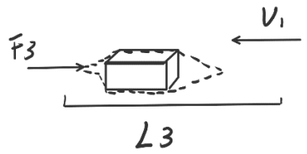

Figure 3

- The balls receive air resistance after launching. Calculating the air resistance received by each ball uses the air resistance formula $F=\frac{1}{2}C_p s v^2$ $F=ma$. It operates for computing acceleration. (Figure 1-3)
- Take the same ball length and conduct three experiments for each ball to take the average value.
- Calculate the time and displacement of the object moving in the air, and record the data into charts with descriptive statistics.
- Using ANOVA test in difference analysis to calculate the influence of air resistance on balls of various shapes.
- Conclusion 1 "The influence of shape on the Motion of the ball in the air."
- The second experience tests how they emit Angle, the ball's mass, and the altitude of emitting place affect the ball's motion. The experience is simulating by computer.
- Suppose the balls of different shapes move in the absence of gravity with standard air. The balls are subject to gravity and impulse.
- Put the frame of the launchpad to the same height.
- The balls receive gravity after launching. The gravity received by each ball calculate by formula $G=mg$, and the downward acceleration of each object is calculated by $F=ma$.
- The balls of different lengths take for trajectory simulation, and three experiments are performed for each ball to take the average value. Record each set of trajectory data. The trajectory data are the value in a coordinate system.
- They are then analyzing data. The multiple sets of data examine for three-way linear regression analysis.
- According to ternary linear regression analysis, trajectory charts of falling groups can obtain.
- Get conclusion 2 "How do the object's mass, the emit Angle, and the altitude control the ball trajectory.
- Finally, residual analysis carries out for checking out these results.

Expected Results

I expect the results include to show me how these elements affect the motion. There are quantity data and discrete data. Some of these data will draw as several chats (Experience 1), and the other data is the value from the coordinate system (Experience 2). We analyze these data and get the effect of different elements.

Future improvement

In the above experiments, I have discussed factors that affect the trajectory of the balls. In the future, more elements that affect the motion will discuss. For instance, rotation causes the Magnus effect and the trajectory changes. The ball may collide with the edge of baskets and rebound. Then, based on these results, I will attempt to improve the ball's inner structure to offset the motion's negative effect and reduce the cost, which is essential and achievable.

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Feasibility study of electric motor as power for aircraft

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Engineering

Abstract: The basic abstract about this topic is to compare the advantages and the disadvantages of electric motors and engines. And investigate the feasibility of using motors as the power resources of the aircraft. However, after further research and the comparison between motors and combustion engines, the major problems which stop this abstract become true is the endurance of the power resources that supply the motors to rotate. So, after further research, the Hydrogen & Oxygen Fuel cells are feasible power resources to provide electricity.

Introduction

At a time when global warming is increasingly serious, and one of the main causes of global warming is carbon emissions from vehicles , so it is crucial for all the vehicles to find a new clean power resources to replace the internal combustion engine, it would greatly reduce the impact on the environment. In the past decade, there are lots of cases of application of electric vehicles, as there are some new electric cars are in the experimental stage. Furthermore, some small aircraft which are already changing to the electric motor as their driving resources, for instance, for most of the UAV products, the already using electric motors rather than engines. However, there is only few of the research are illustrating the application of electric motor as power for aircraft, so it is a blank gap for electric motor's application on aircraft.

Method

Due to the limitation of time and equipment, for most of the research is going under the Literature Review method, for instance, using two reference to make a comparison between electric motors and engines. And, with some data collecting and the measurement of the motors.

For now, the development of the high-power electric engine is mature for using it for power the airplanes. However, for now the main issue which make this idea cannot become true is because the endurance of batteries/power resources. So, for now the best solution is to using fuel cells as the power resource of the airplane, which is a cell that using the redox reactions between Hydrogen and Oxygen, and due to the transformation of the electrons, there will have a potential difference between hydrogen and Oxygen, also after the redox reaction, the remaining Hydrogen will react with Oxygen, to form wastewater, which have no pollutions to the environment

Here is the form for the vertical comparison between internal combustion engine and the electric motor (All the comparison between internal combustion engine and electrical motors is using the specification from CFM56-7B24 engine in database handbook, only compare the data between a single combustion engine with a single electrical motor)

	Electric motor	**Internal combustion Engine**
Pollution	No pollution	Carbon Dioxide and Carbon monoxide produce And cause global warming
Efficiency	"It is observed that BLDC motor gives the best energy efficiency (greater than 95%)"	About 50%
Cost	Low, due to the less complicated mechanical components. With low maintenance cost	High due to the maintenance & replacement of precision mechanical components
Noise	Less or none	Large
Technology developments	A few, due to it is a new technology for us, there is no lots of data to use	A lot, as engines are already developed for many decades.

Table 1

Expected Results

For now, there are more advantages to using the electric motors as power for aircraft. However, in the precedent, the weight is the major problem for developing the new generation of the motors.

"Since the motor will be mounted inside the wheels of an electric car, the priority is to minimize its weight. Besides, a light motor requires less material which may also be positive from an economical point of view (Chau et al, 2007)."

Also, the main reason why in the past there is only a few references and technology improvements on electric aircraft is that the endurance of the power resources, but now, due to the development of power resources, like fuel cells, the endurance problem of the aircraft is nearly to be solved, so the zero-carbon emission plane abstract could become true.

Further improvement and reference

It explored new clean energy, but at the current level of science and technology, as a result of the battery life and energy density of force majeure, aviation aircraft to the motor as a driving force in a short period or cannot be replaced by a combustion aero-engine, therefore, this study aims to explore the motor as the feasibility of aviation aircraft, through the progress of fuel cell technology, In the future how long motor can gradually replace internal combustion engine, become the main source of aircraft power.

In the future, we will make more further research on the energy density, endurance, and development of the fuel cells, which can fix the major problems of the topic, and make it more feasible.

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The fundamental demonstration of exoplanet analysis by specifying the modeling of a multi-planet system

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Physics

Abstract: This article demonstrates the basic principle behind some preliminary calculations performed in exoplanet analysis based on information retrieval and literature review. The article describes a series of well-acknowledged methods in the detection and the analysis of exoplanets, including the clarification of a common model for astrophysical analysis. There is also an illustration of the principle behind the statistical analysis of exoplanet by implementing some essential physics ideas accordingly for each detection method. The transit method itself is being carefully demonstrated around its mechanism and purpose. An instruction for guidance is also being provided in order for the readers to perceive the ideas that this article brings. This article employs literature analysis that examines resources that could be employed in exoplanet analysis and provide convenience for users. These analyses will shed light on generalize the mastery of modeling skill among rookies and ammeters in this field.

Keywords: exoplanets, radial velocity, multi-planet system

1. Introduction

The increasing focus on Astronomy is becoming a major trend around the globe. Researches are being conducted and more details of the universe are being comprehended. At the meantime, the data to process for Astrophysicists are growing rapidly. The programming skills are being deemed as one of the most preliminary requirements for the Astrophysicists to master.

There are dozens of handy programming gadgets that is available for implement for astrophysicist. But on the contrary, there is an absence of a systematic introduction of them and their principle. In fact, many Astronomy lovers would reckon Astrophysics as a distinctive subject compared to their interest. This article will go over on the precise illustration of their principle and mechanism.

2. Detection methods of exoplanets

The most common methods of detection of exo-planets are transit, radial velocity, gravitational microlensing, direct imaging and Astrometry. From the data collected on NASA, the majority of detection is transit and radial velocity.[4]

3. Basic descriptions of the principles behind modeling of multi-planet system and transit method.

3.1 Radial velocity method

From doppler effect, radial velocity is determined using

$$\Delta f = \frac{\Delta v}{c} f_0$$

where f stands for frequency

Since the Kepler model is implemented here, so that the radial velocity satisfies

$$\dot{z} = v_r = \overbrace{K\left[\cos(\nu + \omega) + e\cos(\omega)\right]}^{\text{radial velocity caused by a single planet}}, \quad (1)$$

$$\mathcal{V}_r = \overbrace{\sum_k^{N_{\text{pl}}} v_{r,k}}^{\text{mean center of mass velocity}} + \gamma + \underbrace{\dot{\gamma}(t - t_0)}_{\text{linear acceleraiton}} + \underbrace{\ddot{\gamma}(t - t_0)^2}_{\text{second order}} \quad (2)$$

Input the required parameters in to the python document RV model. Execute the program via python console and you gain your numerical or graphical results depending on your desire.

The algorithm of the RV method work flow is placed below.[2]

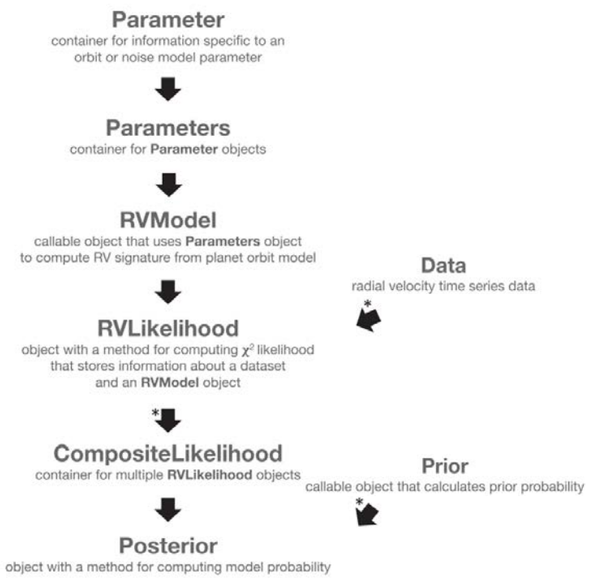

Figure 1. the algorithm of the python package [2]

3.2 The transit method

By input the images and parameters accessed from public archive or access them by yourself (e.g., A high-resolution CCD image of the target system) Adjust the image with a set of restrictions to avert undesired influence such as noise and the image analyzer would be able to fit the light curves of the target star and a bunch of data tables containing information you necessitate.

A complete set of basic parameters of a target system/ Light curve from planets with transit detection [3].

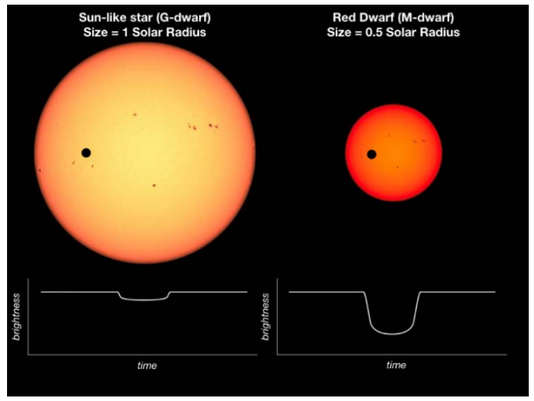

Figure 2. the planets in transit with their stars [3]

$$Depth = (\frac{R_p}{R_*})^2 \tag{3}$$

Rp is for radius of the planet, R* is for radius of the star

$$T_{dur} = P\frac{\alpha}{2\pi} = \frac{P}{\pi}\sin^{-1}\left(\frac{l}{a}\right) = \frac{P}{\pi}\sin^{-1}\left(\frac{\sqrt{(R_*+R_p)^2-(bR_*)^2}}{a}\right) \tag{4}$$

(transit duration; orbital radius)

$$T_{dur} = P\frac{\alpha}{2\pi} = \frac{P}{\pi}sin^{-1}\left(\frac{l}{a}\right) = \frac{P}{\pi}sin^{-1}(\frac{\sqrt{(R_*+R_p)^2-(bR_*)^2}}{a}) \tag{5}$$

a is for orbital radius, Tdur is for transit duration and b is for impact parameter where b satisfies:[5]

$$b = -a\sqrt{e^2-1} \tag{6}$$

4. The expected results from applying the modeling technique

The data obtained above in the RV method would have a statistical significance in multi-planet system modeling. Here is an example of analysis of the refined model via the Radvel gadget.[2]

Table 3
Model Comparison

Statistic	0 Planets	1 Planet	2 Planets (adopted)
N_{obs} (number of measurements)	401	401	401
N_{free} (number of free parameters)	3	8	13
rms (rms of residuals in m s^{-1})	4.97	3.01	2.91
χ^2 (jitter fixed)	1125.56	431.7	397.29
χ^2_ν (jitter fixed)	2.83	1.1	1.02
ln $\mathcal{L}$ (natural log of the likelihood)	−1356.54	−1009.61	−992.41
BIC (Bayesian information criterion)	2731.06	2067.17	2062.74

Figure 3. the statistical result of modeling a multi-planet system [2]

As you could see in the tables there are statistical values such as BIC, that basically indicates how well the model fits. And again, as you could see, in this example 1 planet fit is statistically superior than the two-planet fit. The drawn conclusion could imply how many orbiting planets are inside this system

The result you are expected to receive from the Radvel package is the refined fittings of multi-planet system that has distinct periods and parameters for the planets simulated in the model

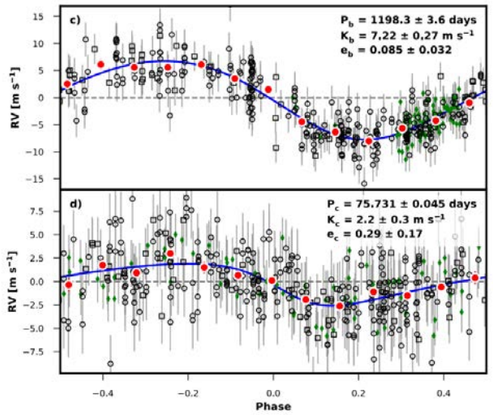

Figure 4. the fittings for the two-planet system[2]

Table 4. orvara Posteriors

Parameter	Planet b	Planet c	Units
Fitted Parameters			
Companion Mass (M_{sec})	$16.4^{+9.3}_{-4.0}$	$17.0^{+13}_{-5.4}$	M_{Jup}
Semi-major Axis (a)	$1.453^{+0.026}_{-0.026}$	$19.4^{+10}_{-7.7}$	AU
$\sqrt{e}\sin\omega$	$0.8373^{+0.0010}_{-0.0010}$	$0.44^{+0.24}_{-0.64}$	
$\sqrt{e}\cos\omega$	$0.0015^{+0.0044}_{-0.0043}$	$0.46^{+0.15}_{-0.23}$	
Inclination	46^{+27}_{-19}	86^{+19}_{-19}	deg
Ascending node	87^{+64}_{-60}	107^{+44}_{-59}	deg
Mean longitude	$173.18^{+0.23}_{-0.24}$	$108.7^{+9.4}_{-13}$	deg
Derived Parameters			
Period	$1.398643^{+0.000035}_{-0.000035}$	68^{+60}_{-36}	yrs
Argument of Periastron	$89.90^{+0.30}_{-0.30}$	62^{+262}_{-32}	deg
Eccentricity	$0.7010^{+0.0016}_{-0.0017}$	$0.455^{+0.12}_{-0.084}$	
Semi-major Axis	$47.26^{+0.83}_{-0.83}$	630^{+328}_{-250}	mas
T_0	$2455590.17^{+0.13}_{-0.13}$	$2476000^{+22000}_{-13000}$	JD
Mass ratio	$0.0100^{+0.0058}_{-0.0024}$	$0.0105^{+0.0080}_{-0.0034}$	
$M_p \sin i$	$11.82^{+0.42}_{-0.41}$	$15.6^{+14}_{-5.1}$	M_{Jup}
Other Parameters			
Jitter	$11.42^{+0.36}_{-0.33}$		m s^{-1}
Stellar Mass (M_{pri})	$1.551^{+0.083}_{-0.078}$		M_{sun}
Parallax	$32.5224^{+0.0010}_{-0.0016}$		mas
Barycenter Proper Motion RA	$-8.23^{+0.60}_{-0.25}$		mas yr^{-1}
Barycenter Proper Motion DEC	$17.22^{+0.16}_{-0.33}$		mas yr^{-1}
RV Zero Point CAT_HES	-14^{+29}_{-48}		m s^{-1}
RV Zero Point APF	-143^{+21}_{-49}		m s^{-1}

Figure 5. the parameters for the two-planet system[2]

5. Introduction to the instructions of implement a python package

1. To run the package successfully you have installed three key toolkits, including python, PyCharm and anaconda. Make sure you leave a shortcut.

2. Setup PyCharm via the method shown on the figure. Make sure you have added your anaconda to your system path. If you are still confused about what to do exactly, just search PyCharm setup on YouTube or Google.

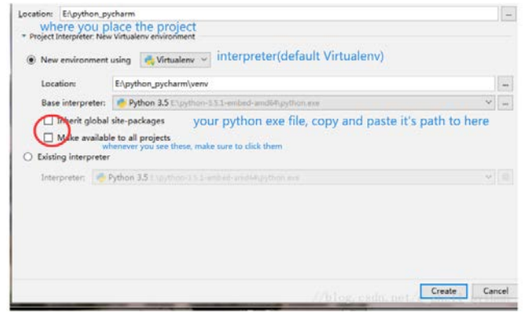

Figure 6. setup python environment

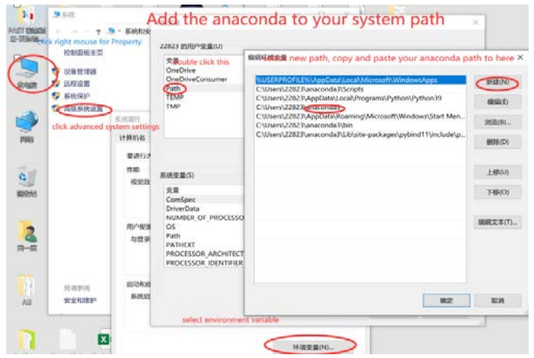

Figure 7. setup python environment

3. After installation you have to setup python environment, just click File-settings-project-python interpreter and search in the available projects. Make sure you chose anaconda for your interpreter

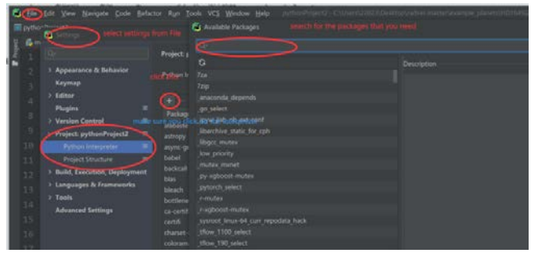

Figure 8. setup the interpreter [5]

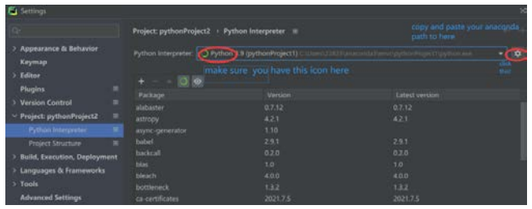

Figure 9. setup the interpreter [5]

4. Then install Radvel package from "Available packages" and all the other gadgets needed for your calculation, execute command to run your program or construct your own file via obtaining parameters through radial velocity method.[5]

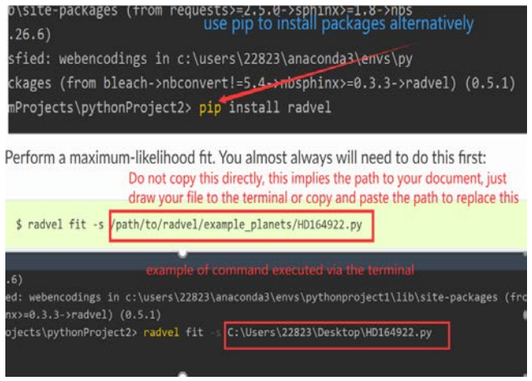

Figure 10. install the package and try to run it. [5]

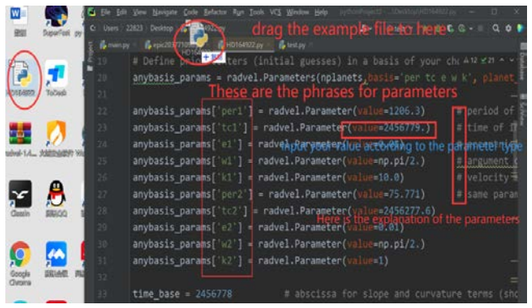

Figure 11. edit the parameters for your convenience.

5. If you could not run the program properly, install and uninstall packages(always works) or go to Getting Started — radvel 1.4.6 documentation for assistance

6. Future improvement

These packages are still restrained to some professional astrophysicists. In fact, most who have a profound interest or beginners in this field might have doubts in how these procedures are carried out to perform complex modeling and this is ever truer for understanding the principle behind. The prospect of all these modeling packages should be designing user interfaces to assist those does not specialize in Computer Science

Additionally, the detection methods still acquire potential in future study and when those vital technique are manipulated by Human being, we would comprehend the universe more thoroughly.

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Different States of Motion of Stone when the Stone Fall into Water in Different Condition & The Falsifiability of an Ancient Chinese Prose – Stone Beast in the Rive

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Abstract: As time passing, some of the theory from many years ago has been proved fake. This essay will talk about the facticity of a theory from ancient Chinese prose which predicted the motion of a stone under the water. Also, the essay will show the design of an experiment that is made for figuring out the relationship between the mass of the stone, the speed of water flow, and the different states of motion of the stone. Then, determine whether the theory from the ancient Chinese prose is true or false.

1. Introduction

In an ancient Chinese prose, the writer wrote that if a stone beast falling into a river, the stone beast will move upstream(纪昀 , nd). Because when the water flow applies force on the stone beast, there will also be a reactive force apply to the sands which are under the rock and face the water flow to form a hole. When the hole is big enough, the stone beast will turn and fall into the hole. The process continues so that the stone beast will move upstream. Figure 1 to Figure 5 shows the detailed process. The theory is reasonable, whereas the prose also mentions that people find the stone beast a few kilometers away from where it fell. This is doubtful. By research, the stone beast cannot move that far (卢望军 , 2021). Figure 6 to Figure 7 explain the reason visually. The essay will first show the detailed research method, then state the expected result, next talk about the expectation of future improvements, and cite the references in the end.

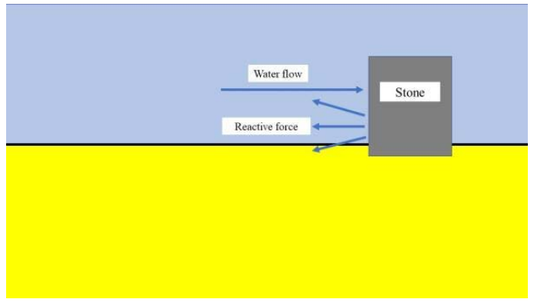

Figure 1 Detailed process

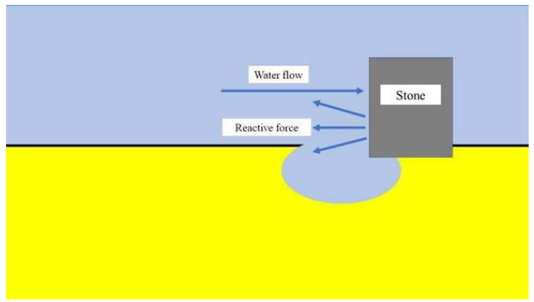

Figure 2 Detailed process

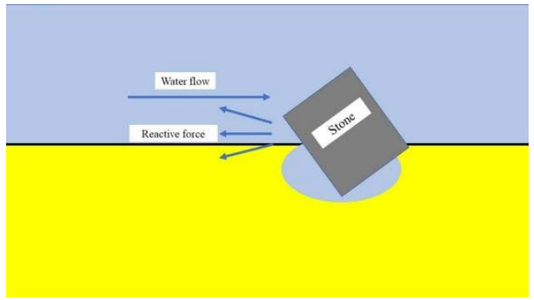

Figure 3 Detailed process

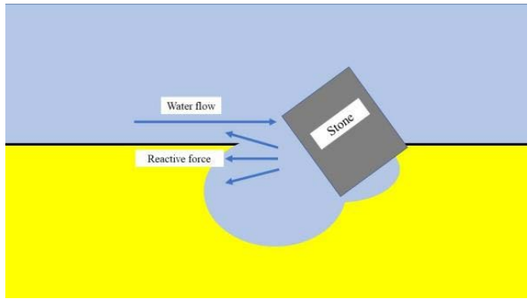

Figure 4 Detailed process

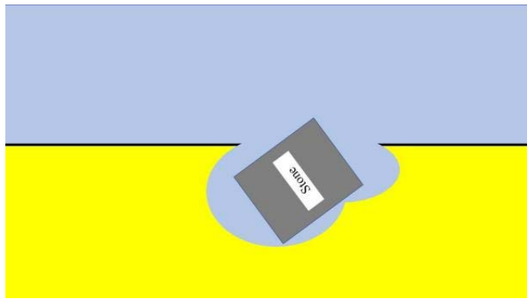

Figure 5 Detailed process

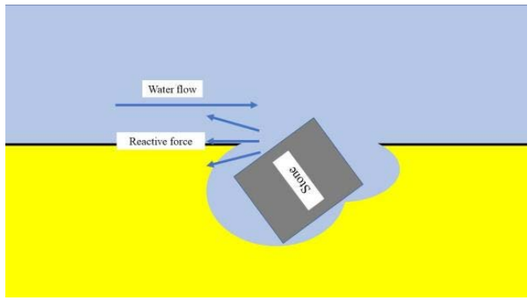

Figure 6 Reason

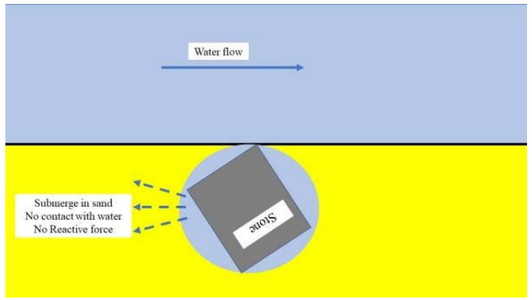

Figure 7 Reason

2. Method

The research goal is to get the equation that describes the relationship between the water velocity, the mass(volume) of stones, and the state of the motion of the stone under the water. Then use the equation to evaluate the trustworthiness of the theory in the prose. The data which is going to be used in this research will be primary data that is collected by experiment. To make the simulation close to the situation in the prose, marble, which is the material of the stone beast, will be used to simulate the stone beast. Therefore, the masses of the marbles can be substituted by the volumes of marbles. The data required include ratio data which is the speed of water and the volumes of the marbles, and rating data which is the state of the motion of the stone under the water. There will be five possible states which are moving along the water flow, moving along the water flow then stop moving, not moving at all, moving in the opposite direction of the water flow then stop, and moving at the opposite direction of the water flow.

First, building a model with acrylic plates, two water pumps, sand, water, and other things to simulate the environment of the river bottom. The detail of the model is shown in the schematic diagram below. Next, search for suitable marbles, the shape of marbles should be close to cuboid, which has the ratio of the length of the edge 1:1:2. There should at least be 10 marbles and their volume should approximately be from 16000cm3 (40cm*20cm*20cm) to 1600cm3 with a common difference of volume 1600cm3. However, it is hard to get the marbles that have volumes that are exactly the same as the idealized volume. Thus, choose vessels that are suitable for each marble and use the Archimedes method to calculate the exact volume of marbles before start the experiment.

Put one marble into the model. Then, change the rotation speed of the two water pumps to 2400r/min, 1900r/min, 1400r/min, 900r/min, and 400r/min. Every time after changing the rotation speed of the two water pumps, measure the water velocity by the current meter and observe the state of motion of the marble. After record the data, take the marble out of the model and put another marble in and do the same thing. The experiment will use a table to record all the data. Which is shown below.

In order to get the equation, the software, IBM SPSS Statistics is going to be used to analyze the data. Due to the types of data used in the experiment, multinominal logistic regression is the suitable analyzing method.

After getting the equation, substitute the volume of the stone beast and the water velocity into the equation, it will show the motion of the stone beast.

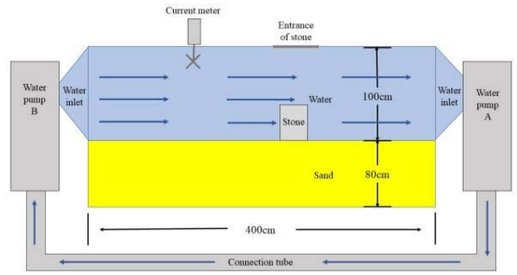

Figure 8 Schematic diagram of the experience equipment

Table 1 Statistical table

Volume / State / Speed	cm^3	cm^3	cm^3	cm^3	cm^3	cm^3	cm^3	cm^3	cm^3	cm^3
m/s										
m/s										
m/s										
m/s										
m/s										

3. Expected Results

In the expectation, both the speed of water and the mass(volume) of the stone will affect the motion of the stone. As the decreasing of the water velocity or the increasing of the mass, the direction of the motion of the stone will change from the same direction of water flow to the opposite direction of the water flow, but the motion will stop eventually. Also, the stone beast in the river will move upstream a short distance and then stop moving.

4. Future improvement

In the future, when the experiment is been taking, there should be more variables being considered in the model. For example, the particle size of the river sand. Also, if the marbles are so heavy that the water flow cannot move them, pick some smaller marbles to experiment.

If the experiment proves that the theory in ancient Chinese prose is wrong, the research will be sent to the internet as a video. Hopefully, this research will teach people that it is important to always be curious and be brave to challenge authority.

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The Students' Saver Plan - "Minty" and Chemistry behind it

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Chemistry

Abstract: This paper will discuss the plan for making the product "minty" and the preparation and synthesis route of the effective ingredient: L-Menthol. And simultaneously, some outlook to further make it into product and industrialize the product. My topic do have several advantages. First, it is practical, and it does not involve knowledge that is too hard for us to tackle, nor requires special equipment to experiment. Secondly, it is valid and can be applied in our daily life, and the consumer would be all students. Then, it is innovative since no specific product is aimed at this phenomenon. The outcome of my research is this paper on the method of producing the product conveniently. My optimistic research goal would be to find a way to make the product at home with no special requirements, and I'll search for papers and do surveys on it. Minty is my product that can quickly refresh your sense when you are in the dilemma of sleepiness.

Keywords: menthol, synthesis, food science, Chemistry

1. Introduction

Menthol is a chemical having the most extraordinary global demand among the mint products. It is widely used as an aroma or flavoring agent in pharmaceuticals, cosmetics, and food products. Among the isomeric menthol, only L-menthol and D-menthol are commonly used in the pharmaceutical and aromatics industries. L-menthol and D-menthol is a pair of enantiomers, having the same molecular formula and roughly the same structure; their properties are similar, except one thing, L-menthol has a sweetish stimulating scent, and its cooling effect is quite strong, while D-menthol has a spicy, refreshing scent and barely has any cooling effect. So L-menthol is more widely used in industries. The paper would be mainly about some synthesis routes of the chemical L-menthol, which would be the primary and effective ingredient of my product.

2. Research and Methods and results

After making L-menthol the main ingredient, we need to find a decent way to synthesize the compound. Several companies' synthesis routes and some in papers that are not industrialized yet were analyzed to decide the route that most meets our needs. The following methods would be only the representative ones.

First, I'll introduce the oldest way of getting the material, which is extraction. No chemical reaction is needed under this circumstance, and what you need is just a set of standard distilling equipment. It's cheap and not energy-consuming, but it has an unacceptable drawback, its impureness. D-menthol and L-menthol are mixed in the product, thus making it less effective, and the expense of the raw materials shall also be taken into consideration.

Then, an industrialized synthesis route by the famous Japanese condiment company: Takasago, which takes over nearly half of the menthol market. The synthesis route utilizes myrcene as the material to synthesize menthol. It was first reacted to HNEt2 with lithium as the catalyst to perform a 1,4- electrophilic addition reaction and connect the NEt2 onto the chemical as a protective agent for later the following reaction, which employs BINAP-Rh to give chirality to some particular carbon atoms in the compound. After that, hydrogen ion was used to perform a hydrolysis reaction to remove the protective agent and form an aldehyde group on the aliphatic compound. Then ZnBr2 was added to create an alicyclic compound with six carbon atoms in a cycle. At last, hydrogen gas was introduced to perform a simple addition reaction to eliminate the last double bond in the chemical.

The route isn't too long, and the catalysts involved are easy to separate and recycle while also suits mass production. It's a great plan, but one thing kills it. BINAP-Rh is extremely expensive as it contains rhodium, and simultaneously, the catalyst is hard to synthesize. Some reactions in the route also require an extreme condition that needs specific equipment to provide.

At last, there's the route industrialized by the German company Symrise, using thymol as the primary material to synthesize L-menthol. It's first reacted with propylene with silicone dioxide and ferric oxide as catalysts, performing an electrophilic substitution reaction to add an isopropyl to C(2). A significant quantity of hydrogen gas and metallic catalysts were added to the compound then. The heat was required to provide the activation energy to destruct the compound's aromaticity, thus turning benzene into a hexatomic ring and forms menthol. The synthesis route is straightforward and doesn't require special conditions, though the uncertainty of the last reaction of the route gives the problem of separating the catalysts and products; it can be solved by utilizing benzoic acid to form an ester group that enables the compound to be later crystallized. This route meets my needs.

After deciding the main ingredient, I shall start to find out an appropriate consistency for the product.

3. Experiment process

3.1. Use 6 test tubes, each put in the same amount of water(10ml), and then put in menthol, which mass is in the ratio of 1:1:1:1:2:3, then dilute the menthol into the water.

3.2. Cool the first, fifth and sixth tube to 10 degrees, second to 20 degrees; heat the third to 30 degrees, and the fourth one to 40 degrees

3.3. Drink them and score the effect of freshness (from 1-5)

3.4 Draw a graph and use SPSS to decide the relationship of temperature and the consistency with the effect of the product, thus finding the most effective one as my final product

4. Future outlooks

In the future, I'll try to add side ingredients that would enhance its flavor and develop a mature process that would help me produce the product regularly and conveniently. After the research on the process, I would test the product by launching a survey to ask the consumers of the product to score it and make some suggestions. If it's all set, optimistically, I will try to apply for a patent.

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A Critical Analysis of the Effects on the Cognitive Functionalities of the Human Brain, from Vitamin C and E

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Abstract: The aim of this dissertation is to seek the effects of vitamin C and E on the cognitive functionalities of the human brain by feeding 3-month specific pathogen-free male and female mice with vitamin C and E for 8 weeks, examining whether it is necessary to take vitamin pills since businesses have kept on boasting the effects of vitamin pills. The mice are tested by Y maze at the 4th week and the 8th week. Paired t-test is used to calculate the significance difference for data.

1. Introduction

Nowadays, vitamin pills are quite popular and taking vitamins orally becomes a trend in the 21st century. By propaganda, businesses selling vitamins sometimes assume that their products are influential on enhancing people's physical or mental health. If vitamins really have those positive effects on cognitive function, it might lead to fewer cases of illnesses, such as dementia. By contrast, if results in the experiment can't represent the effectiveness of those vitamins as the businesses assumed, consumers could change their choices to better products that are more effective instead of blindly believing in what the advertisements advocated.

2. Method

In present study, y maze is used for examination. During the experiment, both male and female mice are presented and each gender is divided into four groups with 5 mice for each. Thereby, there are eventually 8 groups in the experiment. All groups of mice take corresponding types of vitamin pills orally for 8 weeks and vitamins are added into water or feed once a week. Before feeding vitamins, mice are placed in the lab for 1 to 2 weeks to familiarize with the new environment. After that, each group was equally fed with 250mL of normal water and 300g feed for one week, alongside this principle, something extra is added to see the distinction: Group1 has nothing added; 400mg of vitamin E was added in feed for Group2; 300mg of vitamin C was added in water for Group3; Group4 was fed additionally with both 400mg of vitamin E in feed and 300g of vitamin C in water.

A Y maze is used in the experiment at the 4th and 8th week to evaluate the short-term memory of the mice. The principle is that the instinct of rodents determines that they prefer to explore unknown environments, so they are willing to go into an arm that are not previously visited. (Stanford Medicine, n.d.) If the mice go back to the last arm, it means the mice forget the fact that it has been through the arm before. (Stanford Medicine, n.d.)

There are totally 3 arms with the angle between each arm is 120° and the dimension of each arm is 30cm*8cm*15cm (length * width * height).

As the experiment begins, one mouse is placed at A and has free access to other arms in 8 minutes. It is required to record the arms mouse entering into within 8 minutes and find out whether the results are valid or not. The criterion to determine is to see whether the mouse succeeds in entering distinct routes for three times (Fig. 1). Otherwise, the mouse fails (Fig. 2). Then, calculating the index of short-term memory, also called alternation rate, and standard deviation, then making comparison.

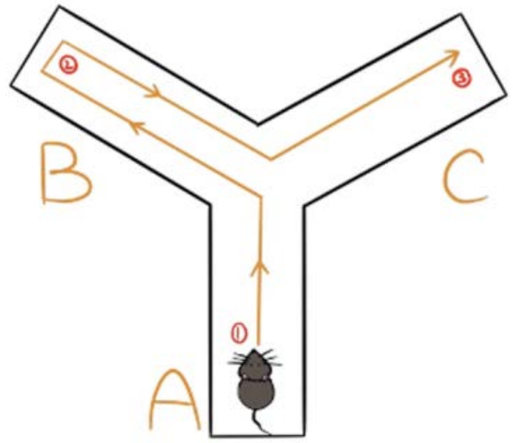

Fig. 1. successful pathway

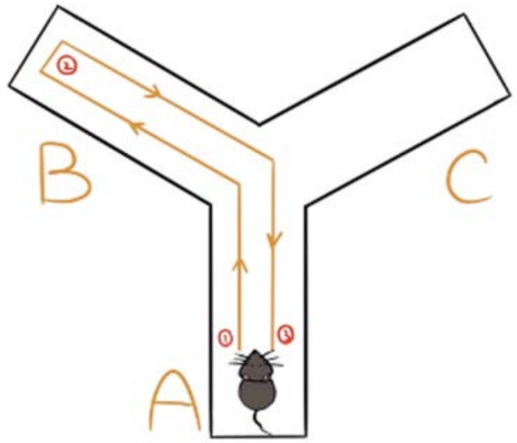

Fig. 2. failed pathway

Alternation rate (%) = number of success ÷ (total number of arms the mouse entered − 2) × 100 (田熊 一敞，永井 拓，山田 清文 , 2007)

3. Results

Paired t-test is used to observe significant difference among the data for the 4th week and the 8th week. If there is significant difference between 2 groups, it means that the probability to observe and receive the same data are less than 5%, which refers that the result is caused by the experimental management or therapy. (Significant Difference definition | Psychology Glossary | alleydog.com, n.d.)

Forms below exhibit that Group2 and 4 mice and Group3 male mice have the probability (P) value smaller than 0.05.

Paired Samples Test

				Significance	
			df	One-Sided p	Two-Sided p
Pair 1	VCmale4 - VCmale8		4	.011	.021

Paired Samples Test

					Significance	
			t	df	One-Sided p	Two-Sided p
Pair 1	VEfemalel4- VEfemale8		-4.304	4	.006	.013

Paired Samples Test

				Significance	
			df	One-Sided p	Two-Sided p
Pair 1	VEmale4 - VEmale8		4	.004	.007

Paired Samples Test

				Significance	
		t	df	One-Sided p	Two-Sided p
Pair 1	VCVEfemale4 - VCVEfemale8	-2.954	4	.021	.042

Paired Samples Test

				Significance	
		t	df	One-Sided p	Two-Sided p
Pair 1	VCVEmale4 - VCVEmale8	-3.219	4	.016	.032

In contrast, Group1 mice and Group3 female mice obtain P value that is larger than 0.05, which demonstrates that there is no significant difference.

Paired Samples Test

				Significance	
		t	df	One-Sided p	Two-Sided p
Pair 1	normalfemale4 - normalfemale8	2.570	4	.031	.062

Paired Samples Test

		t	df	Significance One-Sided p	Significance Two-Sided p
Pair 1	normalmale4 - normalmale8	2.220	4	.045	.091

Paired Samples Test

		df	Significance One-Sided p	Significance Two-Sided p
Pair 1	VCfemale4 - VCfemale8	4	.234	.468

For the following bar graph, the numbers exhibited in Y axes are the alternation rate. The comparison on data of cognitive functions after male and female mice eating vitamins or not for 4 weeks and 8 weeks is present (Fig. 3).

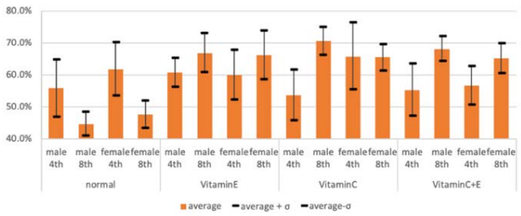

Fig. 3. Results for the experiment

The subsequent results indicate that there is significant cognitive improvement for both genders when eating both vitamin E pills and C pills for 8 weeks. Meanwhile, eating vitamin C pills for 8 weeks could improve male's cognitive function but not that of female. Additionally, vitamin pills will only be effective with constant intake for a long period of time.

4. Future improvement

Virtually, several limitations present in this study. Firstly, consumption might occur when putting vitamins into water or feed, especially when smearing the vitamin E on feed. Volatilization might occur during the week, decreasing amount of vitamin E inside the feed. One solution might be adding slightly higher number of vitamins to reach the amount required. Additionally, mice might not consume exactly the same number of vitamin pills expected, causing deviation in data. Feeding mice one-by-one every day to make sure the amount of intake for the mice might be one solution. Ultimately, the improvement of cognitive functions could be triggered by other factors, such as increase in age or potential amount of vitamins in feed. Thus, it might be better to detect and inactivate vitamins in feed.

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Design of a Submersible for Observing the Behavior of Deep-sea Gastropod Mollusks

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Engineering

Abstract: Mollusks play an important role in the food chain of marine ecosystem. However, due to limited detection technology and equipment, there are few studies on them, which mainly focus on those living in shallow sea. Therefore, this project aims to design a deep-sea observation submersible to conduct a comprehensive underwater ethology survey of the lifestyle, food chain, and life cycle of deep-sea mollusks in a "living" form through stable seafloor detection. It is hoped that this project will contribute to better protection of ecological environment and research on earth science and global change.

Introduction

The development of deep-sea mollusks resources is limited by the detection equipment, resulting in little human understanding of deep-sea mollusks. The Chinese Academy of Sciences has developed a cable-controlled Remotely Operated Vehicle (ROV), with the function of collecting biological specimens and detecting multiple data. But it must be connected the mother ship by umbilical cable and its dive time is limited. Therefore, it is necessary to develop a deep-sea observation submersible which is capable of conducting stable seafloor detection and transmitting clear pictures and use it to carry out a comprehensive underwater ethology survey of the deep-sea mollusks in a "living" form for better ecological environment protection.

Method

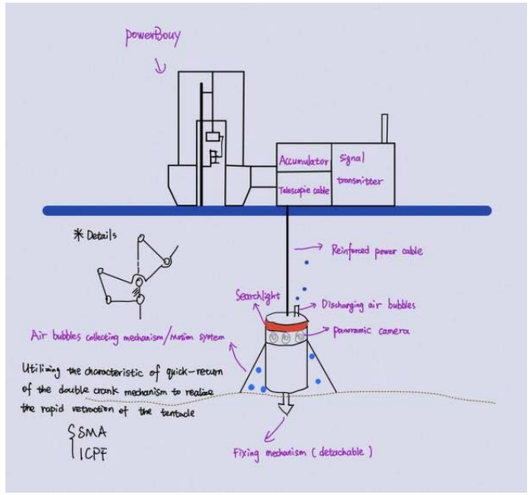
1. Discuss and design the "bionic razor clam and jellyfish-like observation submersible in cold-seep ecosystem" (as is shown in Picture 1). The advantages of the device are as follows.

i. The motion system is equipped with Ionic Conducting Polymer Films (ICPF) and Shape Memory Alloys (SMA). The SMA acts as a support after the bionic jellyfish-like submersible pushes the water away and lands on the seafloor by a form of jet propulsion. The umbrella-shaped ICPF collects air bubbles underwater and discharges them upward through a conduit to minimize the adverse impacts caused by bubbles on observations in cold-seep ecosystem.

ii. The part of the device above water consists of a PowerBuoy, which generates electricity from tidal energy, an accumulator and a signal transmitter, which transmits the data detected on the seafloor to the device above water through a cable and then to the research institute in real time.

iii. There is a telescopic fixing mechanism with great weight attached to the bottom of the device, which can detach from the device and stretch into the sand after the device lands on the seafloor. The separation of the fixed mechanism can adjust the density of the device so as to lift the device up in case of the accidental breakage of the cable.

iv. The device is equipped with a panoramic camera and a special searchlight, which emits special lights in order to avoid the photophobia of deep-sea marine life caused by ordinary light.



Picture 1 Design of deep-sea mollusks observation submersible

2. Research on the effect of anti-adhesion coatings against marine life— looking for the outer coatings on the lens of the detector, which can prevent marine life adhesion.

Optional coating materials:

A. Metal-based coatings: utilizing divalent copper ions (usually extracted from copper (II) acrylate).

B. Low surface energy coatings: increasing the difficulty of marine life adhesion by reducing the surface energy of the substrate.

C. Marine life extractive coatings: extracting biomass coatings from marine organisms that can resist bio-adhesion.

Test method:

i. Take 40 pieces of glass that will be made into lens and divide them into four groups of ABCD, each group of 10 pieces;

ii. Group A is the control group. Cover group B with 5 μ g/L of copper-based coatings, group C with a suitable concentration of low surface energy coatings, and group D with an appropriate concentration of marine life extractive coatings;

iii. Place the four groups of glass pieces in the same sea area near the seafloor, and guarantee the glass pieces will not touch the seafloor and be at the same depth. Each two pieces should be separated by one meter, and be taken out from the sea after one month;

iv. Test the degree of light transmission of ABCD groups and average the results;

v. Compare the data and find out the glass with the highest transmittance.

Transmittance test method: place glass pieces covered with three different coatings in water for 30 days and then measure their transmittance by a spectrophotometer.

Expected results

Record the transmittance of each group and calculate the average. Find out the correlation between coatings and the transmittance by the analysis of variance (ANOVA). The focus should be put on the homogeneity of variance and the results of one-way ANOVA.

Future improvement

1. To investigate what kind of light does not affect the gastropod mollusks; to explore the physics problems to be overcome by deep-sea submersible and their solutions.

2. To find out the pressure range of the jellyfish-shaped submersible, required power supply efficiency, corrosion resistance, underwater movement performance, fixation effect, bubble collection funnel and discharging effect, the maximum pressure the submersible can withstand, and the efficiency of power generation assembly.

3. To equip the submersible with high-definition real-time video transmission system, and fulfill the function of detecting back-end marine organisms.

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Studying on establishing "water-plant-animal" ecological model to solve the problem of eutrophication in Lihu Lake

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Environmental science

Abstract: Eutrophication is the main cause of cyanobacteria outbreak in lakes, and cyanobacteria outbreak often brings more serious water pollution. In order to better prevent and control the eutrophication of Lihu lake, five aquatic plants such as Oenanthe javanica (Bl.) DC., Pistia stratiotes L., Eichhornia crassipes (Mart.) Solms, Canna indica L.and Sagittaria trifolia var. Sinensis were cultured in the eutrophic water body for 4 months. Through observing the plant growth status, the accumulation of nitrogen and phosphorus in the plant and the removal rate of total nitrogen and phosphorus in the water body, the plant species suitable for local growth and strong nitrogen and phosphorus adsorption capacity were selected, It provides a theoretical basis for establishing an ecological model of "water plant animal" to prevent and control the eutrophication of Lihu lake.

Figure 1: Lihu lake map

Introduction

Many lakes often break out "cyanobacteria events" due to water eutrophication. A large number of cyanobacteria will cause water pollution and a large number of aquatic animals, which will seriously affect people's life and production. The construction of ecological environment has been paid more and more attention by local governments. The use of aquatic plants suitable for local growth to absorb the surplus nitrogen and phosphorus in the water body, and after its growth, it is processed and modulated to feed animals, so as to establish an ecological model of "water-plant-animal". It can not only absorb the surplus nitrogen and phosphorus by plants, but also be modulated into feed to feed animals, taking into account ecological and economic benefits, which has important production and practical significance.

Method

1. Test material

1.1 5 kinds of aquatic plants (Oenanthe javanica (Bl.) DC., Pistia stratiotes L., Eichhornia crassipes (Mart.) Solms, Canna indica L.and Sagittaria trifolia var. Sinensis), each of which is 200g (fresh weight);

1.2 15 plastic barrels with length, width and height of 70cm, 60cm and 50cm, and the bottom of the barrel is paved with 20 ~ 30cm yellow sand. The experimental water is the eutrophic water sample prepared by adding an appropriate amount of CH4N2O and Ca3 (PO4) 2 into Lihu lake water. The total nitrogen is 12mg · L-1 and the total phosphorus is 0.3mg · L-1 (this is the highest value of nitrogen and phosphorus in Lihu lake water in 23 years).

2. Test operation and measurement index

The selected 5 plants were cultured in plastic barrels, and each plant was repeated 3 times. The water lost due to sampling, plant absorption and evaporation during culture shall be supplemented with distilled water.

2.1 The plant biomass was measured at the beginning and end of the experiment, and the difference between the two was the net increased biomass of the plant;

2.2 After 4 months of culture, samples were taken from each aquatic plant to determine the fresh and dry weight of the sample and the content of nitrogen and phosphorus in the sample;

2.3 During the test, water samples were taken every 30 days to determine the contents of total nitrogen and total phosphorus in the water;

2.4 The total nitrogen and phosphorus removal, the contribution rate of nitrogen and phosphorus removal and the nitrogen and phosphorus removal capacity of plants in different plant culture water samples were calculated.

Expected results

1. According to the growth performance in the process of hydroponic culture, plant species suitable for local climate and good growth were selected.

2. By calculating and analyzing the total nitrogen and phosphorus removal, the contribution rate of nitrogen and phosphorus removal and the nitrogen and phosphorus removal capacity of plants in different plant culture water samples, the plant species that can adsorb nitrogen and phosphorus efficiently are determined.

3. Combined with the growth and nitrogen and phosphorus adsorption capacity of the selected aquatic plants, the aquatic plant species with strong nitrogen and phosphorus adsorption capacity suitable for local habitat conditions were selected.

Future improvement

In order to improve the proposed "water-plant-animal" ecological model, after screening suitable aquatic plants, it is necessary to conduct a feasibility study on their use as animal feed. After finding such a plant, I will use the investigation method to find out what kind of livestock feed this plant can make; Whether the yield of plants can be enough to supply surrounding pastures after being made.

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Compared To Breeding Predators and Setting Up Special Devices, Can Modifying Mosquito Genes Lead to New Developments in Mosquito Control?

Biology

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Abstract: Mosquitoes cause at least 2.7 million deaths every year and about 500 million cases of mosquito-borne diseases occur annually. Therefore, methods and routines to eliminate those mosquitos has always been placed in a serious position. Currently, there are a lot of new technology be Invented in this area. Such as genetic modification, breeding predators of Mosquitoes or even use the instruments to destroy them. In order to lower the cost of time and resources. I set some simple experiments and investigations to compare those three methods from different aspects - efficiency, cost, time length, technology requirements and covered area and try to find out the appropriate way to eliminate Mosquitos.

1. Introduction

In order to get a clearer view about my experiment. I would first list out some usable knowledge mentioned and some technology relates to this experiment. Firstly, anopheles gambiae, this is a kind of mosquito which carries Malaria. The gene which determine the gender - Yob only appears on the Y chromosome of males. As the content of the investigation said: "If Yob is injected into embryos younger than 2 hours, only male mosquitoes emerge, because Yob's presence is lethal to female embryos." (Science 353 (6294), 67-69) Therefore, by modifying the Yob in the gene of mosquitoes, we can control the gender of them.

Secondly, the special devices are photocatalytic mosquito killer. Photocatalytic mosquito traps use ultraviolet light, which is the mosquito's favorite lamp. They are sucked to the bottom of the trap by the vortex of the fan, where they dry out and die.

The last one is a kind of fish called GAMBUSIA AFFINIS. This is a kind of small fish, living in reservoirs, lakes, ponds, swamps, rice paddies, canals, depressions and other static water bodies. Their movement is lively and agile. An adult fish eats more than 2000 larvae every day.

By designing experiments, I'm going to combine and compare those three kinds of methods used against killing mosquitoes.

2. Method

2.1. Divide the 400-square meter site into four parts and use blocks to isolate them. Build a greenhouse in each part of the site to ensure successful bonding

2.2. Each shed will house 5 pairs of rabbits and 50 pairs of mosquito larvae

2.3. The gene of one male mosquito was modified in greenhouse 1, a pair of mosquito fish was placed in greenhouse 2, and a photocatalyst mosquito killing lamp was placed in greenhouse 3

2.4. The number of male and female mosquitoes in the shed was recorded every 7 days

2.5. The data were collected and compared after 35 days

2.6. Draw and calculate the greenhouses with the least remaining female mosquitoes and the least total number of mosquitoes

Equipment's required

1. Firefox, Google Chrome, Baidu
2. 400 mosquito larvae (200 males, 200 females)
3. 400 square meters of natural ecological environment (water, plants evenly distributed) experiment site
4. 40 rabbits (20 males and 20 females)
5. Rabbit feed (regular supplement)
6. Genetically modified mosquitoes (inferences based on online papers and data if not available)
7. A pair of mosquito fish
8. A photocatalyst mosquito lamp
9. Blocking
10. To shed
11. Four thermometers

3. Expected results

Although can't get real data from experiment, according to the network literature, photocatalytic mosquito killer has great advantages in a short time but can't completely put an end to the production of female mosquitoes, mosquito fish food is also in the same way, and genetically modified mosquitoes' technology can be in long-term governance on the number of female mosquitoes, although the process is slow, but the effect of a few years later forecast will be better than the other two.

4. Future improvement

During the experimental design, I often worried about whether I might miss any variable that might affect the results and doubted whether my design was reasonable because it could not be put into practice now. Later, after consulting the data, I may slowly correct some of the shortcomings. If I could still investigate this, I would like to do it in the field and get real data.

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SILVER

New Ways of Designing Small Sounding Rocket Fins

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Engineering

Abstract: When choosing my project, the first thing that comes into my mind is my love for rocket science. That’s why I decided to go for a topic based on this subject: to design two new ways of stabilizing a small sounding rocket, then test and compare them with traditional method. Also, to compare different materials of the fins of my concept. In my rocket-launching experience, I have discovered that the traditional way of placing rocket fins (on the rear) can cause damage to the fins, even the engine mount. The fins can be easily burned and damaged during the lift-off process causing rockets to be unstable when flying. By moving the fins to the middle of the rocket or replace them with vortex generators, the rocket is more likely to be stable as normal pattern, with bonus benefits including reusability and better launching pattern, in short, to improve the efficiency when launching.

The two ways of placing fins are first designed via Soildedge 3D and SpaceCAD. A small wind tunnel will be built for testing. The two designs will be amended and tested on real rockets by launching them and reusing them, getting solid data to compare.

Introduction

The purpose of putting fins on a small sounding rocket is to provide stability during flight, which means, to allow the rocket to maintain its orientation and intended flight path (Richard Nakka, 2001). Then the rocket can achieve a better flying. The problem here is that the rocket's center of pressure (CP) would be forward of its center of gravity (CG). Fitting fins on a rocket helps to locate the center of pressure aft of the CG. If the rocket is considered stable, the CP would have to be forward of CG, for if there is a change in angle of attack, the fins on the rocket would produce a lift, and this force is balanced by the force due to wind, so the rocket can correct itself during the flight. With such an arrangement, it is simpler to form the root bend on the fins, and end up with fins that were neatly and symmetrically aligned (Richard Nakka, 2001).

In my rocket-launching experience, I have discovered that the traditional way of placing rocket fins (on the rear) can cause damage to the fins. Although the fins are normally placed in the rear end of a rocket, I discovered that using larger fins in the middle, the rocket can also be stable as that one.

The purpose of the launch pod is to make sure the rocket is stable when it leaves the pod without damaging the rocket itself. With the new fins added, the fins can help to stable the rocket as a stand. The diversion trench is used to guide hot air out of the launch tunnel, away from damaging the rocket.

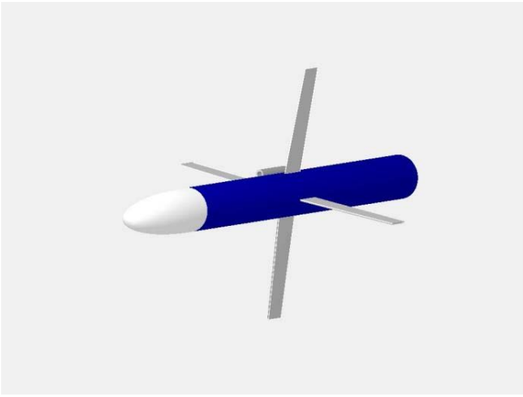


Figure 1. A rendered picture of the design from SpaceCAD

Figure 2. A rendered picture of the launch pod

Another design is using vortex generators instead of the fins to stabilize the rocket. They are used in the project to better controlling the airflow over the rocket without producing much lift.

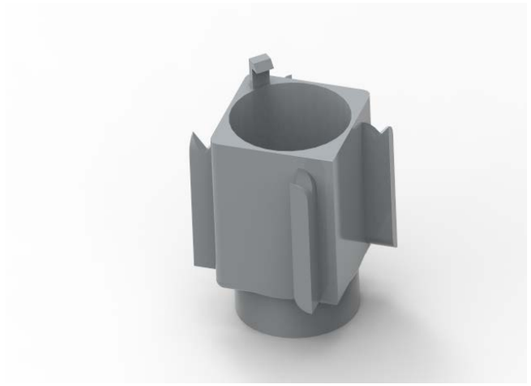


Figure 3. A rendered picture of the engine mount with 4 vortex generators

Method

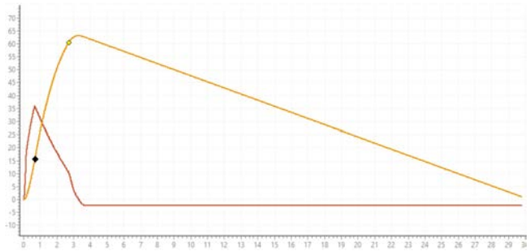
I will use experiment, simulation and statistics in my research. There are many factors that could influence the rocket's flight in the sky, which means we must try to do launch tests based on a real environment to get some feedback. However, before we put our pattern onto a real rocket, we have to make sure that it is stable, safe and useful. That's why I decided to do simulations before the launch.

A total of 6 rockets will be divided into 3 groups, each having a pattern of the fins (one normal, two designed). Each of them will be launched 2 times, meanwhile we have to measure the altitude and the distance between launching point and landing point. Then, we compare these data (including the data from simulation) using independent T-test, to find out the influence of each pattern.

Expected Results

The test would prove that at least the new concept of rocket fins is as stable as the normal pattern. The test may influence by the wind and other environmental conditions, so simulation is of great demand. The new launching pod will also be tested in this period. Different materials of the fins will be applied, and stress tests will be carried out according to the process of designing and testing.

Table 1. simulated result of the rocket using SpaceCAD



Future Improvement

The major difficulty I am facing is how to compare the stability of the rocket. I cannot find a perfect answer now, so I choose to measure the distance between launching and landing points. But I guess it isn't everything about stability. The rocket has to be observed along the flight to compare the track.

The fins located on the front end of the rocket provide plenty of room for servers to control movable fins comparing with the fins on the rear end of the rocket. Longer fins are more likely to have detailed control over the rocket when it is trying to land. So further development of the project would be reusable rockets using this pattern to control it.

Acknowledgements

Richard Nakka's Experimental Rocketry Web Site, http://nakka-rocketry.net/ (Last updated August 26, 2001)

Dealing with Nuclear Waste Wate

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Environmental science

Abstract: The paper takes a look at the general field of the disposal methods of waste produced by nuclear power plants, study the specific case of Kashiwazaki Kariwa station and propose an improved treatment with its own apparatus.

Key words: Nuclear waste water, geological disposal

Introduction

Nowadays, an increasing proportion of electricity utilised by society is produced from nuclear power. However, the disposal of nuclear waste water is a thorny problem, which can even become harmful to mankind and our environment if mishandling. It was recently revealed that during the last 8 years The U.S. had been drained off nuclear waste water of a mass of 3000 tonnes into the Pacific Ocean and therefore irrevocable damage has been caused, leading to tremendous economic and environmental loss. What is more, Japan government decided that an amount of over one million tonnes of water contaminated by nuclear wastes would be dumped in the future since the cost of radioactive treatment was out of Japan's capability. Therefore, there is urgent demand for a new and cheaper dealing process with higher efficiency.
In the past century, human beings had discovered a brand-new area connecting pure mass with energy. Starting from 'J. J. Thomson's discovery of the electron marks, in fact, the true starting point of all subsequent theoretical and experimental investigations of the structure of the electron, the electromagnetic mass, and the mass-energy relation in general.' (Faraj), to '… in 1905, on the basis of Einstein's special relativity, in which variations in mass with speed are generalized and made independent of direction; and at the same time, mass and energy are assumed to be equivalent and convertible into each other, although no physical mechanism has ever been given or specified.' (Faraj), the basic theory of nuclear power utilisation was constructed. Then in 1954, the world's first nuclear power plant generating electricity was built in Soviet Union, which brought the world a new method as well as a difficulty: the disposal of nuclear waste water.

Literature review

How does a nuclear power plant work?

As what the graph implies, all of the nuclear waste is, virtually, dumped into water in order to restrict the detrimental effect of radioactivity and cool down the extremely high temperature. Since ‘water is a great shield against alpha and beta radiation and is pretty effective against neutron and x-ray/gamma radiation. While water is less effective against gamma radiation than is lead (a foot of water provides about the same shielding at 1 inch of lead), it's a lot less expensive and is non-toxic. And water won't crack or develop defects that would permit streaming.' (Karam, 2019), and water's high specific heat capacity due to strong hydrogen bonds, it is in fact an ideal container of nuclear waste.

Mankind has been struggling to find a perfect measure to handle nuclear waste water. As a wide-used method, geological disposal is, for short, 'burrowing nuclear waste into the ground to the point where it is out of human reach.' (Ali, 2011). However, problems included are the liability of seepage which could contaminate water tables and arising concerns of terrorism. Reprocessing is a method that 'involves taking waste and separating the useful components from those

that are not as useful. Specifically, it involves taking the fissionable material out from the irradiated nuclear fuel. Concerns regarding re-processing have largely focused around nuclear proliferation and how much easier re-processing would allow fissionable material to spread.' (Ali, 2011). Besides, other treatment ways, such as transmutation (converting a chemical element into another less harmful one) and space disposal (putting nuclear waste on a space shuttle and launching the shuttle into space), are not so mature and not viable at present, especially the latter one as it will lead to further and even harder problems waiting for human race.

Method

The case study of Japanese nuclear power plant in Kashiwazaki Kariwa

As the world's biggest nuclear power plant, in Kashiwazaki Kariwa station there are 'seven reactors generating 8,212MW, and the station is owned and operated by the Tokyo Electric Power Company (TEPCO) which can provide electricity to 16 million households.' (https://www.power-technology.com/)

'Kashiwazaki-Kariwa has seven conventional nuclear reactors, each with an average output of 1,067MW and a power rating of 1,100MW. Work on the first reactor began in 1980, which came on line in 1985. The last came into operation in 1994.In 1996 Kashiwazaki-Kariwa became the first plant in the world to use an advanced boiling water reactor (ABWR) for commercial use. The ABWR, designed by General Electric, is a Generation III reactor and has an average output of 1,315MW and a power rating of 1,356MW. Another ABWR was opened in 1997. All reactors use low-enriched uranium as nuclear fuel. In 2002, the reactors were shut down after data from the plant was found to have been deliberately falsified. Units 1 to 3 were taken offline for the whole of the 2003 fiscal year.' (https://www.power-technology.com/)

Corresponding to the huge size of the plant and the tremendous amount of electricity produced each year, the KK station brings about considerable waste. The most usual treatment, which is dumping it into water, is applied, and later the nuclear waste water is either stored in large tanks or treated via electrolysis. However, since the water is of an enormous quantity, and more importantly, the half-life of the radioactive waste is drastically long - some can even surpass 4400000000 years, nuclear waste water has been continually dumped into ocean and lakes. It is urgent now to find a feasible method before the ocean becomes irrevocably harmed.

An improved way to deal with waste water in general

Directed at the case of the KK plant, a better measure considering the geography and geology of Japan may be applied. To start with, a method of borehole storage can be applied, since it is proved safe and feasible at the first place. In fact, 'nature has already proven that geological isolation is possible through several natural examples (or 'analogues'). The most significant case occurred almost 2 billion years ago at Oklo, in what is now Gabon in West Africa, where several spontaneous nuclear reactors operated within a rich vein of uranium ore. (At that time the concentration of U-235 in natural uranium was about 3%.) These natural nuclear reactors continued for about 500,000 years before dying away. They produced all the radionuclides found in HLW, including over 5 tonnes of fission products and 1.5 tonnes of plutonium, all of which remained at the site and eventually decayed into non-radioactive elements.' (World Nuclear Association, 2021). In addition, the natural collisions and pressure of the Pacific Plate and the Eurasian Plate under Japan produces great heat, which can provide a portion of energy needed to deal with the waste water, not only saving efforts but also weakening the detrimental influence that can result in earthquakes. As for the disposal measure, applying absorption is well suited in the whole storage environment and plan.

The detailed design of the model waste water treater

Firstly, the main storage tank is located at a depth of 4 km under ground level, which ensures that the radiation of the waste cannot permeate the natural shield of geological formation to cause harm to human society and water resources. 'The presence of "old" saline and chemically reducing waters at depth is a key to the success of deep borehole disposal. The presence of old water at depth, which lost active contact with the surface hydrosphere hundreds of thousands of years ago is evidence that there is little driving force for upward water movement. The presence of dense, saline brines at depth is a barrier to buoyant upward movement of the water into overlying fresher water. Oxygen-poor, reducing 4 conditions at depth slow the degradation of spent fuel and maintain many of the radionuclides in their lower valence states, lowering radionuclide solubility controls, and stabilizing most strongly-sorbed forms (Brady et al., 2009). Also, the great depth of deep borehole disposal decreases the number of surface effects that must be considered for long-term performance. These include groundwater infiltration, human intrusion, and effects from climate change including glaciation.' (Sandia National Laboratories, 2016)

Secondly, the tank is made of a mixture of stainless-steel fibre and cotton with a graphite-resin coating that can create a shield blocking most of the radiation from the waste. The proportion of chromium in the material is 15%, and the whole mixture can undertake a temperature of 800 Celsius degrees, while the nuclear waste water in storage in its hottest state is only roughly 350 Celsius degrees.

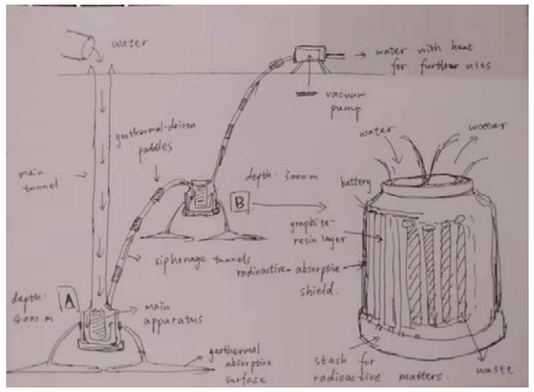
Thirdly, by building long and stable tunnels, water used for cooling and further treatment can be transported into the deep. There, mixing up with denser and saltier deep level water as well as absorbing the heat emitted both by the nuclear waste water and by the collisions of continental plates, the water flow can be circulated by semi-siphonage until it reaches the ground so that the amount of water can be lessened and, on its way back, bringing heat upwards as it does in producing geothermal energy.

Finally, about the treatment of the radioactive matters, they are attracted by the resin due to chemical and physic absorptive effects. After saturated, the harmful matters can be collected by charging the graphite-resin layer and put, by natural pressure, into tiny bottles, stashed in boxes made of highly radiation-absorbed materials.

Experiment design

In order to test the feasibility and efficiency of the new method, a micro-scope experiment can be run and compared with existed methods. The whole simulation can be done with low cost, as the only equipment needed are a source of heat, a simple set of semi-siphonage machine with tunnels and charging plates buried by deep ground soil and absorptive materials. The scale of the device is diminished to a mere 0.2 % of the real apparatus, and in order to make sure the safety of the disposal method, the radiation level 8 metres above the storage tank must drop below 20 mSv per annual. The monitoring of the radiation level can be accomplished by area survey metres. *They are 'Radiation instruments used as survey monitors are either gas filled detectors or solid-state detectors (e.g., scintillator or semiconductor detectors). A gas filled detector is usually cylindrical in shape, with an outer wall and a central electrode well insulated from each other. The wall is usually made of tissue equivalent material for ionization chamber detectors and of brass or copper for other types of detectors.'* (G. Rajan and J. Izewska).

Using the simplified graph below, rough calculations can be made.



Results and discussion

Proper apparatus is needed to run the experiment and obtain data accurately, so detailed figures cannot be presented here. However, the safety insurance of the method can be seen clearly. 'The only radionuclide with a calculated non-zero concentration 1,000 m above the waste disposal zone in the sealed borehole is 129I.

The non-zero 129I concentration (5.3 × 10-8 mg/L) represents the leading edge of the dispersive transport front. However, the center of mass never reaches the top of the 1,000 m sealed section of the borehole because there is effectively no further movement after the few hundred year thermal pulse due to the relative slowness of diffusion. Subsequent diffusive transport to the hypothetical withdrawal well decreases the 129I dose further. The peak dose from the withdrawal well occurs at 8,200 years and is exceedingly small -1.4 × 10-10 mrem/yr and is solely from 129I. For comparison, the Yucca Mountain standard was 15 mrem/yr for the first 10,000 years, and 100 mrem/yr from peak dose to 1 million years.The low-permeability and low thermal conductivity of the surrounding crystalline host rock focus upward flow from the early thermal period through the borehole seals and/or the DRZ. The peak vertical groundwater flux (darcy velocity) through the seals/DRZ is about 0.01 m/yr for about 100 years. This corresponds to a pore velocity of about 1 m/yr, 19 and a center-of-mass advective distance of about 100 m. The region of advective movement is only a small portion of the 1,000 m seal zone. Following the approximately 100-year period of peak thermal perturbation, subsequent radionuclide transport to the biosphere is predominately by diffusion up the borehole seal and DRZ. At this time, most of the short – lived 90Sr and 137Cs have decayed away, leaving just a small mass of 135Cs to contribute to longer-term dose. The baseline scenario results suggest that doses are quite low, even without any performance credit from the waste forms or waste packages. The dose is dominated by 135Cs. Peak dose occurs roughly 2 million years after emplacement and is less than 10-8 mrem/yr.' (Patrick V. Brady, Geoffrey A. Freeze, Kristopher L. Kuhlman, Ernest L. Hardin, David C. Sassani, and Robert J. MacKinnon, 2016). In terms of the economic aspect, it is far cheaper than other methods such as chemical mutation and electrolysis treatment. Actually, 'Borehole disposal of nuclear waste is expected to cost substantially less than traditional mined repositories. Brady et al. (2009) estimated borehole costs of ~ $40M for drilling, completion, and waste emplacement; the whole process for a single borehole would take less than 2 years (approximately 6 months for drilling and a year for emplacement, SNL 2015). More recent, and more extensive cost analysis of Bates (2015) examined spent fuel disposal and varied borehole depth, disposal zone length and borehole spacing in the calculation, while constraining postclosure dose. Bates (2015) established optimized disposal costs to be $45 - $191/kgHM (kg Heavy Metal). These "first-of-a-kind" costs should decrease with experience, but still are substantially lower than the $400/kgHM that was collected in the US nuclear waste fund.' (Sandia National Laboratories, 2016).

Conclusion

Due to the uniqueness of water, virtually all nuclear waste is storage in it, and because the existing treatments of the radioactive matters show their drawback, some of them detrimental, a better way is demanded by the whole human society. After scanning closely at the field of nuclear waste treatment and making comparisons between present methods and the proposed model, it is deemed to be of more efficient and economical to adopt the new measure. Further applications will test the new method, and at the same time, further research is required since the future of the nuclear power greatly depends on the feasibility to handle the waste it produces.

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Airport of the Future Evaluate typical airports that have used robotics and artificial intelligence, and analyze the changes that Nanjing Airport can make now to reduce the use of human resources and increase convenience for passenger and airport management

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Engineering

Abstract: Artificial intelligence and robots have entered the public's field of vision, including industrial and civilian robots. Many airports are already using artificial intelligence and robots to help people get a better experience, but most airports in China have not started to use robots as an auxiliary tool extensively. This also greatly reduced the operating efficiency of the airport and the passenger experience. This article focuses on the evaluation and analysis of some case airports where robots and artificial intelligence have been used as well as providing ideas for the future development direction of China's airports and emphasize the usage of small robots, biometrics.

Introduction

There was a large-scale of covid-19 pandemic had swept in Nanjing at the end of July. One of the reasons was the failure of management of the airport, which led to the spread of the virus on a large scale among relatives. If prevented from the source, that is, to reduce the use of human resources, theoretically, it can not only greatly improve the operating efficiency of the airport, but also increase the convenience for passengers as well as enhancing the "no manual" internal airport services, so as to avoid frequent occurrences such as inefficient airport operation and extremely poor passenger experience. Furthermore, I also studied some applications of artificial intelligence and robots in airports in the summer institution of the University of Hong Kong this summer. I agree that this is a topic worthy of research.

Method

I've watched a lot of authoritative YouTuber videos、official website information, documentaries and other second-hand materials to investigate background as well as use the method of descriptive statistics to carry out the statistics and analysis of the data, then evaluate each application of artificial intelligence and robots in turn, finally find the best fit plan for Nanjing Airport. The cases analyzed include the Remote-Control Tower at London Airport, Smart-Gate at Dubai Airport and other related technologies.

Expected results

Find a feasible solution for the use of robots and artificial intelligence in Nanjing Airport, including economic feasibility and technological feasibility. This includes evaluating and analyzing whether some advanced technologies already in foreign airports can be introduced into China. Furthermore, I will use graphs to show my ideas (such as bar-charts (used to compare the speed improvements brought by various technologies, display proportional data), etc.), and I will use tables to compare my comparisons as well as visualize evaluation results and compare existing problems and improvements such as the use of artificial intelligence and robots. In addition, I will use the Richter degree table to rank my final assessment results. In the end, I hope it can successfully display with exhibition boards and animations in the LIYSF scientific research exhibition.

Conclusion

According to my survey of people's feelings about airport robots, it's clear that the people who choose to "like" the most, and some of these comments indicate that they support the technology of the motherland, and some indicate that they have had a good experience, such as their elders once experienced

robot guides at the airport. Furthermore, about the investigation of the time allocation in the airport, I made some comparisons on the time schedule within the airport and some data that can be collected. First, I compared artificial intelligence, self-service consignment, manual passport control and security , and Dubai's unique Smart Gate . The first set of data that surprised me is that self-service consignment and manual consignment are actually the same in terms of time, but since self-service consignment saves labor costs, I think self-service consignment actually has a certain value. Secondly, the Smart Gate unique to Dubai Airport is a lot ahead of other groups in terms of speed, convenience and efficiency. This once again proves to us that biometrics is a very convenient technology.

Further improvement

My project is unable to conduct actual primary surveys and data collection due to time constraints, so the most feasible improvement plan is to investigate the case airport entities in the research plan (such as Seoul Airport, London Airport, Dubai Airport). My choice of topic is very specific, and it is also a topic that few people pay attention to but there are indeed problems. So, I can also gain a lot of new knowledge while researching, which is beneficial for my future study. In addition, as I mentioned before, this field is indeed a field with very little information, including many papers that have not been formally implemented after being published (such as the remote-control tower of NATS). The lack of information means that there are few things to learn from, and the output of papers is very difficult. Secondly, it is also having time limitations. Because the course period is too short and there are few materials, I spent a lot of time in the stage of checking the materials, which is longer than the budget, and the paper creation is a carrier that requires a lot of words and a lot of knowledge. In addition, once you have one hand of data, you can perform data hypothesis testing to truly draw a truly authoritative and feasible conclusion from a mathematical point of view.

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Method, Procedures and an Example of Making a Fusor

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Physics

Abstract: A fusor is a device that uses an electric field to heat ions to nuclear fusion conditions. This project produces a working fusor which demonstrates the fusion reaction. The factors causing failure of the fusion and safety measures for the fusion reaction experiment are also discussed in this research. Some methods to increase the efficiency of the fusor are experimented. This is a feasible and significant project which generates exciting and fascinating results!

KEYWORDS: Fusor, fusion reactor, nuclear fusion reactor, inertial electrostatic confinement device

1. Introduction

Energy is the power source driving the rapid development of human society. Scientists all over the world have been looking for a clean and efficient energy source. Controllable nuclear fusion technology is one of the most promising. Similar to the way the sun burns, it also has a vivid name called "artificial sun", which is an ideal energy source that is almost inexhaustible.

It is not easy to artificially duplicate the sun. However, it is possible to build a fusor in a school laboratory for demonstration. A fusor is a device that uses an electric field to heat ions to nuclear fusion conditions. It is one kind of an inertial electrostatic confinement device - a branch of fusion research.[1] The target of this project is to produce a working fusor which demonstrates the fusion reaction.

2. Method

2.1 Research Framework

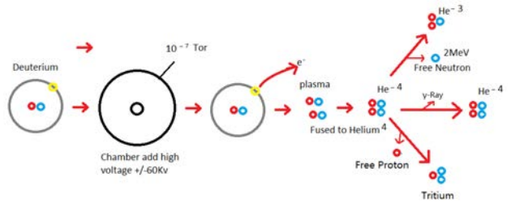

Figure 1. The principle of the fusion experiment.

2.2 Research Methods

The research methods applied for this project are experiment, observation, measurement and statistics. Descriptive statistics is utilized to analyze the experiment result. All the data are quantitative data, which can be measured and will participate in statistics.

The variables include: vacuum level, chamber voltage, current to the chamber, gamma radiation, neutron radiation, inner dimension and volume of the chamber, and grid size.

2.3 Research Material and Equipment

Table 1. Research Material and Equipment List

No.	Item
1	Turbovac 361C turbomolecular vacuum pump
2	NT20 turbomolecular pump controller
3	Edwards ESDP12 scroll vacuum pump
4	ACM2000 ADIXEN vacuum meter
5	M-336MX-SP ANILVA vacuum gauge
6	1110-0153 HVA high vacuum valve
7	60KV 600W voltage supply
8	High voltage passthrough
9	Standard vacuum valve
10	Radiascan-701 α β γ Geiger counter
11	Helium-3 neutron detector
12	Vacuum chamber
13	Fused quartz observation window
14	Needle valve
15	Own-made electrolyze unit with gas collection on anode and cathode
16	Deuterium gas (heavy water if deuterium gas is not available)
17	Tungsten grid
18	Aluminum frame to fix all equipment and devices
19	PC sheets to fix all equipment and devices
20	Stainless steel flange for making the chamber
21	Vacuum sealings
22	High voltage electric wires
23	Teflon Insulator for on the high voltage passthrough
24	Wire connections
25	Two stainless steel halve domes for the chamber
26	Clamps to hold the flanges and sealing together
27	Lithium (if deuterium cannot be made by electrolysis)

2.4 Research Procedures

Step 1: Search available literature and physical resources. Calculate cost and collect funds.

Step 2: Make a design for the fusor and buy necessary parts, equipment, devices and materials.

Step 3: Clean the inner surface of the chamber and all other parts. Assemble all the parts and connect all the equipment and devices. Test the vacuum system.

Step 4: Design and make tungsten fusor grid, controllers, moderator for the neutron counter, deuterium gas flow stabilizer, lead shielding for the chamber, and water cooling for the vacuum pump. Prepare all electric wiring.

Step 5: Make deuterium gas by heavy water and lithium, or by electrolysis with a gas collection on the anode and cathode.

Step 6: Test the fusor with deuterium to see if free neutrons can be measured, which is a sign of a working fusor. In case of insufficient lead shielding or an electric shock, the experiment should be suspended immediately.

Step 7: Analyze the result and review the details of the experiment. Identify all the factors which may lead to a failure result. In case of a failure result, analyze the possible causes and modify the design or improve the experiment condition. Determine all the points for safety in such an experiment.

Step 8: Experiment with different grids to see if the fusion efficiency can be improved by different shapes or sizes of grids.

Step 9: Conclude the project with a project report.

3. EXPECTED RESULTS

3.1 Possible Reasons for Experiment Failure and the Solutions

3.1.1 Insufficient Vacuum Value

It can be a result of incompletely smooth or incompletely clean connecting surface. Bare hands touching should be avoided.

3.1.2 Insufficient Voltage or Power of the Power Supply

The solutions can be: replace the chamber by a smaller one; check insulation issues (arcing); adjust the grid size; or replace the power supply to increase available power.

3.1.3 Unstable Flow of Deuterium

In this case, needle valve may need to be replaced and more coiled tube between valve and chamber need to be added.

3.2 Successful Experiment Result

Figure 2. Picture of own-made fusor.

A successful result of the fusion experiment can be confirmed by the bright purple color glow of the grid in the center of the chamber, which can be observed through the transparent fused quartz observation window. It is also the sign of a successful experiment that neutron emission can be detected by Helium-3 neutron detector, and radiation can be detected by Radiascan-701 α β γ Geiger counter.

4. FUTURE IMPROVEMENT

It is significant to discover more factors causing failure of the fusion and discuss more about the safety measures for the fusion reaction experiment, especially when it is carried out by students. It is also important to study the efficiency of the fusor, to compare the reality and theory, and to further come up with new ideas based on the observed phenomenon, for example, how to improve the efficiency of a fusion reactor, and what contributions this project can contribute to the ultimate dream - making an artificial sun.

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Effect of clusters and sizes of $NaYF_4$ NC_S ls on their luminescence efficiency and drug carrying capacity

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Hylology

Abstract: Synthesis $NaYF_4NC_S$ with different morphologies by solvothermal method, and observe their morphologies and luminescence efficiency. Use cell experiments to test the safety of the material. loaded the upconversion material with doxorubicin(DOX) was obtained,and test the toxicity to tumor cells by cell experiments. Final want to find $NaYF_4NC_S$ with smaller size and agglomeration and higher luminescence and drug loading performance.

Key words: $NaYF_4NC_S$, solvothermal method,morphologies, iuminescence efficiency, drug loading performance

1. Introduction

Nowadays, in the treatment of cancer, chemotherapy is one of the commonly used means, but it has certain limitations, such as low drug efficiency, also is harmful to other cells in the human body. [1]

Upconversion nanomaterials are expected to be used in tumor therapy to compensate for the limitations of chemotherapy. Due to its special upconversion luminescence mechanism, it has unique advantages, such as high sensitivity, strong tissue penetration, no background fluorescence interference. [2] $NaYF_4NC_S$ was chosen as the main research object because of its high luminescence efficiency, large specific surface area, and corresponding controlled release through Light stimulation, which has great medical prospects. [3]

When nanoparticles are too large to metabolize, they will interfere with normal cell work, while when the size and agglomeration of nanoparticles are reduced, there are few studies on their luminescence efficiency and drug loading ability.

The subject of the following research is to modify the luminescence efficiency and drug loading capacity of the $NaYF_4NC_S$ by synthesis different proportions of glycol solutions, in order to find $NaYF_4NC_S$ with smaller size and agglomeration and higher luminescence and drug loading performance.

2. Method

Firstly, synthesis $NaYF_4NC_S$ with different morphologies by solvothermal method, and observe their morphologies and luminescence efficiency.

Next,Use cell experiments to test the safety of the material.

Then, loaded the upconversion material with doxorubicin (DOX) was obtained.

Finally, test the toxicity to tumor cells by cell experiments.

2.1 Synthesis $NaYF_4NC_S$ by solvothermal method.

a Weighting 0.298g Y(NO3)*6H2O、0.089g Yb(NO3)3*5H2O、0.008g Er(NO3)3*5H2O, add 30ml ethylene glycol(EG)，than mixing it for 10 mins.

b Adding0.45g NH4F and 0.0584g .NaCl to the mixture, than mixing it for 20 mins, and hydrothermal it for 12h at 200°C.

c Centrifuging(3mins 12000rps) the mixture 2~3 times by water and ethanol, until no black impurities, dying it for 15mins.

d Repeat steps a~c with using different concentration of EG. (30ml EG, 25ml EG 5ml pure water, 20ml EG 10ml pure water,15ml EG 15ml pure water respectively)

e observing the morphology of the the $NaYF_4NC_S$ by SEM.

f Observing the luminescence efficiency of $NaYF_4NC_S$ by fluorescence microscope.

2.2 Cell death staining experiment.

a Dispensing complete medium and100 μl of cell suspension (5000 cells/well) in a 6-well plate.

b Adding10 μl of various size and morphology of $NaYF_4NC_S$ to be tested to the plate.

c Incubating the plate for 3 hours in the incubator.

d Adding 10 μl of Calcein, AM(2M) and 15 μl of Propidium Iodide(4.5M) to each well of the plate.

e Incubating the plate for 15mins in the incubator.

f Measuring the absorption by inverted fluorescence microscope to observe the safety of $NaYF_4NC_S$.(at 488nm for living cell, at 561nm for dead cell)

2.3 Drug loading

a Configuring 1mg/ml PBS-DOX solution.

b Titrating the pH of PBS-DOX solution to 8 by NaOH and HCl

c Adding 10~20mg NaYF4NCs to 3mg PBS-DOX solution,than adding 1ml PEI(5mg/ml)

d Mixing the mixture for 12hours,and wash it 2 times.

e Make sure the drug is loaded on the $NaYF_4NC_S$ by ultraviolet spectrophotometer.

4.Cell Counting Kit-8 (cck-8) Cell Proliferation and Cytotoxicity Assay

a Dispensing complete medium and100 μl of cell suspension (5000 cells/well) in a 96-well plate.

b Adding10 μl of various morphology of Drug loading upconversion material to be tested to the plate.

c Incubating the plate for 24 hours in the incubator

d Adding 10 μl of CCK-8 solution to each well of the plate.

e Incubating the plate for 4 hours in the incubator.

f Measuring the toxicityof Drug loading upconversion material to tumor cells at 450 nm by a microplate reader to calculate viable cell .

3. Expected result

Water and EG will form microemulsion structure. We expect that the ratio of water and oil will affect the size of water nucleus and the nucleation growth of materials. As the concentration of ethylene glycol increased, the size and agglomeration of nanoparticles became smaller. However, when the size and agglomeration are small, the luminescence efficiency and drug loading capacity may also decrease. Therefore, $NaYF_4NC_S$ with small size and agglomeration and high luminescence and drug loading performance have greater chance to be generated by 20mL EG and 10ml water.

If the experiment is as I expected, the morphology and size of $NaYF_4NC_S$ produced by 20mL EG and 10ml water are measured by SEM are small，In Cell death staining experiment, when the material was put into the cells, the cell death rate was similar to that of the natural group. In cell Cell Proliferation and Cytotoxicity Assay, the material killed more cells.

4. Further improvement

$NaYF_4NC_S$ were ultimately intended for use in cancer therapy, and in the design of the experiment, only cells were tested. After the completion of this test can be further used in mice experiments, the purpose is to gradually tighten the internal environment and internal circulation system with the human body.

In the design of the experiment, the amount of drug the $NaYF_4NC_S$ could deliver was not measured, only the toxicity to cancer cells. The measurement of drug load quantity can be added after drug load.

In the experiment, only the luminescence efficiency of the $NaYF_4NC_S$ without drug loading upconversion material was tested, and the steps to test the luminescence efficiency could be added after drug loading in order to be closer to the real drug environment. (During tumor therapy, fluorescent images of the drug loading upconversion material should be detected by x-ray)

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Causes and Countermeasures of Flood in Taklimakan Desert

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Environmental science

Some time ago, there was a century's rainstorm in the Taklimakan Desert, and the precipitation in the past two years in one day. As we all know, Xinjiang is the driest region in China, while toxon is a rare one in China. The annual precipitation is only 5.9 mm. Although Xinjiang is the largest province in China, with an area of 1.66 million square kilometers, the desert area has reached 421000 square kilometers, accounting for 1 / 4 of the total area of Xinjiang, It has the largest desert in China, the Taklimakan Desert, but recently until June 15. At night, there was a large-scale rainstorm in Hotan area of Xinjiang. The meteorological observatory posted a Red Rainstorm warning signal. The precipitation from June 15 to June 16 reached 86.2mm, which exceeded the precipitation in the previous two years. This rainstorm is really rare in a hundred years and is jokingly called century rainstorm. In addition, as early as May 14, extreme rainstorms also occurred from the middle of lamagan desert to Tacheng area, which is also equivalent to the precipitation in the past few years.

1. Reason

1.1 Long term stay of clouds

It is very rare for such a cumulonimbus cloud to stop in Taklimakan. Professionals have clearly found this problem through satellite detection. Although such clouds are not particularly large compared to many coastal areas, rainfall itself is a rare thing for deserts.

1. 2 Very poor drainage capacity

Once the soil is sandy, it is easy to produce soil erosion after rainfall. Even rivers passing through the desert often do not have a particularly stable river channel. This is why people are very cautious in the process of planting shelterbelts. A little change may have an impact on the ecosystem in the desert.

1. 3 The ice and snow melted a lot

The arrival of summer and the impact of global warming have led to the perennial melting of snow in the mountains. As these melted snow water enters the rivers, it will further contribute to the scale of floods and have a deeper impact.

2. Advantages and disadvantages

For the Taklimakan Desert, the flood should be seen in two. The positive side is that from the matter of desert rainfall, we can see that our current desert governance has brought remarkable results, because only this earth can conserve water, from cumulus to rain, or even heavy rain. Because after all, this is not the north and south poles, and it is not so terrible.

The disadvantage is that it is also a problem of water conservation here. Have you ever thought about where these water sources come from? Moreover, in recent years, the global rainfall has increased significantly, which may be related to the melting of Beichuan in the north and south poles. Moreover, climate warming is a bad thing for most traditional human living areas, but it may be a good thing for some parts of the earth. For example, the defeated Chengguo site in Northwest China once had a warm climate. Perhaps the history of rich soil, fertilizer and water in Northwest China has come

Utilize

In that case, why not apply the experience of desert management to the Taklimakan Desert and transform the Taklimakan desert into an oasis?

In fact, it is not that China is unwilling to transform the Taklimakan Desert, but that it is unable to transform it into an oasis. This is because although Mu Us desert is a desert, it does not have a lot of rainfall every year, with an annual rainfall of 40-400 mm. The reason why it will appear desertification is mainly because human overgrazing and over reclamation lead to soil degradation, so as to form soil desertification. As the desert is mainly caused by human factors and there is continuous rainfall, local reconstruction can be carried out.

However, Taklimakan desert is a desert formed by geographical conditions because of its sparse rainfall and very large evaporation. Because there is no maintenance of rainfall, it is impossible to plant trees locally. Otherwise, even if the plants can survive, it will be a disaster to the local area.

3. Countermeasures

Hydraulic engineering measures:The Guan men Tsui reservoir, which will be built in the future, is a large reservoir with power generation and flood control as the main consideration, taking into account the flood, irrigation and fishery. The completion of the reservoir will raise the standard of the Wutong river embankment to 20~50 in the lower reaches, and then prevent and control the flood disasters in the middle and lower reaches by effective reinforcement of the river and embankment. Field engineering measures mainly include building horizontal terraces, slope terraces and ridges in sloping farmland, adjusting ridge direction and equal height operation, so as to slow down slope, cut off surface runoff and control water and soil loss

Water and soil conservation measures:For example, at the beam top, beam slope, terrace ridge, ditch head, ditch slope, ditch bottom, beach side, both sides of the ditch, around the reservoir, both sides of the road and places where it is necessary. to prevent wind and fix sand, according to different terrain parts, erosion conditions and protection purposes, adjust measures to local conditions, make reasonable layout, correctly select water and soil conservation forest species, and combine them with economic forest, To minimize runoff erosion and soil erosion, prevent natural disasters such as flood, sandstorm and drought, and promote high and stable agricultural yield

Science and technology: Meteorological disasters are one of the important natural disasters in China, and rainstorm and flood disasters are major and frequent disasters in meteorological disasters. Therefore, it is very important to master the spatial distribution information of rainstorm and flood disasters. Flood disasters often have the characteristics of sudden and wide range. Monitoring large-area floods with satellite remote sensing has a wide field of vision and clear flood boundary, Therefore, the introduction of remote sensing information products will make flood disaster monitoring more timely and accurate.

Solution in a long time

Temperature control and control of global temperature rise are the most important key points. How to control the temperature rise? Is to reduce carbon (greenhouse gas) emissions. How to reduce it? This is not a problem that can be solved by one person or one country. Countries all over the world need to work together to deal with it

The United Nations will play an important and key role in this. The Paris Agreement is an important document for countries around the world to deal with global warming. It was adopted at the 21st United Nations Climate Change Conference on December 12, 2015. On April 22, 2016, 178 parties (175 countries) all over the world signed it at the United Nations building in New York. It has been officially implemented since November 4, 2016.

The core content of this agreement is to control the global average temperature rise within 2 ℃ before industrialization and strive to control it within 1.5 ℃ by the end of this century. With this goal, the agreement requires countries to control their carbon emissions

(greenhouse gas emissions) within a certain range.

The so-called carbon neutralization means that within a certain period of time, the total greenhouse gas (carbon dioxide) emissions of a certain region, unit or country are offset by afforestation, energy conservation and emission reduction, so as to achieve zero carbon dioxide emission. In this way, we should reduce emissions and increase emissions at the same time.

Biliography

Why is the desert hit by floods? (Yu,d. 2021; Ai,P. 2021)

Effects of running on human brain

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Biology

In today's human society, mental work gradually began to replace physical activity. People trapped by all kinds of anxiety but unable to vent began to gradually produce negative emotions, which did great harm to people's psychology and physiology. The World Health Organization mentioned that in 2017, more than 100 million people in the Western Pacific suffered from mental health disorders. Depression alone accounts for 5.73% of the disease burden here. At worst, depression can lead to suicide. Nearly 800000 people die of suicide every year.

Facing the common psychological problems in human society, I started the research on whether running has a positive impact on the human brain. The ultimate goal is to let people understand the benefits of running through experimental data, to actively participate in practice. This can effectively improve people's psychological situation and greatly improve the happiness of the whole human society.

To achieve my goal, I will do two sets of experiments. One is to measure the heart rate to reflect the impact of regular running in a long-term situation; The other is to measure the brain wave frequency to reflect the impact of running on the human brain in the short term.

The first set of experiments is to explore whether running can reduce human heart rate. Studies have found that a strong heart can produce a more efficient supply to the brain. For this group of experiments, I will measure the changes before and after the two groups. Through a control experiment between a group of people who often exercise and a group of people who don't exercise, their heartbeat is measured at 8, 9, and 10 o'clock every night to observe whether it is different.

The second set of experiments will explore human brain wave signals. There are four kinds of brain waves in the human body. When people release beta brain waves, it means that they are in a good mental state; The frequency of beta brain waves is much higher than that of other types of brain waves. I will conduct a group of controlled experiments again according to this survey. To explore whether a group of patients with depression measured in a quiet environment a week ago can have different patterns of brain waves after exercise. The reason why patients with depression become volunteers is that their psychological status is more irregular than ordinary people. The experimental data I can measure can more clearly reflect the changes in brain waves caused by running. In terms of experimental equipment, I intend to use the dry electrode EEG system as an EEG instrument. They can be used for general health detection and are relatively cheap. During the experiment, volunteers will be given material rewards.

To complete the whole set of experiments, I will use the methods of literature review and survey method. Through literature review, I can form a general impression of patients with depression, which is helpful for observation and interview. Through the survey method, I can measure the situation of specific people before and after or two groups of different people, and analyze, synthesize, compare and summarize a large amount of data collected in the survey, to provide people with regular knowledge.

For the data analysis I used after the experiment, I will use descriptive statistics to help me analyze the data. For the second experiment, I will measure the EEG images before and after exercise. I will observe the frequency of the images and judge the experimental

data. If after exercise, the brain wave frequency of patients with depression is significantly higher than before, it shows that running can help people. For the first experiment, the heart rate of the two groups was measured. I will first use SPSS to see whether the two groups of data meet the normal distribution, and then use the independence test in the difference comparison to see whether the two groups of data are significantly different from the original. In this way, if the heart rate data of people who do not exercise for a week are different from those of people who often exercise, it will be statistically significant.

However, this experimental design still has shortcomings. In the experiment of measuring brain wave frequency, it may be difficult for patients with depression to volunteer to participate in running or measurement, which greatly reduces the feasibility of the experiment. I plan to adopt the form of a questionnaire survey and cooperate with the hospital after having more convincing data. If running has little impact on the human brain in the short term, I will strive for long-term cooperation with the hospital, which may effectively improve people's mental condition.

I think the future of this discipline still has a long way to go. Because the human brain itself is a very complex human organ, there must be more experiments to explore the secrets of the brain and understand its operating mechanism. These are also the directions I want to explore in the future.

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BRONZE

Bionic Robotic Fish Applied to Marine Ecology and Environmental Monitoring

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Abstract: The ocean is important to the sustainable development of the entire global environment, so we need to treat marine ecology problem seriously. This article concluded the design of a new type of biomimetic robotic fish by improvingthe defects of existing ocean exploration robots in terms of material, volume and power supply, achieve the aim of monitoring the marineecologyagile and precise at a low cost. With different monitoring and sensing devices, it can be used for sea water quality monitoring; marine species monitoring; long term marine mineralexploration. In order to fill the marine database, and help the marine ecological and environmental protection work to the greatest extent.

Introduction

The ocean occupies 71% of the earth's total area, but the human understanding of the ocean is less than 5% of it. The ocean work for the food chain equilibrium and energy supply, so it can can directly affect the ecology and climate of the continent. With the development of submersible technology in recent years,emergence of the ‘Fendouzhe Striver deep-sea manned submersible’ and the'REMUS 600' unmanned submersible, new marine species have been discovered constantly. These new species urgently need biologists to study and investigate. In addition, due to human activities, a large amount of industrial water was discharged into the sea, such as thenuclear waste water leakage accident at the Fukushima nuclear power plant in Japan, which led to the deterioration of sea water quality. So protecting the ocean is really important. After investigation, the shell of the traditional submersible is made of high-strength pressure-resistant alloy material, and the high demand for alloy has caused the problem of high manufacturing cost; the propulsion power of the traditional submersible is the propeller, which is prone to noise when approaching underwater creatures. In order to solve these problems, I envisioned the designing which is a small bionic robotic fish that can perform long-term tasks for marine ecology and environmental monitoring. This design uses soft new materials instead of rigid materials to create a small and smart bionic robotic fish to minimize the impact on the living environment of marine organisms; a new type of power system is used, and the Piezoelectric Effect is used to make the material stretch and move to imitate fish. The swing generates thrust to move forwardto save energy; combined with solar power supply while reducing the original power provided, the new robotic fish designed with low noise, high flexibility, and goal for the lowest impact on the marine organisms, manufacturing costs will reduced, so that large quantities can be produce and put into marine survey work.

Method

This design uses the pressure that a new type of soft material can withstand in the water, for the depth that it can dive to underwater, the speed of the bionic fish based on the fin swing power design, the speed of charging using wave energy or solar energy as the variable for different part of the experiment, carry out literature review and table comparison, for comparing and screening the production materials, energy-saving methods of robotic fish. Perform descriptive statistics and inferential statistics, such as showing the pressure-resistance extent of the material through the rate of changing of the material while undergoing increasing

pressure on it; measuring the power obtained by the fin swinging and the speed of it during charging and repeat this work to calculate the average value. The continuous pressurization of the new material in the experimental site can infer its experimental conditions in seawater. If the experiment in the actual seawater can obtain similar results as in the experimental site, the inference is accurate.

Expected results

Through the collection and analysis of necessary experimental data, and through the analysis of the degree of pressure change of the material under increasing pressure, it is concluded that the soft material: silica gel combined with Polytetrafluoroethylene, compared to the alloy material, it has liked high pressure resistance and corrosion resistance, it also has the advantages of low cost, low quality, lifelike and environmental protection. Combining the use of photoelectric effect, it is concluded that solar power supply has the advantages of energy saving and long-term automation compared with battery power supply, but also has the disadvantage of small power supply. Therefore, combining the two way to reduce part of the power supply. By repeatedly measuring the power obtained by the fin swing and the charging speed, the Young's modulus can be used to form the swing using the elasticity of the material, reducing part of the power demand. The final expectation is the use of silica gel combined with Polytetrafluoroethylene to make the outer skin, solar battery combined with power supply, and small marine survey bionic fish with fin swinging energy to make it realistic and flexible, and realize environmentally friendly, low-noise, and efficient survey work.

Future improvements

The research in this report covers engineering issues, not just through article review and information conclusion, butactual data is needed to calculate and draw charts to check, because error will occur between actual and theories, experimental adjustments are needed at the final plan. Meanwhile, after the new type of marine-detection bionic fish, the follow-up needs to be studied are the various sensors mounted on the bionic fish to achieve the following work, with the characteristics of light, pressure resistance and low temperature resistance, also being able to interact with other submersibles and water detection vessels, in this way we can realize the all-round real-time monitoring of the ocean, and help the protection of the ocean environment.

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