STEM EDUCATION NEWSLETTER

SPECIAL ISSUE ON STEM FEST

Samtse College of Education, 2023

Volume 3

Inside this issue

STEM Fest Coordinators' Message

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The future of the world is going to be dominated primarily by science and technology. As such, Bhutan has already made a modest beginning of initiating STEM related programmes in the schools such as the annual STEM Olympiad, introduction of a coding curriculum beginning from pre-primary school, and iSherig ICT Education Master Plan (2019-2024), a government policy document to promote technology-enhanced teaching, learning and assessment practices across all levels of education.

Samtse College of Education has been cognizant of this development and has been making conscious efforts in its vision and action. Under the advisership of the President, the STEM Fest was successfully conducted on 22nd April, 2023 by the Department of STEM Education (DSTEME), SCE on the theme “Engaging with STEM in Education".

The intention of conducting the Fest was to make STEM education a more joyful and exciting learning experience for the learners and to provide opportunities to the student teachers of Samtse College of Education to think of innovative and creative ideas to teach STEM subjects.

A lot of support was rendered by the Principals, teachers and students of Samtse Higher and Lower Secondary Schools. Students and teachers expressed that all the exhibits were interesting and promoted learning in STEM. They opined that they would like to take this learning forward into their own school.

All the exhibits were evaluated by the team of four teachers teaching STEM subjects in the schools and prizes were also awarded to the winners.

Improvised working model demonstrating Hydroponics

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Introduction. Hydroponics is a modern method of growing plants without soil, which has been gaining popularity in recent years. In this technique, plants are grown in a nutrient-rich water solution, with their roots suspended in the liquid. This method has numerous advantages over traditional soil-based agriculture, including higher yields, faster growths and more efficient water usage.

The basic components of a hydroponics system include a water reservoir, a nutrient solution, a pump to circulate the solution, and a growing medium to support the plants. The growing medium can be anything from gravel to perlite, depending on the type of plants being grown. There are several types of hydroponics systems, including deep water culture, nutrient film technique, aeroponics, and drip irrigation. Each system has its unique advantages and disadvantages, and the choice of system depends on the specific needs of the plants being grown.

Project. Our hydroponic model used nutrient film technique where the system uses a pump to deliver fertilized water to the growing container and a drain pipe to recycle the unused nutrient solution. The pump used is the Direct Current (D.C) water where the water is carried to the top

container through the pipe.

The materials used for the hydroponics were improvised using easily available materials so that it is cost-efficient. We also added extra features so ensure that the hydroponics is presentable, no matter where the model is placed. We improvised the containers with the Coca cola bottles which is easily available. We used the wood planks as a stand and also made a base, so that, it can be used to keep the other plant such as flower pots to ensure that the room where the hydroponics is kept is presentable.

Advantages. One of the key advantages of hydroponics is the ability to control the growing environment more precisely than in traditional soil-based agriculture. This includes controlling factors such as pH, nutrient levels, and temperature, which can have a significant impact on plant growth and health. Another advantage of hydroponics is the ability to grown year-round, regardless of weather conditions. This is especially important in areas with harsh winters or other environmental challenges.

Relation of hydroponics to STEM education

Hydroponics is an excellent tool for STEM education as it provides students with a hands-on approach to learning about science, technology, engineering and math. Hydroponics systems offer a variety of opportunities for students to learn about these subjects in a real-world context, from designing and building to their own systems to analyzing the results of experiments and optimizing plant growth.

Science. Hydroponics offers an excellent opportunity for students to learn about plant biology and environmental science. Students can learn about the various types of plants that can be grown hydroponically, the nutrients and water requirements for each plant and how environmental factors such as light, temperature, and humidity can affect plant growth.

Biology. Biology play a critical role in hydroponics, as it involves understanding the biology of plants, particularly their nutrient requirements and growth patterns. In hydroponics, plants are grown in a sterile, soil-free environment, so it is essential to provide them with the right balance of nutrients, water and oxygen. The nutrient solution used in hydroponics must contain all the essential elements that the plants need to grow, including macro-nutrients such as iron, zinc, and copper. Biologist also study the biology of plant roots and how they absorb nutrients, as this information is used to develop hydroponic systems that optimize nutrient uptake and minimize waste.

Chemistry. It is also essential in hydroponics, as the nutrient solution used in hydroponics must be carefully formulated to provide plants with the right balance of nutrients, pH levels, and conductivity. The pH of the nutrient solution must be carefully monitored and adjusted, as plants can only absorb nutrients within a specific pH range.
Chemical analysis is often used to monitor

the nutrient levels in hydroponic systems to ensure that plants are getting the nutrients they need to thrive.

Physics. Hydroponic system uses pumps and other equipment to circulate water and maintain the proper water levels and maintain the proper water levels and flow rates, which requires an understanding of the principles of fluid dynamics.

Technology. Hydroponics systems use a variety of technologies, including pumps, sensors and controllers, to regulate water flow, nutrient levels and other environmental factors. Students can learn about the different types of technology used in hydroponics systems and how they can be programmed and controlled to optimize plant growth.

Engineering. Hydroponics systems require careful designs and engineering to ensure optimal plant growth. Students can learn about different types of hydroponics systems, how to design and build their own systems, and how to troubleshoot and optimize existing systems.

Mathematics. Hydroponics systems require precise calculations and measurements to ensure optimal plant growth. Students can learn about the math involved in calculating nutrient ratios, water flow rates, and other important factors that affect the plant growth.

In addition to these specific subjects, hydroponics also offers opportunities for interdisciplinary learning. For example, students can learn about history and economics of agriculture, the ethics of sustainable farming practices, and the socio-cultural implications of food production and distribution.

Overall, hydroponics is an excellent tool for STEM education, offering students a hands-on approach to learning about science, technology, engineering, and math in a real-world context. Hydroponic systems can be used in a variety of educational settings, from elementary schools to universities, and can be adapted to a wide range of learning objectives and curriculum goals.

Introduction to GENETICS

Chandra Mann Rai
Sangay Bidha
Sangay Dorji
Sonam Dorji
Tshering Phuentsho
Dr. Kinley (Advisor)

The STEM department of Samtse College of Education organized STEM FEST on the theme "Engaging with STEM in Education" on 22 May, 2023, and all STEM subjects took part in it. The M. Ed II Biology group took advantage of the opportunity and prepared a DNA model. DNA is the genetic material which carries all the hereditary information and genes are the small segments of DNA. A 3D DNA model is constructed applying physics concept

while a still model is also prepared with the intent of explaining genetic engineer and gene editing. All members took active part in the exhibition.

Genetics is one of the major topic in module on Advance Studies III in Biology. It helped us to explore in depth on the topic in the process of preparing for the exhibition. The currency and relevancy were considered as the knowledge of genetics is being used in field of agriculture (GMOs), medicine (treating and diagnosing diseases) and forensic science. The knowledge of physics was applied while designing the model of DNA to make it more interactive and realistic eventually aligning to the concept of cross pollination.

The DNA structure can be thought of as a twisted ladder. This structure is described as a double-helix, as illustrated in the model. The basic building blocks of DNA are nucleotides, which are composed of a sugar group, a phosphate group, and a nitrogen base. The sugar and phosphate groups link the nucleotides together to form each strand of DNA. Adenine (A), Thymine (T), Guanine (G) and Cytosine (C) are four types of nitrogen bases. These 4 Nitrogenous bases pair together in the following way: A with T (A-T), and C with G (C-G). These base pairs are bonded by hydrogen bonds and it is essential for the DNA's double helix structure, the strands are helically twisted. Human beings has 23 pairs of chromosomes, and each chromosome has a single molecule of DNA in it (46 DNA).

The range of audiences such as the college management, faculty, students, school teachers and school students during the science exhibition has uplifted our morale. The youngest of the audience was a little boy studying in class VI who came running towards our model murmuring "DNA, DNA...." When asked about it we were surprised that he hasn't even learned cells, yet he knew about the DNA. For lower grade students we had to explain the DNA model by relating to having similar looks of their parents or dissimilarities among siblings.

A class XI science student kept nodding his head until we finished explaining and sighed a relieve saying what he didn't understood in class X Biology last year is finally understood today. Some audiences has no knowledge on Biology and DNA yet wanted to know about DNA because they were curious about forensic and the heritable traits from their parents which will be passed on to their offspring.

Especially, the science students enjoyed viewing DNA as a prototype and they were very happy to clear their doubts regarding base pairing, gene editing and the pros and cons of genetic engineering.

Members explaining about the model and concept to the teachers and students of a nearby school

Wastewater Treatment Plant (WWTP) Working Model

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Purna Bdr
Lobzang Dawa
Sonam Wangchuk
Kelzang Wangchuk
Dr. Kinzang Dorji (Advisor)

Water is one of the most important substances needed by living things. Due to the increase in anthropogenic activities, some of the sources of water have started to dry up in Bhutan. Living things need clean water that is free of contaminants which are harmful to the health of organisms .In order to produce clean, safe water that meets the standards of quality and purity needed for human consumption, agriculture, laundry, industrial use, we have to clean wastewater effectively before it is released back into the environment. The basic operating principle of a water treatment plant is to remove contaminants and impurities from the dirty/raw water using a combination of physical, chemical, and biological processes.

The objectives of the design and exhibition of the working model were to: exhibit visual knowledge required for making a wastewater treatment plant (WWTP); convey the message related to use of clean and safe drinking water; create awareness on use of plants like phragmites for treatment of wastewater (biofiltration); demonstrate that a wastewater treatment plant can be made using locally available materials (inexpensive).

The working model of Wastewater Treatment Plant was made using the following materials: Plastic or glass containers, Pipe/rubber tube, Cello tape, Alum, Pebbles/gravels, Phragmites/colocassia, Sand and Charcoal, Wire mesh, Adhesive /Fevicol.

Working Principle of Wastewater Treatment Plant: Wastewater treatment plants (WWTPs) are crucial for removing pollutants from wastewater before being used for consumption, agricultural purposes, for laundry, or discharging it back into the environment. WWTP model works where large sized pollutants are screened, allowed to undergo sedimentation, biofiltration using phragmite plants, aeration, filtration, and finally disinfection.

The goal of a WWTP is to remove organic matter, nutrients, and pathogens from wastewater before discharging it back into the environment. WWTPs' design can vary, but they all aim to remove as much of these pollutants as possible.

Significance and Application

The importance of water treatment facilities can be attributed to their role in ensuring that the water we use is safe for consumption, agricultural, laundry, industrial and other purposes. Water treatment facilities provide water that can be used for both industrial and commercial purposes.

WWTP is very handy in places where there is scarcity or shortage of water. It can be used for treating wastewater producing clean water that can be used for household and agricultural purposes. It also plays a crucial role in protecting our environment by releasing water that is free of pollutants or contaminants.

Unfolding the world of curiosity with improvised microscope

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Pema Zangmo
Anu Uraon
Phub Zam
Karna Bdr Ghalley
Nima Dorji
Nima Tshering
Ugyen Tshering
Tshering Yangchen
Ran Singh Tamang (Advisor)

Objectives

The aims of our designing prototype are to:

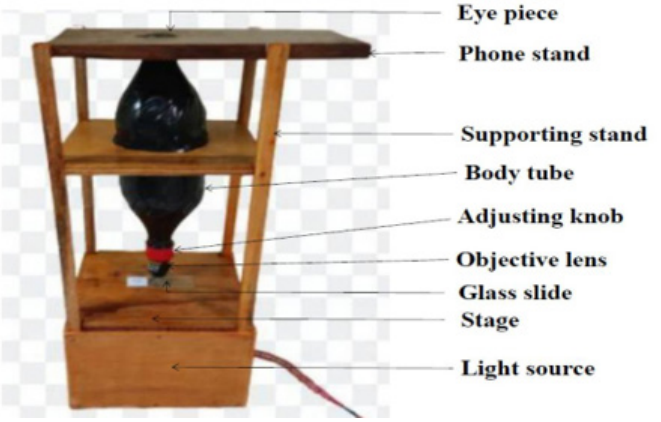
1. Develop deep interest to observation.
2. Generate curiosity in exploring the flora and fauna through prototype device.
3. User friendly application.
4. Cheap and effective to be used anytime and any place.
5. Accessible for all learners to display their observation through video and photo.

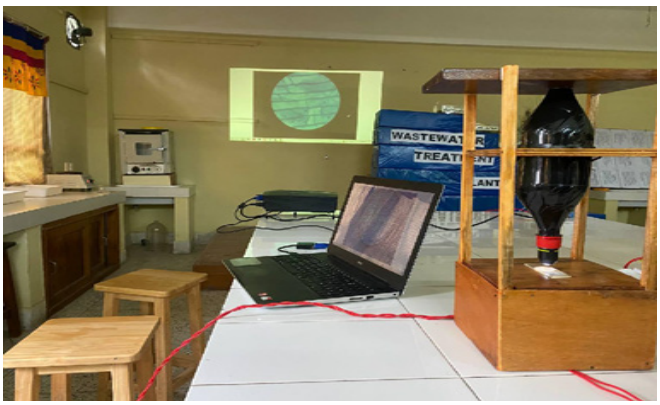
Unveiling an unseen world: The story Behind the creation of IMBII

Initially, we brainstormed challenges encountered while learning biology. Consequently, we chose to focus on the topic of microscopes. Through online research, we discovered a helpful YouTube video and drew inspiration from it, aiming to create a unique design for our improvised microscope. Additionally, we conducted a survey at a nearby school and found a limited number

of microscopes, hindering effective learning. Thus, we decided to create an improvised microscope.

Prototype I



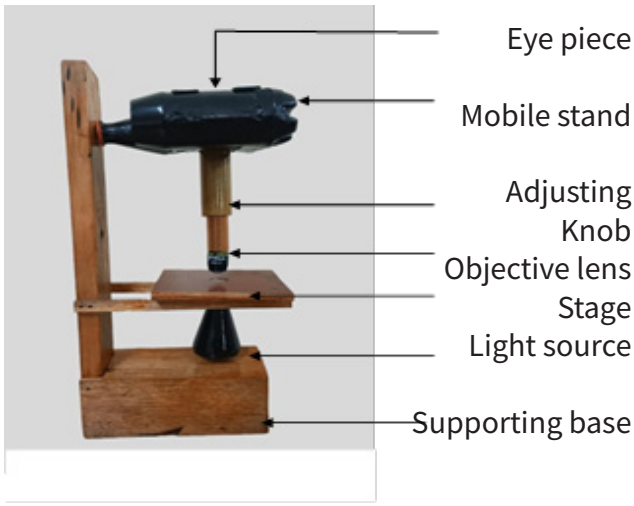


Procedure

Raw materials: Two lenses, two plastic bottles, cello tape, black paint, cardboard, glue, nails, bulb and bamboo.

1. Cut the bottles in half.
2. Painted or pasted black paper inside the bottle halves.
3. Modified the bottle cap to fit the lenses.
4. Created microscope stand using cardboard.
5. Built the cardboard box for the light source.
6. Cut hole in the cardboard to fix the microscope.
7. Attached thick cardboard on top with a hole to hold the phone.

Prototype II



Working Mechanism

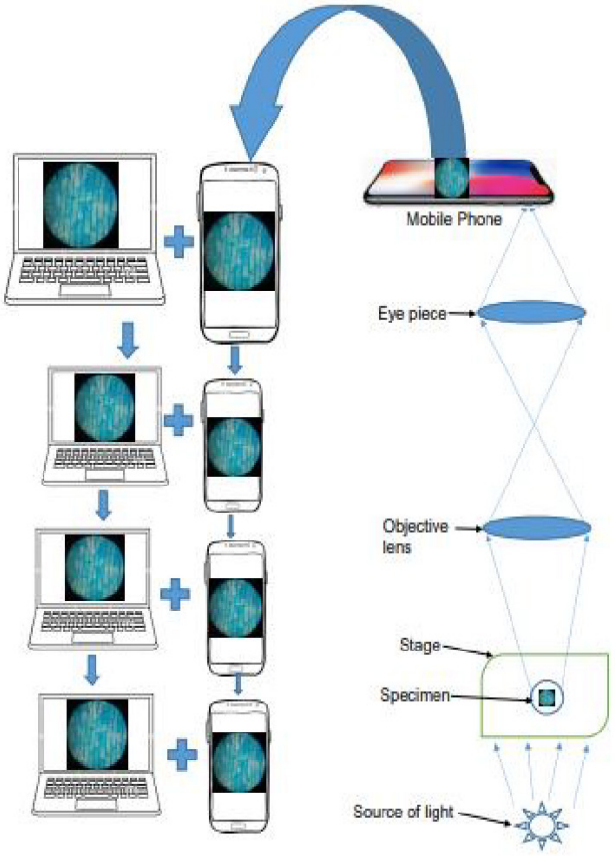
- In our improvised microscope, we harness the power of a LED bulb as a light source, which passes through a permanent slide.
- The light then travels through a specially designed black hollow bottle, minimizing any unwanted reflections.
- It finally reaches the eye piece lens, where the image is formed and captured using a mobile phone. With the help of various technological tools, particularly a laptop, the captured image can be easily shared.

Triumph in the Spotlight: Securing First Prize at the STEM Fest

Bathed in the glory of our achievement, we were awarded the prestigious first prize in the STEM Fest, 2023, Samtse College of education, where esteemed examiners from diverse fields of study meticulously evaluated

our work. It was undeniably a moment of immense pride and accomplishment.

Working Mechanism (Illustration)

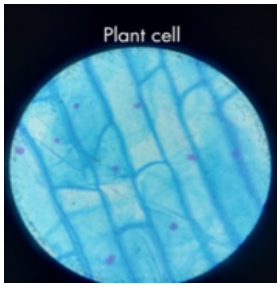
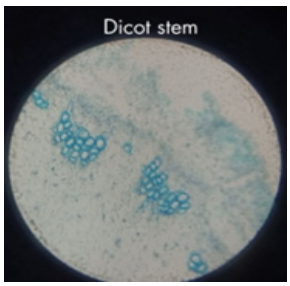
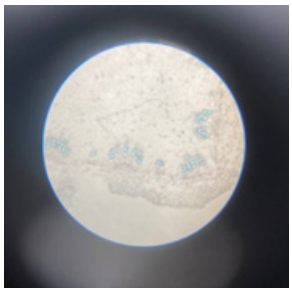
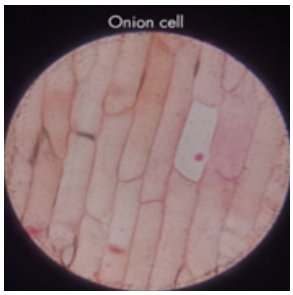
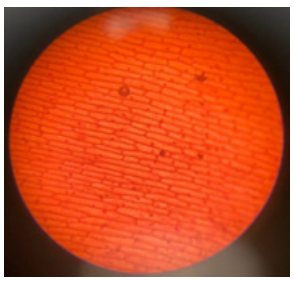


Pictures With Examiners

Recommendation

1. We are planning to disseminate this idea through out the schools in the country especially in schools where there is shortage of microscope
2. We can further improve our microscope by making it potable, flexible and take pictures from any angle
3. We can connect it to our printer making it easier for us to print the pictures

Microscopic Picture Of Imbii Vs Compound Microscope

Improvised Microscope	Compound Microscope
	
	
	

Bioplastics a solution to synthetic plastics

Krishna P Dhungyal
Norzang Wangchuk
Dr. Reeta Rai (Advisor)

Aim

Demonstrate the use of common fruits and vegetables to produce bioplastics.

Objectives

The audience will be able to:

1. Create awareness on the impact of plastics on the natural world
2. Differentiate between bio-degradable and non-degradable waste
3. Learn the process of making bio-plastics

Materials required

Potato, watch glass, cutter, beaker, petri dish, distilled water, stirring rod, mixer grinder, glycerol, and vinegar.

Procedures

- Gathered potato starch, water, glycerol, and vinegar
- Extracted the Starch from potato
- Mixed the potato starch and water
- Heated the mixture
- Added glycerol and vinegar
- Once the mixture is fully mixed, it is poured into a mold or onto a flat surface and allowed to cool and harden
- Once the bioplastic has hardened, it can be removed from the mold and used in a variety of applications.

Theory

Starch is made of long chains of glucose molecules joined together. Strictly, it contains two polymers: amylose, which is straight-chained, and amylopectin, which is branched. When starch is dried from an aqueous solution it forms a film as a result of hydrogen bonding between the chains. However, amylopectin inhibits the formation of the film. The addition of hydrochloric acid breaks the amylopectin down, allowing a more satisfactory film formation. The straight chains of the starch (amylose) can line up together and make a good film.

However, it is brittle because the chains are good at lining up – areas of the film can become crystalline, which causes brittleness. The addition of propane-1, 2, 3-triol has an effect because of its hygroscopic (water-attracting) properties. Water bound to the propane-1, 2, 3-triol gets in amongst the starch chains and inhibits the formation of crystalline areas, preventing brittleness and resulting in more 'plastic' properties.

Why Bio Plastic for this exhibition?

The bioplastics industry is young; in 2019, bioplastics represented only 1% of the world's plastic production. Every year, about 11 million tons of plastic waste are dumped into the world's oceans. Up to 51 trillion microplastic particles floating in our oceans. Waste production and treatment are becoming more important in Bhutan due to some waste-related environmental and health issues.

Bhutan produces wide categories of waste and food waste topped (42.9%) all others with 26954.3 tons of food waste generated from different sources annually. Most of this waste ends up either in landfills or dumped into the environment. The average adult human ingests an estimated 883 particles of microplastic each day—an irreversible intake that accumulates in body tissue.

Advantages of using bioplastics

1. Sustainable: Bioplastics are made from renewable resources such as corn, sugar cane, and potatoes, which can be regrown
2. Recycling of wastes: Reduces carbon foot prints by removing waste from the land fills and environment
3. Biodegradable: Bioplastics can decompose naturally over time with optimum conditions
4. Economic: Can help people make a living from the collection and processing of waste
5. Versatility: Can be used in a variety of applications, including packaging, textiles, and automotive parts

Chemistry with Jackfruits: Production of Jackfruit wine

Sonam Choden
Dechen Wangmo
Lham Tshering
Chimi Zam
Mr. Lapchu (Advisor)

Jackfruit (Artocarpus heterophyllus) is a tropical fruit native to South and Southeast Asia. It belongs to the Moraceae family, which includes figs and mulberries. Jackfruit is the largest tree-borne fruit in the world, with some specimens weighing up to 80

pounds (36 kilograms). The fruit has a unique appearance, with a rough, spiky green or yellowish exterior and a fleshy, fibrous interior that contains numerous edible bulbs or "pods." These pods are yellow or orange and have a sweet, tropical flavor.

Jackfruit is highly versatile and can be consumed both in its ripe and unripe forms. Ripe jackfruit has a sweet taste and is often enjoyed fresh or used in desserts, smoothies, and ice creams. The unripe or green jackfruit has a mild flavor and a meaty, fibrous texture that makes it a popular meat substitute among vegetarians and vegans. It can be cooked in savory dishes, such as curries, stir-fries, and stews, and its texture resembles pulled pork or chicken when prepared in certain ways.

Apart from its culinary uses, jackfruit has also gained attention for its nutritional value. It is a rich source of dietary fiber, vitamins, and minerals, including vitamin C, potassium, and magnesium. Jackfruit is also known for its potential health benefits, such as improving digestion, boosting the immune system, and supporting heart health.

Jackfruit wine is a fermented alcoholic beverage made from the pulp of the jackfruit, a tropical fruit known for its distinctive sweet and tangy flavor. The process of making jackfruit wine involves extracting the pulp from the ripe fruit and fermenting it with yeast to convert the sugar into alcohol. This results in a wine with a unique fruity flavor and aroma, which can vary depending on the ripeness of the fruit and the fermentation process used. Jackfruit wine is not very popular in Bhutan and also around the world, however it is a refreshing and exotic alternative to traditional grape wines.

The production of jackfruit wine is interesting for several reasons. First, jackfruit is a highly nutritious and abundant fruit that is grown in many tropical regions, making it a sustainable and cost-effective ingredient for wine production. Second, the unique flavor profile of jackfruit wine sets it apart from traditional grape wines, offering consumers a new and exotic taste experience. Additionally, jackfruit wine has potential health benefits due to the presence of antioxidants and other nutrients in the fruit.

Finally, the production of jackfruit wine can provide economic opportunities for small-scale farmers and entrepreneurs in developing countries, where the fruit is often grown. Overall, the production of jackfruit wine offers a novel and sustainable approach to winemaking that has the potential to benefit both producers and consumers alike.

Why Jackfruit Wine?

NOVEL AND SUSTAINABLE APPROACH TO WINE MAKING

- Abundant, Easily available and Highly

Nutritious fruit

- Sustainable and Cost-Effective ingredient for wine making
- Unique flovor profile
- Potential health benefits
- Producation of value added goods
- Provide economic opportunities

The Process

1. Obtaining fully ripened jackfruits
2. Preparing and Processing the fruit to obtain the pulp separated from the seeds (Image 1)
3. Mash the fruit pulp and then mix yeast and water. Keep it in an airtight container and a warm and dry place
4. After 2-3 weeks of fermentation depending on the environmental conditions, strain out the fruit pulp (Image 2)
5. Sweet and Tangy Jackfruit wine is obtained (Image 3)


Image 1

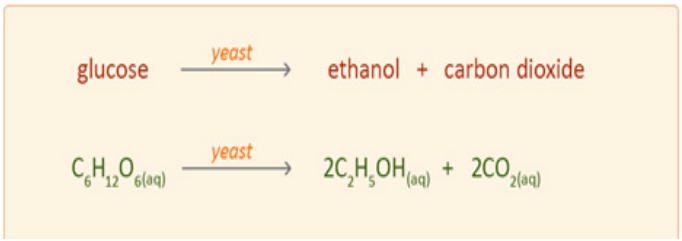

Image 2


Image 3

Fermentation

Fermentation is a metabolic process that occurs in the absence of oxygen, where microorganisms, such as yeast or bacteria, convert organic compounds into simpler substances. One of the most well-known forms of fermentation is the fermentation of alcohol. This process involves the conversion of sugars, such as glucose or sucrose, into ethanol and carbon dioxide by yeast through a series of enzymatic reactions.

The yeast consumes the sugars present in the raw materials, such as fruits, grains, or other plant-based substances, and produces alcohol as a byproduct. The fermentation of alcohol has been practiced by humans for centuries and is utilized in various applications, including the production of alcoholic beverages such as beer, wine, and spirits. The duration and conditions of fermentation can greatly influence the flavor, aroma, and alcohol content of the final product, making it a critical step in the production of alcoholic beverages.



Oxygen Generator

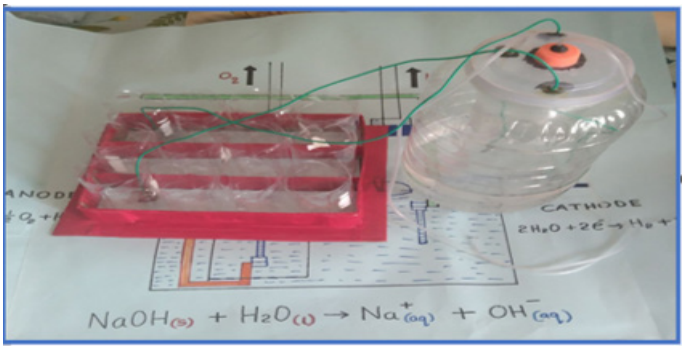
Karma
Pema Wangdi
Dr. Reeta Rai (Advisor)

Aim and Objectives

The aim and objectives of the project were to teach the audience how to generate oxygen at home during an emergency and to raise awareness about the importance of oxygen, primarily focusing on the health benefits of oxygen.

Materials Required

Adopter, wires, two iron nails, a soldering iron, a cutter, a tube, a jar, a plastic bottle, caustic soda, and water.



Procedures

In our experiment, we started by taking a jar and adding NaOH (sodium hydroxide) to it. This served as our chemical mixture. Next, we proceeded to modify a bottle by cutting off its base and making a hole in the top. Through this hole, we inserted one end of an adapter wire, while the other end was placed inside the jar, making sure it came into contact with the NaOH solution.

We then positioned the bottle inside the jar and attached a tube to its top. To complete the setup, we connected the adapter wire to the power source and turned it on. As we observed over time, a small amount of foam started to form on the surface of the water in the jar. This foam was a result of the chemical reaction between NaOH and water, which produced hydrogen gas.

Theory

The process of generating oxygen using NaOH (sodium hydroxide) can be achieved through the process of electrolysis. In an electrolytic cell, an electric current is passed through a solution of NaOH, causing the NaOH to dissociate into sodium ions (Na+) and hydroxide ions (OH-). At the anode (positive electrode), the hydroxide ions lose electrons to form oxygen gas and water: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$. The oxygen gas is released as bubbles at the anode, which can then be collected for further use.

At the cathode (negative electrode), the water gains electrons to form hydrogen gas and hydroxide ions: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$. This process of electrolysis allows for the generation of oxygen gas at the anode and hydrogen gas at the cathode, providing a means to produce oxygen in certain situations or settings.

Why an Oxygen generator for this exhibition?

An Oxygen generator was chosen for this exhibition due to the critical role oxygen plays in sustainable chemistry. Oxygen can be utilized in various ways to reduce the environmental impact of chemical processes. It is involved in combustion reactions and oxidation-reduction (redox) reactions, which are fundamental processes in numerous chemical applications (Zhao & Shen, 2021). Likewise, compared to alternatives like chlorine or bromine, oxygen serves as a more efficient and environmentally friendly oxidant.

Moreover, the process of photosynthesis, which converts sunlight into energy in plants, relies on oxygen as a reactant. Consequently, oxygen plays a vital role in enabling more environmentally friendly chemical processes and supporting the advancement of renewable energy sources (De Vos et al., 2020). Oxygen is also a critical element for the survival of living organisms. It plays a crucial role in respiration, the energy-producing chemistry that drives the metabolisms of most living things (Hüppi, 2009). Moreover, oxygen is used in medical treatments for respiratory illnesses, surgery, and trauma. Oxygen supplement is crucial for individuals who have difficulty breathing (Meletis & Wilkesa, 2019).

Safety tips while using oxygen at home (Norco Patient Orientation Handbook, 2020)

To ensure the safe use of oxygen equipment at home, certain precautions should be followed. It is important to keep the equipment away from heat sources like stoves, heaters, or candles, as they can cause oxygen to ignite. Smoking should be strictly prohibited near the equipment due to the high risk of fire. Avoid using oils, lotions, or creams as they are flammable and can lead to fire hazards. By adhering to these guidelines, individuals can safely manage their breathing difficulties and enhance their quality of life at home.

Conclusion

The STEM festival shed light on the critical significance of oxygen generators in the realm of scientific advancements. We showcased how these devices have transformed healthcare, ensuring a steady supply of life-sustaining oxygen to patients in need during emergencies.

Through engaging displays and demonstrations, visitors witness the simple processes involved in oxygen from other gases, gaining a deeper understanding of

its importance in medical treatments and emergency situations at home.

The STEM festival highlighted the vital role oxygen generators play in saving lives, highlighting their efficiency, portability, and potential to transform healthcare systems at home. Overall, the STEM festival emphasized the undeniable impact of oxygen generators as indispensable tools in the pursuit of improved patient care and well-being at home during emergencies.

Preparation of Soap at Home by the Saponification Process

Melam Dorji
Karma Tshering
Dr. Reeta Rai (Advisor)

Introduction. Soap is an important part of our daily life. Soap is a chemical compound resulting from the reaction of an alkali (commonly sodium or potassium hydroxide) with a fatty acid. Soaps are the metallic salts of long-chain fatty acids. When mixed with water during bathing, cleansing, or washing, they help people and clothes get clean by lowering the chance of dirt and oil getting to the skin or fabric.

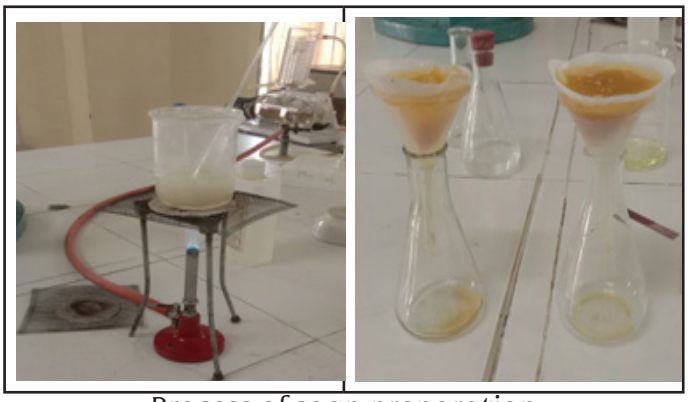
Materials and Methods

- Coconut oil
- 20% sodium hydroxide solution
- Common salt
- Measuring cylinders
- Glass beaker (250 mL)
- Blue and red litmus papers
- Glass rod
- Bunsen burner
- Wire gauze
- Tripod Stand
- Filter funnel
- Filter paper
- Spatula
- Knife

Procedures

- Take 25 mL of coconut oil in a measuring cylinder and pour it into a 250 mL glass beaker.
- Measure 30 mL of 20% NaOH solution in another measuring cylinder and add it to the beaker containing vegetable oil. Then, vigorously stir the mixture using a glass rod.
- Place the beaker on a wire gauze placed over a tripod stand.
- Heat the beaker using a Bunsen burner till the mixture becomes a whitish paste.
- Remove the beaker from the flame add 15g of common salt. Then, stir it well with a glass rod.
- Take a filter funnel, place filter paper in it, and fix it on a stand.
- Then, cut it into the desired shape with a knife.

Results and Discussion



Process of soap preparation

Soaps in various colors, shapes, and sizes

Conclusion

Soap can be prepared at home by the saponification process, which involves the reaction of fats or oils with an alkali, typically sodium hydroxide, also known as lye. This process results in the formation of soap and glycerin. However, it's important to note that making soap at home can be a complex process and requires careful attention to safety guidelines and chemical handling procedures. It's important to use accurate measurements and follow proper procedures to ensure that the soap is safe and effective to use.

Therefore, if we are interested in making soap at home through the saponification process, it's a great way to create our own customized soaps with unique scents and ingredients.

History of Soap : Story about Soap

No one really knows when soap was discovered, but there is a wonderful story surrounding its beginning.
According to Roman legend, soap was named after Mount Sapon ancient site of animal sacrifices. After an animal sacrifice, rain would wash animal fat and ash, which collected under the ceremonial altars, down to the banks of the Tiber River.

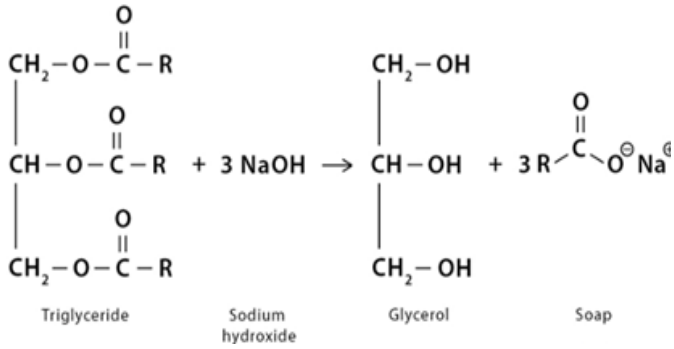
Women washing clothes in the river noticed that if they washed their clothes in certain sudsy parts of the river after a heavy rainfall their clothes were much cleaner. Thus the emergence of the first soap – or at least the first use of soap as the legend goes.

Although this explanation seems possible, evidence of the legendary Mt. Sapon, which was supposed to exist somewhere near Rome, has never been found.

Chemistry behind Soap

Two types of alkali can be used to prepare soap based on the need. Sodium hydroxide (NaOH) or lye is used for hard soap and potassium hydroxide (KOH) for soft soap.

General reaction when NaOH is used
RCOOR' + NaOH --> ROH + R'COO– Na+



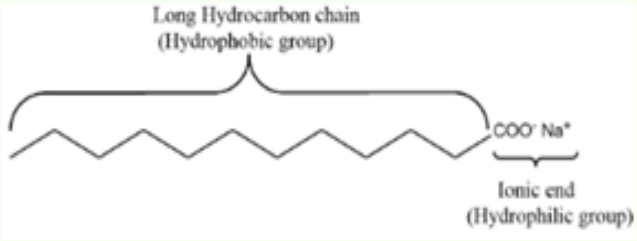
Lye + oils/fats---------- > Soap

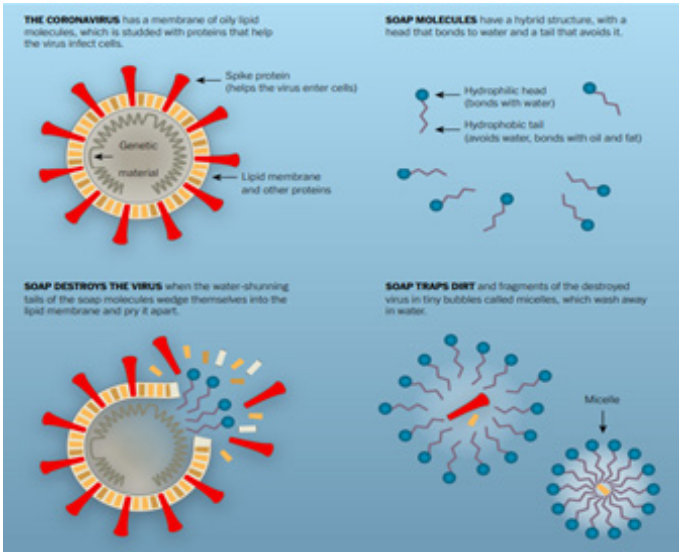
Triglycerides + Sodium hydroxide ---------- > Glycerol + Sodium stearate

Presentation made to the STEM Fest enthusiasts

Cleansing Effect of Soap

The dirt on the clothes is organic and insoluble in water. Therefore, it cannot be removed by only washing it with water. When soap is dissolved in water, its hydrophobic ends attach themselves to the dirt and remove it from the cloth.





MQ-3 Alcohol Detector

Chey Chey
Pema Lekzin
Jigme
Nima Euden
Sonam Chophel
Sujana subba
Kezang wangmo
Kelzang Nima
Rinchen Gyeltshen
Dorji Tamang
Kezang Choden (Advisor)

Objectives

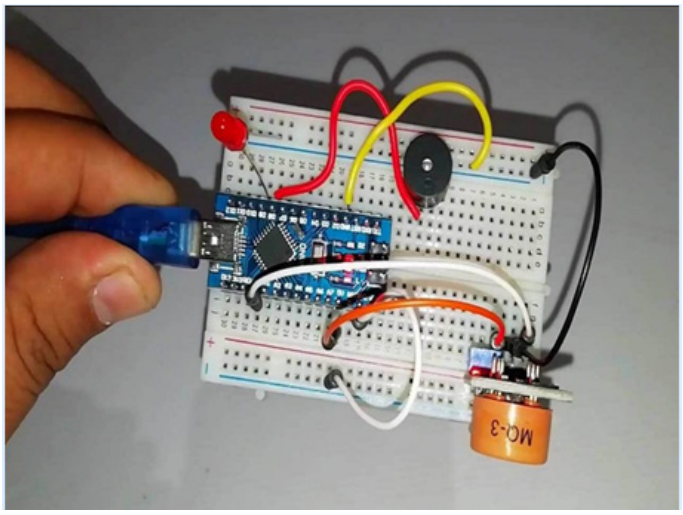
1. Promote scientific inquiry and experimentation
2. Develop technical skills in sensor technology and circuitry
3. Foster interdisciplinary learning
4. Promote awareness of social issues
5. Encourage innovation and creativity

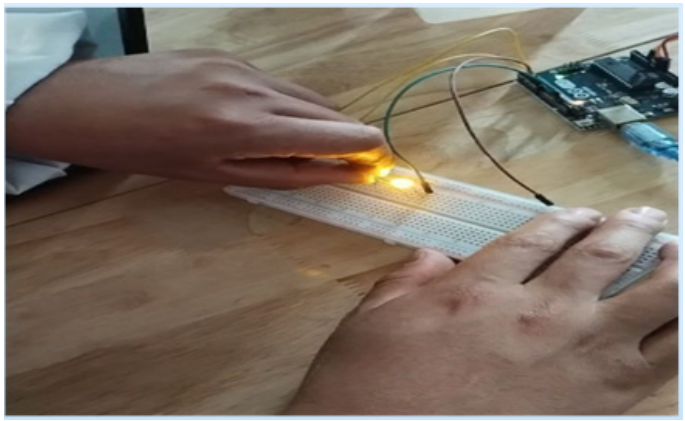
Procedure

Raw materials used: MQ-3 sensor, microcontroller sensor (Arduino), breadboard, wires, power source, resistors, LED bulbs, cardboard.

Procedure

1. Study the MQ-3 sensor module's data sheet for pinout and specifications.
2. Design and assemble the circuit, connecting the sensor to Arduino.
3. Write code to initialize the microcontroller, read analog input from the sensor, convert the values to alcohol concentration and trigger the LED bulbs.
4. Calibrate the sensor as per the data sheet instruction and adjust the code accordingly.
5. Test the detector in various environments with known alcohol concentration.
6. Refine the code and circuit based on test results and finalize the design.





Working mechanism

1. The sensor consists of a tin dioxide (SnO_2) semiconductor sensing element. SnO_2 has a high electrical resistance in its natural state.

2. The sensor has an integrated heating

element that is used to heat the sensing element. This heating is necessary to increase the sensitivity and response time of the sensor.

3. When the sensor is powered on, the heating element warms up the SnO_2 sensing element to a specific temperature.

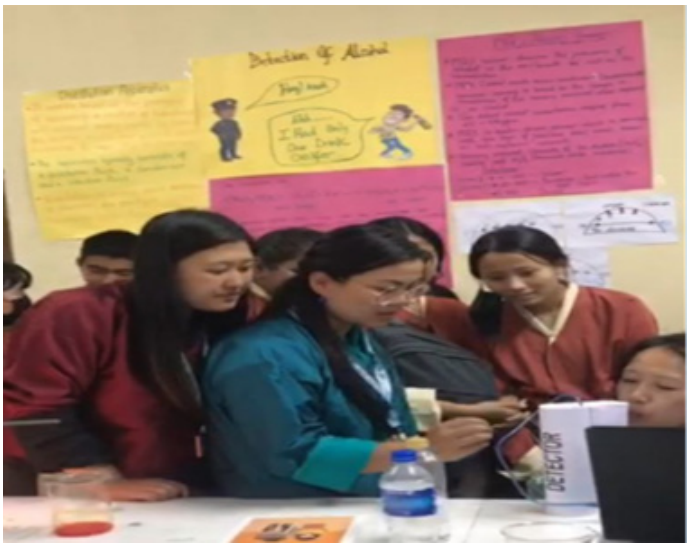
4. When alcohol vapor is present in the air, it enters the sensor chamber. The alcohol molecules interact with the heated SnO_2 sensing element.

5. The presence of alcohol causes the SnO_2 to undergo oxidation. This oxidation process leads to a reduction in the electrical resistance of the sensing element. The degree of resistance change is proportional to the concentration of alcohol vapor in the air.

6. The change in resistance is measured by the sensor's circuitry, and the output is typically an analog voltage or a digital signal. (Green LED = sober, yellow= intoxicated to a legal limit, red= drunk).

7. Calibration is necessary to correlate the sensor's output to actual alcohol concentration levels, which requires exposing the sensor to known alcohol concentrations and mapping the corre- sponding sensor response.

Pictures with examiners



Complaint Management System

Sangay Dema
Chenga Dorji (Advisor)

Introduction

As is commonly understood, Bhutan has taken the path of prioritizing STEM education for a more promising future, under the guidance of His Majesty, the King. Within this realm, coding, a fundamental pillar of STEM innovation, receives significant attention across various agencies and institutions in the nation, with the aim of cultivating upcoming coders.

Furthermore, a central focus of the education flagship program is the integration of digitalization within schools. This initiative strives to ensure that students are introduced to Information and Communication Technology (ICT) from their early years, aiming not only to impart IT literacy but also to foster proficiency in coding and programming.

At Samtse College of Education, efforts are made to equip prospective IT graduates with advanced coding skills. This is accomplished through active participation initiatives that have impactful results in the College. An example of such a project involved the enhancement of the complaint management system at the Samtse College of Education.

Aims

The primary objective of this complaint management system is to establish a communication channel that enables students to voice their grievances and provide feedback concerning various aspects of student services. The intention behind this platform is to facilitate timely resolution of issues by the relevant service providers, leading to enhanced service delivery. While the system can be utilized for addressing a range of concerns, its primary emphasis lie in addressing matters related to the College mess, academic affairs, ICT facilities, and sports amenities.

Features of Complaint Management System

- **Register**– Register for making complaints.
- **Login** – Login as a Student or Admin.
- **Add Complaints** - Students can add complaints.
- **ViewSolved/Unsolved Complaints** - Students can check the status of a complaint.

Coding and Development

The web application employs the Python Django framework in conjunction with the Model-View-Template (MVT) architecture, a widely adopted approach for back-end web development. For the front-end aspect, HTML5, CSS3, and JavaScript were utilized, alongside the Django Template Language (DTL). For user database management, the application relies on the PostgresQL database.

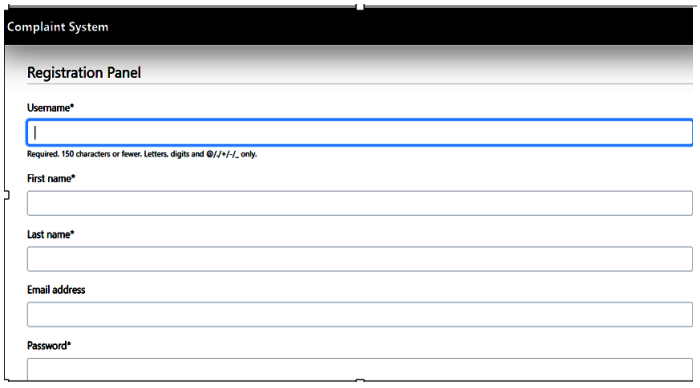
Frameworks and languages used

How to Use

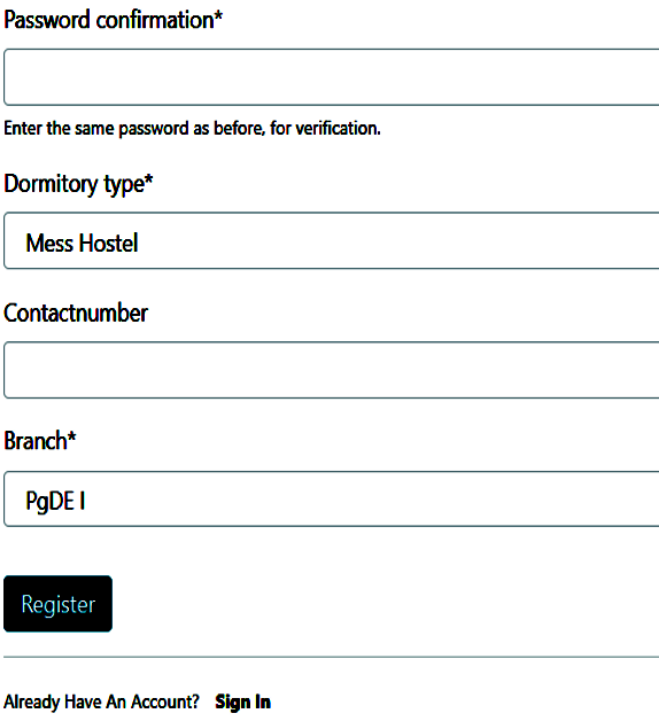
1. To submit a complaint, students must first register by clicking on register button on the top right corner of a Home page

Home page

2. Then a Registration panel will pop-up which needs to be filled up.

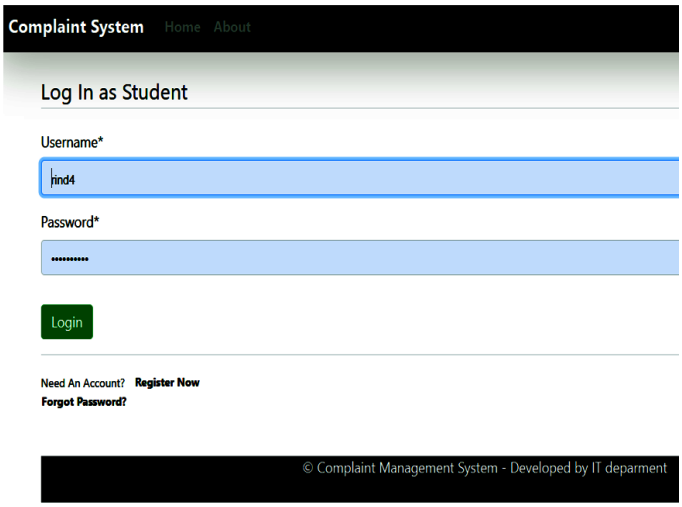


Registration Panel 1



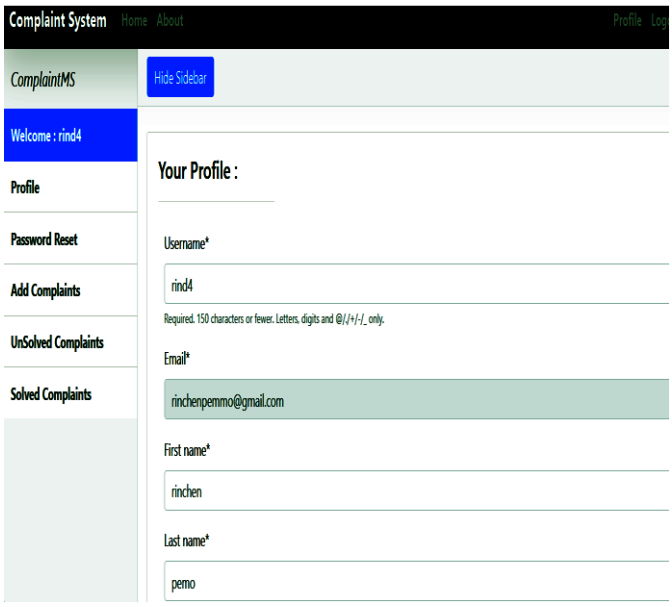
3. After registering successfully then the user needs to login with username and password as shown in Login 1 and Login 2.

Login 1



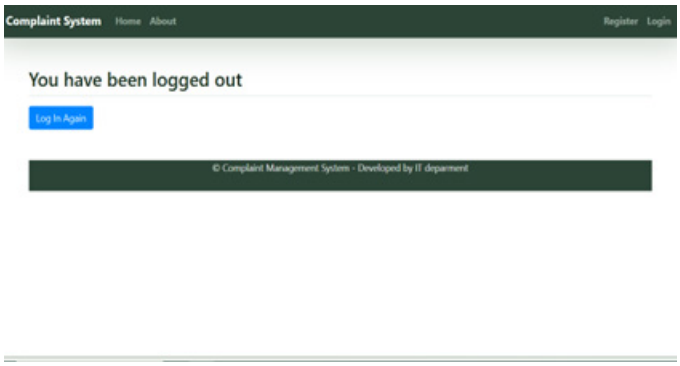
Login 2

4. Then the Complaint MS page will be shown. Users can add complaints and check for solved and unsolved complaints.



Complaint MS page

5. User must log out his/her account when not in use.



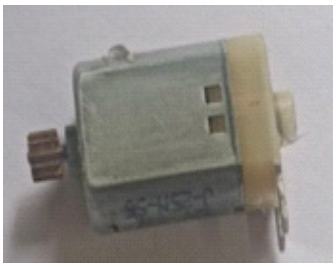
Log out

Battery or Electricity Run Vacuum Cleaner

Tshering Choden
Ugyen Tshering
Sonam Dorji
Purna Bahadur Subba (Advisor)

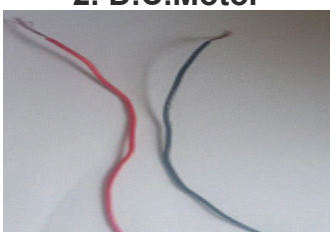
Materials required

1. Propeller



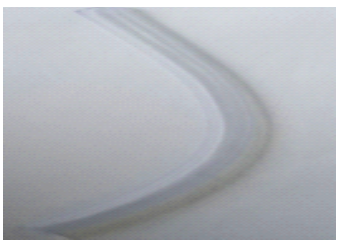
2. D.C.Motor

3. Plastic Bottle



4. Wire

5. USP Cap



6. Pipe

7. D.C switch

8. Adapter

9. Battery

What is a vacuum cleaner?

A vacuum cleaner is also known as a vacuum or a hoover. It is a device that causes suction in order to remove dirt from floors, upholstery, draperies, and other surfaces.

Working principle of vacuum cleaner

Vacuum cleaners work because of Bernoulli's Principle, which states that as the speed of air increases, the pressure decreases. Air will always flow from a high-pressure area to a low-pressure area, in order to try to balance out the pressure (maintain equilibrium).

When a centrifugal fan rotates, it makes the air to flow by adding external kinetic energy. The air is sucked from behind and pushed forward with pressure and so that it creates a negative pressure behind the fan. An ideal vacuum cleaner has such a centrifugal fan in it connected to a motor. This unit has suction and discharge connections, on the suction side filter bag is fitted before the hose connection. The discharge has another air purifier filter and opens to the atmosphere.

When the electric power is given, the motor rotates and so the centrifugal fan. Air from the suction side is sucked into the unit, along with the airborne particles, cat allergen, mist, dirt, and small solid particles are carried to the suction filter. They are trapped in the filter and dirt-free air is pushed out from the discharge opening.

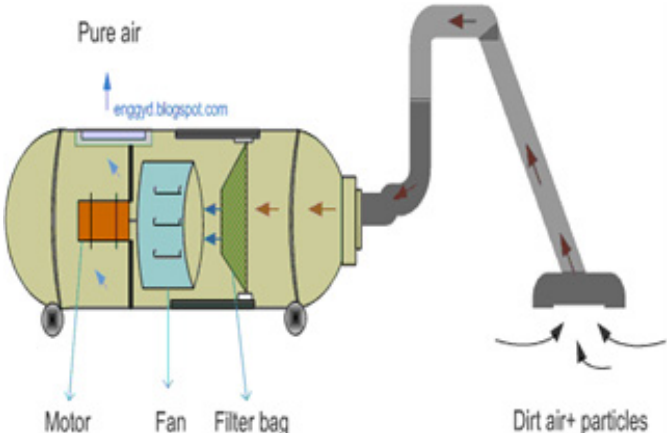


Image showing the working principle of a vacuum cleaner

Source. *https://tse1.mm.bing. net/th?&id=OVP.S86KNlHbkhf61V79o5tUpgEsDh&w=330&h=186&c=7&pid=1.7&rs=1*

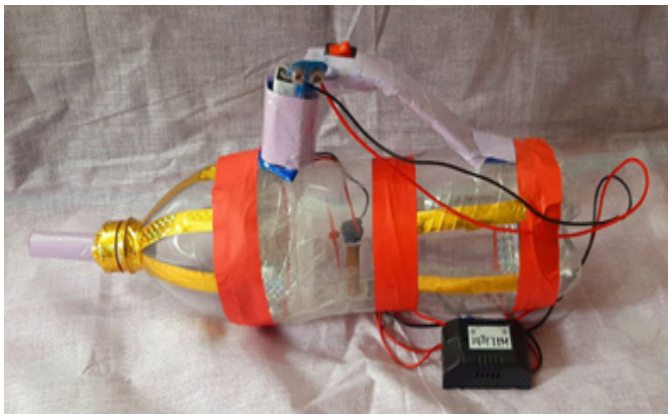


Image of vacuum cleaner (prototype)

Physics concepts involved in vacuum cleaner

A vacuum cleaner utilizes a combination of Physics principles in its operation. Here are some of the Physics concepts involved in a

vacuum cleaner.

1. **Airflow and air pressure:** A vacuum cleaner works by creating a low-pressure area inside the machine that sucks up dirt and dust. This is achieved by a motor that drives a fan that pulls air into the machine, creating a flow of air that carries the dirt and dust with it

2. **Friction:** The rotating brush of a vacuum cleaner uses friction to dislodge dirt and dust from carpets and upholstery, allowing it to be sucked up into the machine

3. **Electrostatics:** Some vacuum cleaners use static electricity to attract dirt and dust particles to the collection filter

4. **Sound waves:** The noise produced by a vacuum cleaner is the result of sound waves created by the motor and fan inside the machine

5. **Thermodynamics:** The motor of a vacuum cleaner generates heat during its operation, which must be dissipated to prevent the machine from overheating

Mathematical concepts involved in vacuum cleaner

Mathematical concepts involved in the design and operation of a vacuum cleaner, includes.

1. Geometry and Trigonometry: The shape and size of the vacuum cleaner's nozzle, as well as the angles and curves of its components,are determined by Geometry and Trigonometry. These mathematical concepts help us to optimize the vacuum cleaner's suction power and cleaning ability by ensuring that air flows through the machine in the most efficient way possible

2. **Calculus:** Calculus is used to optimize the perfor- mance of the vacuum cleaner's motor and suction system

3. **Linear Algebra:** Linear algebra is used to control the movements of the vacuum cleaner's brush head and other components

4. **Probability and Statistics:** Probability and Statistics are used to design the vacuum cleaner's dustbin and filter systems. We use Probability to determine the likelihood of different types of dust entering the machine, while Statistics are used to optimize the design of the filter to maximize their capacity and efficiency

Applications of vacuum cleaner

Some common applications of vacuum cleaner include.

1. **Floor cleaning:** Vacuum cleaners are commonly used to clean floors, especially carpets, rugs, and hardwood floors. They can effectively remove dirt,

dust, pet hair, and other debris from these surfaces.

Source. *https://media.juiceonline.com/2020/12/vax1-600x600.jpg*

2. **Upholstery cleaning:** Vacuum cleaners can also be used to clean upholstery, such as sofas, chairs, and curtains. They can remove dust, lint, and other debris from these surfaces.

Source. *https://thumbs.dreamstime.com/z/vacuum-cleaner-brush-telescopic-tube-carpet-floor-cleaning-attachment-copy-space-211784404.*

3. **Car cleaning:** Vacuum cleaners are often used to clean the interior of cars, including the seats, floors, and carpets. They can effectively remove dirt, crumbs, and other debris from these surfaces.

Source. *https://thumbs.dreamstime.com/z/woman-cleaning-interior-car-using-vacuum-cleaner-56225963.jpg?w=992*

4. **Pet hair removal:** Vacuum cleaners can be especially useful for pet owners, as they can effectively remove pet hair from carpets, furniture, and other surfaces.

Source. *https://thumbs.dreamstime.com/z/combing-ginger-cat-comb-brush-home-woman-owner-taking-care-pet-removing-hair-healthy-clean-animals-combing-ginger-cat-169329498.jpg?w=992*

5. **Allergy relief:** Vacuum cleaners can help to reduce allergens in the home, such as dust mites, pollen, and pet dander. High-quality vacuum cleaners with HEPA filters are particularly effective at removing these allergen from the air.

Source. *https://www.health.com/condition/allergy/best-vacuums-for-allergies*

6. Industrial cleaning: Vacuum cleaners are also used in industrial settings to clean factories, ware houses, and other large spaces. Industrial vacuum cleaners are typically larger and more powerful than residential vacuum cleaners, and they may be designed to handle hazardous materials or other specialized cleaning tasks.

Source. *https://www.iqsdirectory.com/articles/vacuum-cleaner/industrial-vacuum-cleaners.html*

Catapult

Tshering Dema
Kinzang Norbu
Sangay Chophel
Jigme Tshomo Dorji
Man Singh Singer (Advisor)

Homemade catapult

The STEM Fest was organized on 22nd April, 2023 by Department of STEM Education (DSTEME) of Samtse College of Education on the theme "Engaging with STEM in Education". As part of the STEM community, we also got an opportunity to exhibit the mathematical model. Our model was a catapult and a hologram. Taking through our models individually, we would highlight how it works, the material required, the output of models, and real-life applications.

The catapult, an ancient yet remarkable mechanical device, has played a pivotal role throughout history in warfare, engineering, and scientific exploration. In this write-up, we delve into the mathematics behind a catapult model, exploring its working principles, required materials, output, and real-life applications. By understanding the mathematical underpinnings, we can appreciate the precision and power with

which catapults operate.

How the Model Works

The catapult model functions based on fundamental mathematical principles governing energy, forces, and projectile motion. The following steps illustrate its operation.

1. **Energy Storage:** The catapult stores potential energy in various forms, such as tension or torsion, using ropes, springs, or other elastic materials. These energy-storing components are stretched or twisted, accumulating potential energy.

2. **Release Mechanism:** When the stored potential energy reaches a threshold, a release mechanism is triggered. This mechanism can be activated manually or by using a counterweight, lever, or other mechanisms.

3. **ProjectileLaunch:** Upon release, the stored potential energy is rapidly converted into kinetic energy. The release mechanism transfers this energy to the projectile, propelling it forward.

4. **ProjectileTrajectory:** The mathematical principles of kinematics govern the trajectory of the launched projectile. Equations of motion, such as those derived from Newton's laws, enable us to predict the projectile's range, height, and flight path.

In this working model, we have utilized the properties of an elastic material, specifically rubber, to throw an object a certain distance. By applying a force to stretch the rubber, we harness the elastic force generated by the material's tendency to return to its original shape. The rubber is attached to the object in a way that forms a certain angle, enabling the object to be launched in a projectile motion, maximizing the distance covered.

To establish the relationship between elastic force, angle, and the distance covered, we employ the principle of Hooke's law. According to Hooke's law, the force required to stretch or compress a spring is directly proportional to the displacement from its equilibrium position. Mathematically, this can be expressed as:

$F = -k * x$

Where:

'F' represents the force applied to the spring or elastic material,

'k' is the spring constant or elastic constant,

'x' denotes the displacement or change in length from the equilibrium position.

By determining the spring constant, we can ascertain the amount of force necessary to achieve a specific distance. Consequently, we can establish the relationship between the angle, force, and the distance covered. When the rubber is stretched further, a greater elastic force is produced, resulting in a larger angle formed. As the angle increases, the distance covered by the object also increases.

In summary, we can conclude that in this model

1. The elastic force is directly proportional to the distance covered by the object.

2. The arc of the angle formed is directly proportional to the elastic force.

3. The distance covered by the object is directly proportional to the arc of the angle.

Materials Required

To construct a catapult model, the following materials are typically required

1. **Frame:** Sturdy materials, such as wood or metal, to form the structural framework of the catapult.
2. **Energy Storage Components:** Elastic materials, like rubber bands or springs, or torsion devices, such as twisted ropes or torsion springs, to store potential energy.

3. **Launching Arm:** A lever or other mechanism to provide mechanical advantage and control the release of potential energy.

4. **Projectile:** Objects suitable for launching,such as small balls or simulated projectiles.

Output of the Model

The catapult model generates several measurable outputs, influenced by its design, launch parameters, and the laws of physics. Key outputs include:

1. **Projectile Range:** The horizontal distance covered by the launched projectile.

2. **Projectile Height:** The maximum height reached by the projectile during its tra-jectory.

3. **Projectile Velocity:** The speed at which the projectile leaves the catapult.

4. **Projectile Trajectory:** The path followed by the projectile, affected by the angle of launch, force applied, and other factors.

Real-Life Applications

Catapult models, despite their historical origins, find practical applications in various fields today, including.

1. **Education and STEM:** Catapult models serve as effective educational tools to teach students about energy, forces, and projectile motion. They provide hands-on experiences and foster an understanding of mathematical concepts and engineering principles.

2. **Engineering and Design:** Catapult models aid engineers in designing and optimizing systems that launch objects, such as trebuchets, slingshots, or mechanical launching devices. Mathematical modeling enables engineers to predict performance and enhance efficiency.

3. **Sports Science:** Catapult models help analyze and improve athletic performance in sports such as discus throw, shot put, or javelin. They assist coaches and athletes in understanding the impact of launch variables on distance and accuracy.

4. **Historical Analysis:** Catapult models assist historians and researchers in recreating and studying ancient warfare techniques. By understanding the mathematics behind these devices, researchers gain insights into the capabilities and strategic applications of catapults.

The catapult model, driven by mathematical principles, showcases the interplay of energy, forces, and motion. By leveraging mathematics, engineers, educators, and researchers can explore and optimize the performance of catapult systems. Beyond their historical significance, catapult models continue to find relevance in modern-day applications across education.

Hologram. Holography, the science and art of creating three-dimensional images, has fascinated researchers and enthusiasts alike for decades. In recent years, advancements in technology have led to the development of hologram models that utilize mathematical principles to generate stunning visual representations. This write-up explores the intricacies of a hologram model with a specific focus on its mathematical underpinnings, working mechanism, required materials, output, and real-life applications.

How the Model Works

The hologram model operates based on the principle of interference. It employs mathematical concepts such as wavefront reconstruction and Fourier transforms to recreate the appearance of a three-dimensional object from a two-dimensional image. The process involves the following steps.

1. **Capturing the Object:** A high resolution photograph or computer-generated image of the desired object is obtained.

2. **Mathematical Encoding:** The image is mathematically encoded using a technique called Fourier transform. This transform breaks down the image into its constituent frequencies, creating a holographic interference pattern.

3. **Physical Representation:** The encoded image is printed onto a transparent material, typically a holographic film or glass plate.

4. **Illumination:** The hologram is illuminated with coherent light, such as a laser. As the light passes through the encoded hologram, it diffracts and interferes, reconstructing the original object's wavefront.

5. **Observation:** The viewer perceives the hologram as a three-dimensional image, floating in space. Asthey move

around the hologram, the perspective changes, giving the impression of depth and parallax.

Materials Required

To create a hologram model, the following materials are typically needed:

1. High-resolution photograph or computer-generated image of the object.
2. Holographic film or glass plate for encoding the image.
3. Laser or other coherent light source for illumination.
4. Optics and supporting structures for projecting and positioning the hologram.

Output of the Model

The hologram model generates visually captivating three-dimensional representations of objects. These holographic images provide an immersive viewing experience, where the viewer can observe different angles and perspectives of the object as they move around it.

The output is highly realistic and can convey intricate details and depth, offering a unique visual perception not possible with conventional images or videos.

3-D hologram image of a dinosaur
Source. *https://appadvice.com/app/hologram-dinosaur-3d-simulator/994408646*

Real-Life Applications

Hologram models find diverse applications across various fields, including

1. **Education and Research:** Holographic models are invaluable tools for teaching complex mathematical concepts, such as geometry, topology, and spatial transformations. They enable students to interact with mathematical objects in a tangible way, fostering deeper understanding.

2. **Product Design and Prototyping:** Designers and engineers can use holographic models to visualize and refine their prototypes in three dimensions. This allows for better evaluation of product aesthetics, ergonomics, and functionality.

3. **Medical Imaging:** Holographic models have the potential to enhance medical

imaging techniques. They can be employed to visualize complex anatomical structures, aiding in surgical planning and patient education.

4. **Entertainment and Advertising:** The entertainment industry can leverage hologram models to create captivating visual effects and immersive experiences in movies, virtual reality, and live performances. Additionally, holograms can be used for innovative advertising campaigns to attract and engage audiences.

The hologram model, with its foundation in mathematics, opens up a world of possibilities for visualizing three-dimensional objects. Through mathematical encoding, holographic interference, and precise illumination, these models provide realistic and interactive representations.

As technology continues to advance, holograms are poised to revolutionize education, design, medicine, entertainment, and advertising, offering a new dimension of visual communication and engagement. and advertising, offering a new dimension of visual communication and engagement.

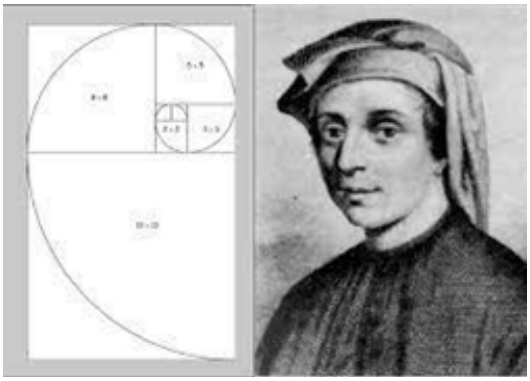
Fibonacci Spiral Clock Philosophical Background

Dorji Minjur
Ugyen Wangchuk
Nim Dem
Sonam Pemo
Purna Bahadur Subba (Advisor)

Philosophical Background

The Fibonacci sequence was published by Leonardo of Pisa in 1202 in the "Liber Abaci", the "Book of Calculus". He was born in 1175 A.D. and is an Italian Mathematician.

Leonardo of Pisa, better known as Fibonacci, wrote his series of number (1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, ...) to solve a hypothetical problem of breeding rabbits in his Calculation Book. In its content, the fundamental thing is to know that whatever the number in the sequence is, it is the result of the sum of the two previous ones. For example: 2 + 3 =5, 5 + 3 = 8, etc.



Leonardo Pisano

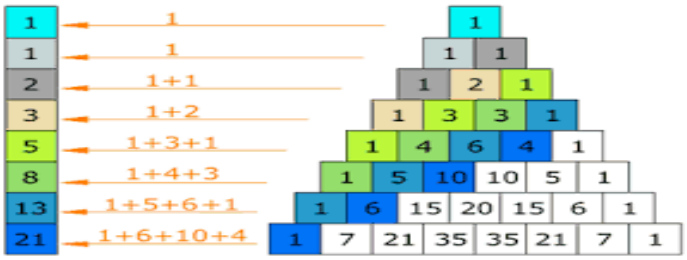
Source. *https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.wetheitalians.com%2Ffrom-italy%2Fleonardo-pisano-fibonacci&psig=AOvVaw2Y2pD1fa8B5Xd2TPOqmk4m&ust=1699959848469000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCOjlv-TpwIIDFQAAAAAdAAAAABAD*

What is Fibonacci Sequence?

The Fibonacci sequence is a sequence in which each number is the sum of the two preceding ones. Numbers that are part of the Fibonacci sequence are known as Fibonacci numbers. The sequence commonly starts from 0 and 1.

Starting from 0 and 1, the first few values in the sequence are:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144.



Fibonacci pattern or Fibonacci sequence

Source. *https://andymath.com/wp-content/uploads/2019/07/Fibonacci-Sequence-1024x434.jpg*
https://cdn1.byjus.com/wp-content/uploads/2021/03/Fibonacci-Numbers-1.png

Fibonacci Sequence Formula

The Fibonacci sequence of numbers "Fn" is defined using the recursive relation with the seed values

$$F_n = F_{n-1} + F_{n-2} \qquad F_n = F_{n-1} + F_{n-2}$$

Materials required

1. Quartz clock movement
2. Quartz clock hands sets (hour, minute and second hands)
3. AA size battery
4. Cardboard
5. A4 photo sheets
6. Thin flexible wire
7. Black paint and brush
8. Cutter knives
9. Scissors
10. Glue
11. Markers, scale, tweezer, tape and pencils

Working Principle

The clock works by combining a spiral arm, designed using a Golden Ratio rectangle or a rectangle comprising contiguous squares whose sides are Fibonacci numbers.

Golden Ratio

The golden ratio is derived by dividing each number of the Fibonacci series by its immediate predecessor. Where F (n) is the nth Fibonacci number, the quotient F (n)/ F (n-1) will approach the limit 1.618, known as the golden ratio.

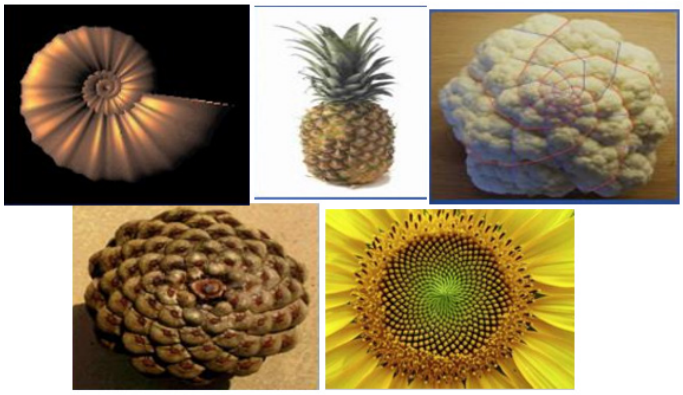
The number 1.61803... Frequently appears in art, architecture, and natural sciences. It is derived from the Fibonacci series of numbers, where each entry is recursively defined by the entries preceding it.

Fibonacci Spiral Clock

Fibonacci Spiral Clock

Application

- Fibonacci clocks help us know the time.
- It can be used to teach patterns in mathematics, music, art, language and science.
- Fibonacci numbers can also be found in nature such as in snails, leaves of plants, flowers, fruits and vegetables.

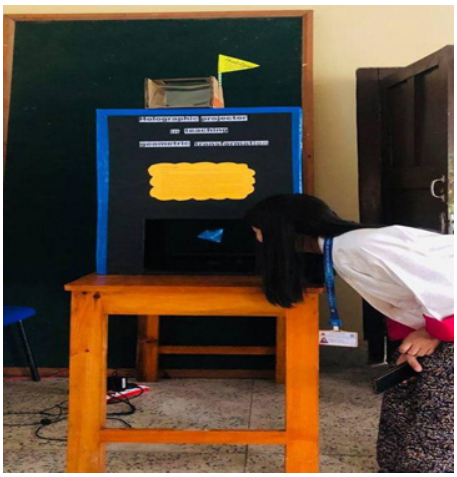


Fibonacci numbers in nature

Source. *https://1.bp.blogspot.com/-jb62CMl2lO4/WjYe0CsJx1I/AAAAAAAACDo/LDn5jgQ9x5Ql2znd-BeitmL5Y-j08wFK_ACLcBGAs/s1600/Golden-ration-in-nature.jpg*

The holographic projector in teaching Geometric Transformation.

Dechen Wangmo
Gyelsthen
Jigme Wangmo
Kaka
Purna Bahadur Subba (Advisor)



A participant demonstrating the working of a Holographic projector to the visitors.

- A three-dimensional image formed by the interference of light beams from a laser or other coherent light source(oxford dictionary)

- A hologram is a picture of a 3-D image created using 2-D holographic video.

- A three-dimensional image reproduced from a pattern of interference produced by a split coherent beam of radiation (such as a laser).

Definition of holographic projector

History

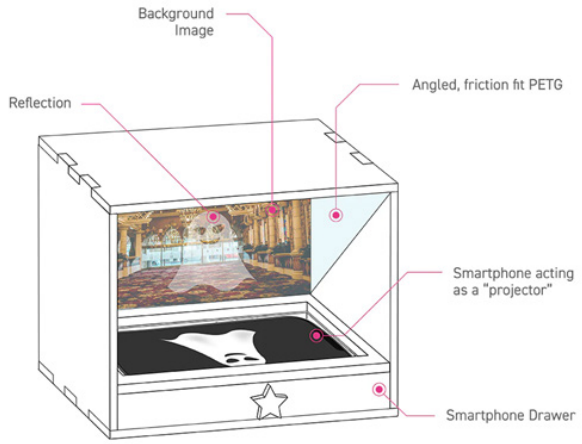
Dennis Gabor (Hungarian-British Electrical engineer and Physicist) who was known as

the father of Holography and Holographic technologies was the discoverer of holograms.

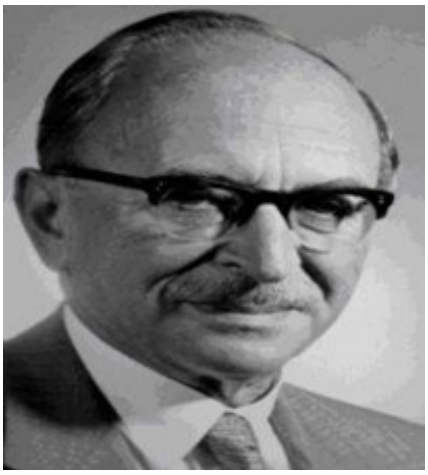
He made holograms only of transparencies where his reference beam was the unobstructed light that went through the clear parts of the transparency. He realized simple holograms by using the "green" light of a mercury vapors-based lamp. Optical holography did not really advance until the development of the laser in 1960 which enabled the first practical optical holograms that recorded 3D objects to be made in 1961.

Materials: Glass, fevi-quick, superglue, chart paper, OHP sheets, Cello tape, phone/ laptop

Diagram



Different parts of a Holographic projector.



Working principle

Hologram works based on the principles of reflection and refraction of light rays.

Working

Working of this model typically uses a combination of projection technology and reflective surfaces to create the illusion of a holographic image. Holographic projectors that use holographic videos work on the principle of reflection. The characteristics of the reflective surface can affect the brightness, contrast, and clarity of the holographic image. The holographic video is projected onto a reflective surface that is angled towards the viewer. The reflective surface acts as a holographic plate, and the projected video creates a virtual image that appears to float in space.

The virtual image is created by reflecting the light from the video off the reflective surface and into the viewer's eyes creating the illusion of a 3D holographic image. The holographic plate or reflective surface contains a pattern of lines or dots that correspond to the interference pattern produced by the two light waves. When the

plate or reflective surface is illuminated, the interference pattern causes the light waves to diffract, or bend, creating the illusion of a 3D image.

Applications of Hologram

1. Entertainment
2. Advertisement
3. Medicine
4. Military and defense
5. Design and engineering
6. Education

Education

Hologram projectors are used in education to create interactive and engaging visual displays of scientific phenomena, historical events, and other educational topics. This technology allows for immersive and interactive learning experiences, and can help students better understand complex concepts.

Benefits of the use of the holographic projector in teaching and learning mathematics

1. It helps students to visualize complex 3D shapes and understand mathematical concepts such as geometrical shapes, calculus, and topology. For example; To teach 3D geometry, the teacher usually displays a video of 3D shapes using a projector. However, it is believed that whatever we see in the video, it is considered as 2D. So therefore, if we make use of the holographic projector instead of displaying video, students will be able to visualize the real image of a 3D shape in the floating space.

2. It can be used to teach the concept of Transformation of Geometry.

3. It can be used to find the volume and surface area of geometrical shapes by displaying a 3D hologram. For example, the teacher could display a hologram of the sphere and show how its volume changes as its radius increases.

4. It can be used to teach the symmetry of 3-D figures.

Mathematics in holographic projector Input (construction)

To construct the holographic projector, we have used the idea of mathematics such as

1. Measurement
2. Trigonometry or Pythagorean theorem to create an angle 45^0

Process

Hologram works based on the principles of reflection and refraction of light rays. Therefore,

1. Involves Where θi= angle of incidence,θr=angle of reflection
2. Also involves complex mathematical calculations related to the principle of refraction of light rays

Output

1. Represent 2D video images in 3D
2. Transform 2D Geometry in video into 3D Geometry in hologram
3. View the symmetry of the object in hologram from different angles and observe how the object appears to change

Notes

- How is hologram different from other 3D imaging techniques?

3D images techniques

Requires viewers to wear special glasses or use special equipment to visualize real images in 3D.

Hologram

Doesn't require viewers to wear special glasses or use special equipment to visualize real images in 3D. It can be viewed with naked eyes.

- Why is the image in video considered 2D?
  In video, the image is typically consideredas2D because it is composed of pixels arranged in a rectangular grid and it represents a single moment in a time.

Portable Automatic Water Pump usable in Uphill Cultivation

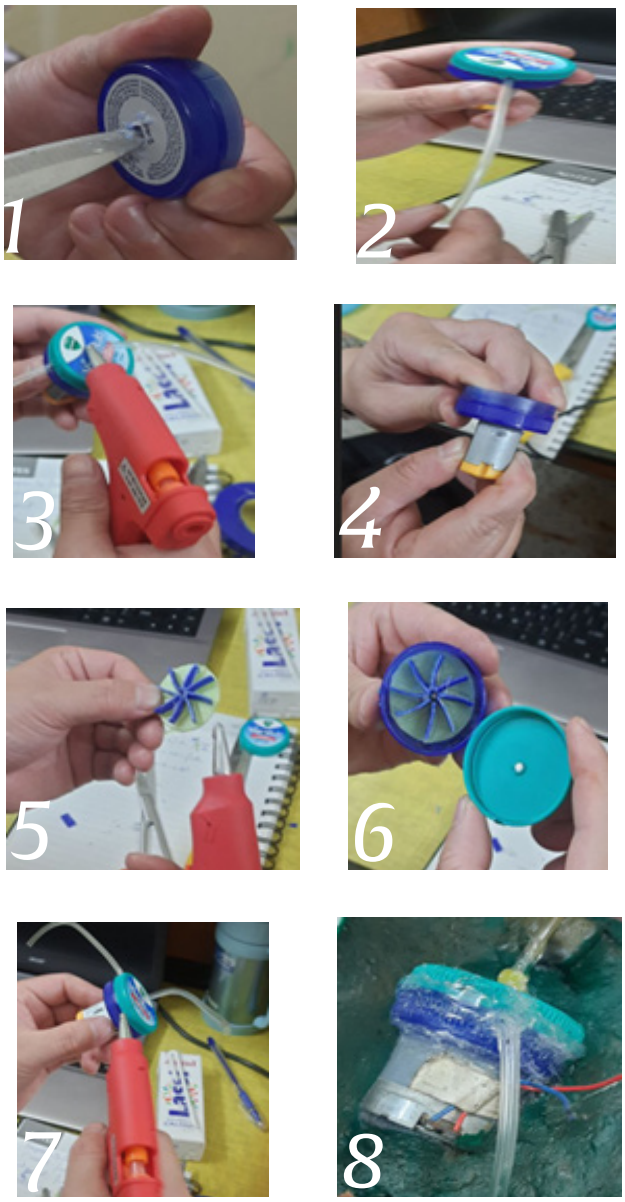
Chimi Singye
Rinchen Dorji
Tshering Choden
Purna Bahadur Subba (Advisor)

Materials required:

1. Two bottle caps. 2. DC motor 3. Wires 4. Small Plastic tubes. 5. Mobile adaptor 6. Glue gun 7. Cello tape 8. Plank 9. Clay 10. Card board	

Diagram of the Portable water pump machine with procedure.

Portable water pump



Different parts used for making a Portable water pump.

Procedure to construct the Portable water pump machine

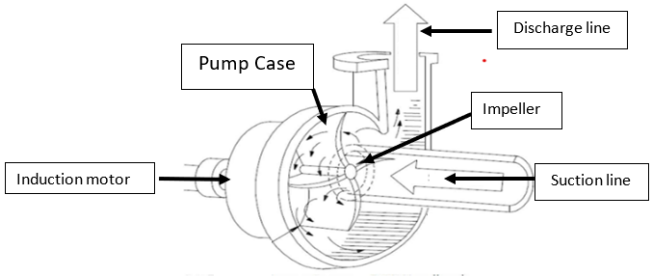
1. Drill a small hole in the center of one of the bottle caps
2. Cut the plastic tube to a length of about 10-15 cm
3. Attach one end of the tube to the bottle cap with the hole using the glue gun
4. Glue the DC motor to the other bottle cap
5. Make the fan inside the motor in spiral shape to give the correct flow of the direction of water
6. Attach the fan to the rotating motor pin
7. Glue the bottle caps together and ensure there is no leakage

What is a Water Pump?

The water pump can be defined as a pump which uses the principles like mechanical as well as hydraulic throughout a piping system and to make sufficient force to pump water from low level to high level.

Working Principle of the portable water pump

These pumps use AC power or DC power for energizing the motor of the water pump. A coil of wire carrying a current in a magnetic field experiences a force that tends to make it rotate. Electrical energy is converted into mechanical energy in terms of centrifugal force. Centrifugal force converts mechanical energy into hydraulic energy by the use of centrifugal force acting on the water. According to the working principle of the centrifugal pump, when the impeller rotates, the water is forced to the discharge line by the centrifugal force and a vacuum is formed at the center of the impeller and the water is sucked to form a continuous working process of the water pump.



The working principle of the Portable water pump

Before starting the water pump, it must first be filled with water to drain the air inside the pump case. If the pump case is not filled with water but full of air at start up, since the air density is much less than the density of water, when the impeller rotates at the same speed, the centrifugal force generated by the air will be much less than the centrifugal force of water. Therefore, before starting the water pump,

it must first be filled with water to drain the air in the pump case to maintain the normal operation of the pump.

Mathematical concept involved in water pump

1. **To calculate the volume of water lifted:**
   Power=(work done)/time
   P=(Potential Energy)/Time
   P=mgh/t
   P=pVgh/t
   V=Pt/pgh

Where PE is the potential energy in lifting water. Work done is equal to the change in potential energy in this case.
m=pV,where p=density and m=mass of water.

2. **Calculate Flow rate:** Pump flow rate simply refers to the volume of fluid that is moving through a pump in a given time period.

3. **To calculate hydraulic power:** Power transmitted by the controlled circulation of pressurized fluid

   P(h)=Q×H×p×g/1000
   1. Q = flow rate
   2. H= total head generated by pump
   3. P=density of the water
   4. g= acceleration due to gravity

4. **To calculate Pump shaft power**: the shaft power is the power required transferred from the motor to the shaft of the pump.

Ps=(hydrolic power(Ph))/(pump efficiency)

5. T**o calculate electrical input power P(m):** this is the maximum power required to operate a system.

Motor power P(m)=(pump shaft)/(motor efficiency)

6. **Tom calculate horsepower:** Water horsepower is the minimum power required to move water.

Horsepower=(TDH×Q×SG)/(#960)
TDH= total dynamic head
Q=flow rate
SG=Specific gravity

Applications of Water Pumps

The water pump is a portable device and can be applied in several household applications. These pumps are used for pumping huge amounts of water from one place to another. The main purpose of a water pump is to be versatile. A quality pump which can be selected carefully may be perfect for draining

water from a low flooded region, refilling the swimming pool, bathtub, and circulating pesticides or fertilizers.

Spirograph

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Sangay Wangmo
Sonam Zam
Peldhen Tsheltrim
Purna Bahadur Subba & Man Singh (Advisor)

Introduction

Spiral graphs are captivating mathematical patterns that have intrigued both artists and mathematicians for centuries. These intricate designs consist of gracefully curving lines that gradually wind inward or outward, forming mesmerizing spiraling shapes. By exploring the symmetrical and repetitive nature of spirals, these graphs offer a unique blend of artistic expression and mathematical precision.

The beauty of spirographs lies in their ability to create visually striking patterns through the simple act of drawing and connecting lines. By manipulating the parameters that determine the curvature and spacing of the lines, one can create an infinite array of captivating designs. These designs often exhibit mesmerizing symmetries and mesmerizing patterns that seem to draw the viewer's gaze deeper into the artwork.

Back Ground History

An instrument called a Spirograph was invented by the mathematician Bruno Abdank-Abakanowicz between 1881 and 1900 for drawing spirals.

How does it work?

The Spirograph set includes a set of pens or pencils that can be inserted into the gear's arms to create different patterns as they move around the wheel. By changing the position of the gear arm, different designs can be created. As you rotate the gears, the pen follows the path determined by the interaction of the fixed and rotating gears' teeth. The gears interlock, causing the pen to move along a specific trajectory. This movement creates intricate patterns, loops, and curves on the paper.

The Spirograph set usually includes multiple gears with different sizes and numbers of teeth. By swapping the gears or changing their positions on the frame, you can create a wide range of patterns. Larger gears typically result in broader patterns, while smaller gears produce more intricate details.

The underlying principle behind the Spirograph model is the mathematical concept of epicycles, which involves the

motion of smaller circles rolling along the inside or outside of larger circles. The interaction of these circles' paths generates the mesmerizing patterns seen in Spirograph drawings.

A participant demonstrating the working of a Spirograph to the visitors

Model Illustration

C = 2 * PI * R where R is the radius of the circle. From another side, the circumference of a gear, as a circle, is C = N * L, where N is the number of teeth of the gear, and L is the length of one tooth.

Illustration of a Spirograph

Materials required.

- Set of pens
- Cartoon to make gears
- Glue
- Scissors
- Plywood
- Paper

Output of model

The intricate designs produced by the Spirograph

Application

1. **Engineering and Design:** Spirograph can be used to create complex gear designs and patterns that can be applied to mechanical systems, such as gearboxes, transmissions, and precision instruments.

2. **Architecture:** Spirographs can be used to create intricate designs for decorative elements in buildings and structures, such as ornamental grilles and screens.

3. **Textile Design:** Spirographs can be used to create intricate patterns and designs for textiles, such as fabrics, wallpaper, and carpets.

4. **Education:** Spirographs can be used in mathematics education to teach concepts such as Geometry, Trigonometry, and Graphing.

5. **Therapy:** Spirographs have been used as a therapeutic tool for individuals with developmental disabilities or as a relaxation technique for individuals with anxiety or stress.

Additionally, Spirographs have remained a popular toy for many years and have been used by artists and designers to create unique and intricate designs. It is a fun and creative way to explore the principles of Geometry and mathematics, while also encouraging creativity and imagination.

Moreover, Spirographs find practical applications beyond their artistic appeal. They have been employed in fields such as Architecture, where they help create visually appealing structures with harmonious proportions. In Physics and Engineering, Spirographs have been utilized to study waveforms, analyze magnetic fields, and model the growth of natural phenomena.

Arduino Motion Sensors

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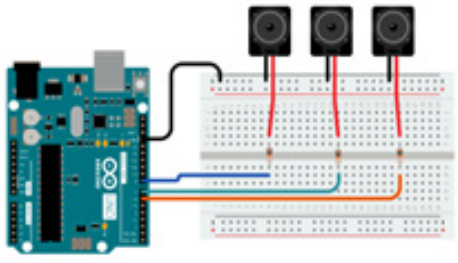


A Arduino motion sensor
Source. *https://docs.arduino.cc/static/adb3528b1395f51d79046bdaa9559b1f/29114/circuit.png*

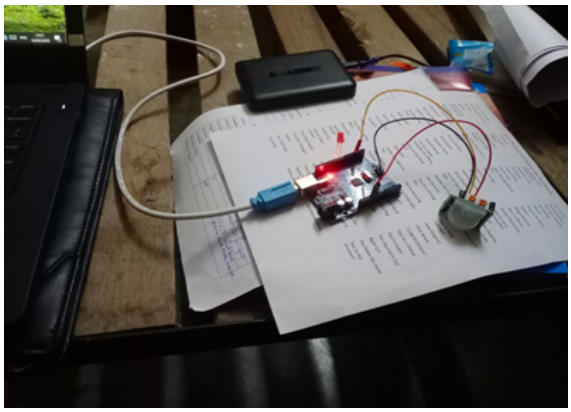
What is it about?

A motion sensor is a device that can detect movement or motion in its surroundings. It works by sensing changes in the environment, such as changes in infrared radiation, sound, or pressure. The most common type of motion sensor used in household applications is the passive infrared (PIR) sensor, which detects changes in heat emitted by moving objects.

Motion sensors are widely used in security systems, lighting control systems, home automation, and other applications where it is necessary to detect and respond to movement. For example, in a security system, a motion sensor can trigger an alarm or alert the homeowner when it detects movement in a protected area.

In addition to PIR sensors, there are other types of motion sensors such as ultrasonic sensors, microwave sensors, and optical sensors. Each type of sensor works differently and is suitable for different types of applications. Overall, motion sensors are a useful tool for detecting and responding to

motion, making them an important part of many modern technologies.



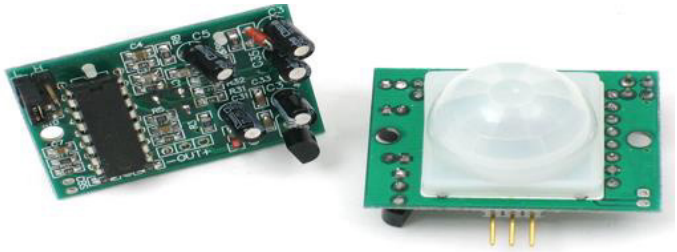
Home-made working model of a Arduino motion sensor

Mechanism of working

PIR sensors allow you to sense motion. They are used to detect whether a human has moved in or out of the sensor's range. They are commonly found in appliances and gadgets used at home or for businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

Following are the advantages of PIR Sensors:

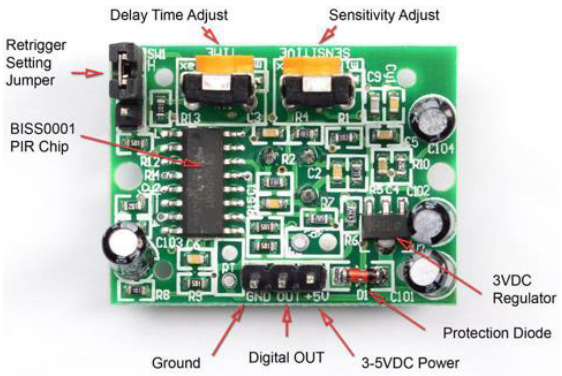
- Small in size
- Wide lens range
- Easy to interface
- Inexpensive
- Low-power
- Easy to use
- Do not wear out



Intricate parts of a Arduino motion sensor
Source. *https://www.circuitbasics.com/how-to-setup-passive-infrared-pir-motion-sensors-on-the-arduino/*

PIRs are made of pyroelectric sensors, a round metal can with a rectangular crystal in the center, which can detect levels of infrared radiation. Everything emits low-level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is split in two halves. This is to detect motion (change) and not average IR levels. The two halves are connected so that they cancel out each other. If one-half sees more or less IR radiation than the other, the output will swing high or low.

PIRs have adjustable settings and have a header installed in the 3-pin ground/out/power pads.



Arduino motion sensor parts
Source. *https://www.researchgate.net/profile/Venkat-Markapuri/publication/342120813/figure/fig1/AS:901442760089600@1591932110992/Raspberry-Pi-Device-Description_W640.jpg*

For many basic projects or products that need to detect when a person has left or entered the area, PIR sensors are great. Note that PIRs do not tell you the number of people around or their closeness to the sensor. The lens is often fixed to a certain sweep at a distance and they are sometimes set off by the pets in the house.

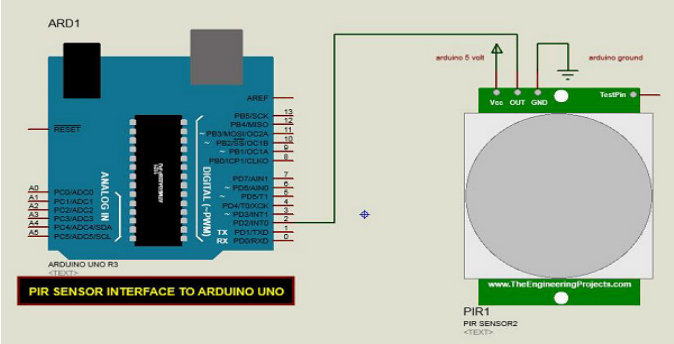
Components Required.

You will need the following components –

- 1 × Breadboard
- 1 × Arduino Uno R3
- 1 × PIR Sensor (MQ3)

Procedure

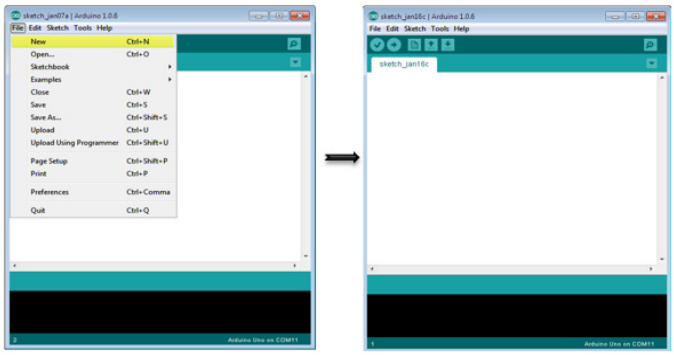
Follow the circuit diagram and make the connections as shown in the image below.



Arduino motion sensor circuit diagram
Source. *https://i.pinimg.com/564x/42/c3/46/42c346716e32eebe34d68750880e24fe.jpg*

Sketch

Open the Arduino IDE software on your computer. Coding in the Arduino language will control your circuit. Open a new sketch File by clicking New.



Arduino IDE Manage Libraries
Source: *https://s4scoding.com/images/arduino-ide-manage-libraries.webp*

Arduino Code

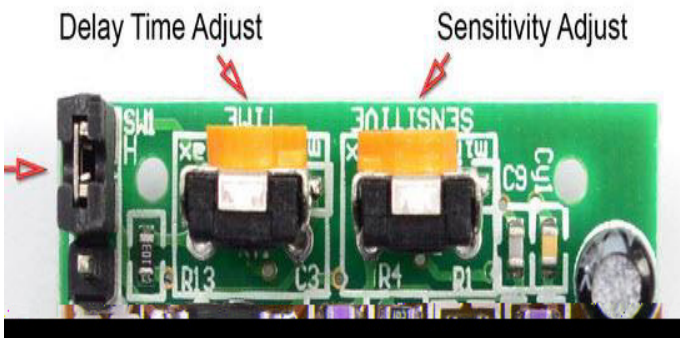
```
int calibrationTime = 30;

//the time when the sensor outputs a low impulse
long unsigned int lowIn;

//the amount of milliseconds the sensor has to be low
//before we assume all motion has stopped
long unsigned int pause = 5000;

boolean lockLow = true;
boolean takeLowTime;

int pirPin = 3;    //the digital pin connected to the PIR sensor's output
int ledPin = 13;

/////////////////////////////
//SETUP
void setup() {
Serial.begin(9600);
pinMode(pirPin, INPUT);
pinMode(ledPin, OUTPUT);
digitalWrite(pirPin, LOW);
```

```
//give the sensor some time to calibrate
Serial.print("calibrating sensor ");
for(int i = 0; i < calibrationTime; i++){
Serial.print(".");
delay(1000);
        }
Serial.println(" done");
Serial.println("SENSOR ACTIVE");
delay(50);
}

////////////////////////////
//LOOP
void loop(){

if(digitalRead(pirPin) == HIGH){
digitalWrite(ledPin, HIGH);   //the led visualizes the sensors output pin state
if(lockLow){
//makes sure we wait for a transition to LOW before any further output is made:
lockLow = false;
Serial.println("---");
Serial.print("motion detected at ");
Serial.print(millis()/1000);
Serial.println(" sec");
delay(50);
}
```

Code to Note

PIR sensor has three terminals - Vcc, OUT and GND. Connect the sensor as follows –

- Connect the +Vcc to +5v on Arduino board.
- Connect OUT to digital pin 2 on Arduino board.
- Connect GND with GND on Arduino.
- You can adjust the sensor sensitivity and delay time via two variable resistors located at the bottom of the sensor board.



Arduino sensors and terminals
Source. *https://i.pinimg.com/564x/0b/03/ed/0b03ed3fd34e11dbedc585e9017b5992.jpg*

Once the sensor detects any motion, Arduino will send a message via the serial port to say that a motion is detected. The PIR sense motion will delay for certain time to check if there is a new motion. If there is no motion detected, Arduino will send a new message saying that the motion has ended.

Result

You will see a message on your serial port if a motion is detected and another message when the motion stops.

Applications

1. **Security systems:** Motion sensors are commonly used in security systems to detect the movement of people or objects and trigger an alarm or alert.

2. **Lighting control:** Motion sensors can be used to control lighting in a room or outdoor area. They can turn on lights when motion is detected and turn them off when there is no activity.

3. **Home automation:** Motion sensors can be integrated into home automation systems to trigger actions such as opening doors, adjusting temperature, or turning on appliances.

4. **Energy conservation:** Motion sensors can be used to conserve energy by turning off lights and other devices when no one is in a room.

5. **Industrial automation:** Motion sensors can be used in industrial applications to detect the movement of machinery or products and triggeractions such as stopping the production line or diverting products to a different location.

2. Smartphone projector

Smartphone projector

Source. *https://dornob.com/wp-content/uploads/2015/11/Smartphone-Projector-3.jpg*

Source. *https://dornob.com/wp-content/uploads/2015/11/Smartphone-Projector-3.jpg*

What is it about?

A smartphone projector is a device that allows you to project the screen of your smartphone onto a larger surface, such as a wall or a screen. The smartphone projector also involves mathematical principles, such as pixel density and aspect ratio. Pixel density refers to the number of pixels per unit of area, which determines the sharpness and detail of the image. On top of that, the design and construction of a smartphone projector also involve mathematical concepts such as measurement, geometry,

and spatial reasoning. The size and shape of the projector, as well as the placement and alignment of its components, must be carefully calculated and optimized to ensure optimal performance and efficiency.

Advantages of smartphone projector

A smartphone projector is a compact device that allows you to project the screen of your smartphone onto a larger surface, such as a wall or a projector screen. There are several reasons to choose a smartphone projector over traditional projector as follow:

1. Portability

Smartphone projectors are small and lightweight, making them easy to carry around. This makes them ideal for business presentations or for watching movies on the go.

2. Cost-effective

Smartphone projectors are generally less expensive than traditional projectors, making them a cost-effective option for people who need a projector for occasional use.

3. Easy to use

Most smartphone projectors are designed to be easy to use, with simple setup and operation. They also typically come with a range of connectivity options, such as HDMI, USB, and Wi-Fi, making it easy to connect your smartphone or other devices.

4. Space-saving

Smartphone projectors are typically small and compact, which means they take up less space than traditional projectors. This makes them a good choice for people who don't have a lot of space to spare. Overall, a smartphone projector can be a useful tool for anyone who needs to project the screen of their smartphone onto a larger surface.

5. Application of smart phone projector in daily life.

Smartphone projectors have a wide range of applications in daily life, including:

1. Entertainment:

We can use a smartphone projector to watch movies, TV shows, and videos on a bigger screen. It can be a great addition to your home theater setup or for outdoor movie nights with friends and family.

2. Gaming:

With a smartphone projector, you can project your favorite mobile games onto a larger screen, providing a more immersive gaming experience.

3. Presentations:

If you need to give a presentation at work or school, you can use a smartphone projector to display your slides and materials on a bigger screen. This can be especially useful when presenting to a large group of people.

4. Education:

Smartphone projectors can be used in

classrooms or for homeschooling, allowing students to view educational content on a larger screen, making it easier for them to learn and understand complex concepts.

5.Travel:

If you're traveling and want to watch a movie or TV show, a smartphone projector can be a great option. You can project your content onto a wall in your hotel room or while camping, making it feel like you have your own personal cinema.

6. Video conferencing:

With the rise of remote work and virtual meetings, smartphone projectors can be used to display the video conference call onto a larger screen, making it easier for everyone in the room to see and participate.

Mathematical concepts exhibited by the model and materials used:

Following are the concepts in mathematics that can be found in this model:
Optics, ii. Geometry, iii. Trigonometric function, iv. Refraction, v. Digital signal processing, vi. Measurement, vii. Optimal distance, viii. Pixels density & ix. Ratio and Accuracy. The materials used are Convex lens, Mobile holder, Mobile phone and Planks

Electric Power Generation Using Wind Turbine

Choney Wangchuk
Kuenga Namgay
Singer Tamang
Rigzen Lethro
Purna Bahadur Subba (Advisor)

Aim: To build a working model of Electric power generation using wind turbines.

Objectives

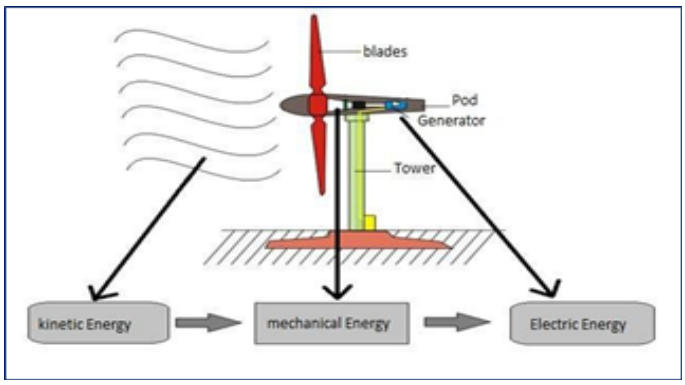
- To explore the working of wind tubines.
- Explore how motors produce electricity when a wind turbine rotates.

Materials used: Motor, fan, wire, bulb, glue, scissors, papers, cardboard, paints, mud, mosses etc.

Descriptions: Working principle of wind turbine

Wind is the renewable energy source. It demonstrates how wind is utilized to generate power. The turbine/fan on the motor is rotated by the wind's energy.
The kinetic energy possessed in the wind is transformed to mechanical energy by wind turbines.

The wind turbines that transform kinetic energy into mechanical power, and from there into electricity that serves as a valuable source. This electricity can be connected to home and utilize it for a variety of things.



Working principle of a wind turbine

The wind energy formula is given by,

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

Where,

P = power,

p = air density,

A = Area of blades given by

$$A = \pi r^2$$

where r is the length of the blades.

V = velocity of the wind.

Exam ple 1

Determine the power in the wind if the wind speed is 30 m/s and blade length is 40 m.

Solution Given:

Wind speed v = 30 m/s,

Blade length (r) = 40 m,

Air density P = 1.23 kg/m.

The area is given by,

A = π × 1600 $A = \pi r^2$

= 5024 m

The wind power formula is given as,

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

P= 1/2 ×1.23 ×5024×30^3

P = 83423.52 W

Working of motor.

Motor depends on the two factors such as speed and torque. These two important factors describe how powerful the motor is. The motor speed and torque – the turning force of the motor that determines the power of the motor.

Output mechanical power can be calculated by using,

P.out = τ x ω

output power (P.out) is measured in watts (W)

T– torque is measured in Newton meters (Nm)

w– angular speed is measured in radians per second (rad/s).

we can easily calculate angular speed if we know the rotational speed of the motor in rpm (rotation per minute):

ω = rpm x 2π / 60

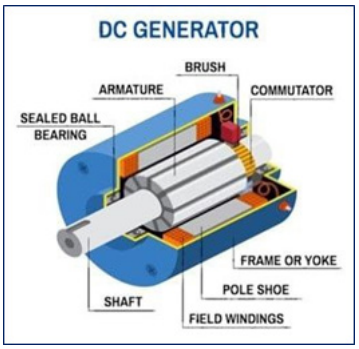
where w – angular speed is measured in radians per second (rad/s)

rpm – rotational speed per minute;

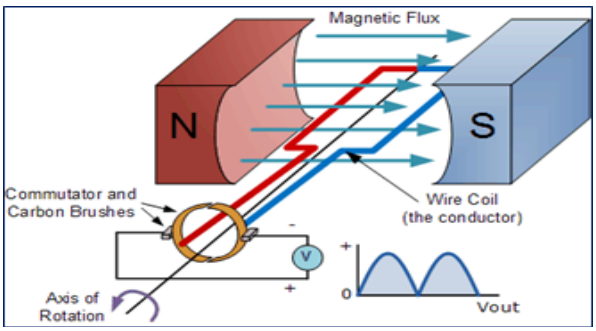
π – constant pi (3.14).

60 – seconds in a minute.

All electrical power is transformed to mechanical energy if the motor is 100% efficient. Such motor types do not exist. Even carefully constructed tiny industrial motors, which we are employing as the generator in this model, may have a maximum efficiency of 50 to 60%



Direct Current Generator Components



DC Generator Design for Wind Turbine Generation

Measuring the torque requires special expensive equipment. Therefore, we can use following formula to calculate:

Efficiency of the motor is (mechanical output ÷ by electrical input).

E = P.out / P.in

So, P.out = P.in x E

Substitute and we will get

τ×ω=I×V×E

τ x rpm x 2π / 60 = I x V x E

thus, the formula for torque is.

τ = (I x V x E x 60) / (rpm x 2π)

The maximum efficiency of the motor at a certain speed may be 15%. Efficiency may range from 0 to maximum.

For example

Consider 1100 rpm. And assuming 9% efficiency (Ɛ = 0.09).

= Speed = 1100 rpm,

= Voltage = 6 Volts,

and Current = 220 mA (0.22 A):

T= (0.22 x 6 x 0.09 x 60) / (1100 x 2 x 3.14)

= 0.001032 Nm

Application in real life.

Windmills are generally located in the windy area of the country. In Bhutan we can see such a type of windmill in Wangdue Phodrang as it is considered as a windy place.

Wind-powered energy does not produce dangerous waste that is harmful to animals/ people and the environment. However the wind does not blow unceasingly, so methods of storing the electricity must be designed, as well as alternative methods of generating electricity. In most of the countries the wind mills are used to produce electricity.

*Power generation using wind turbine in Wangdue Phodrang, Bhutan.
Retrieved from wind turbine in bhutan - Bing images

ཐུལ་འཁོར་གཀངཏྲི། (The Mechanized Spindle wheel)

Kuenga Legpa
Dorji Wangchuk
Ugyen Chophel
Dawa Tshering
Dr. Karma Utha (Advisor)

Introduction

The Bhutanese national dress- 'gho' for men and 'kira' for women, holds profound cultural and symbolic significance in the Kingdom of Bhutan. These traditional garments are powerful expressions of Bhutanese identity, heritage, and values. The gho and kira is worn on a daily basis.

However, the intricately woven garments with patterns and often made out of silk are not worn as an everyday clothing – they are worn during big formal events like religious festivals, important official gatherings, weddings, and other major cultural celebrations. These garments are like time machines, connecting Bhutan's present to its past, and they stand tall as symbols of the nation's enduring cultural pride. They are cherished symbols, deeply woven into the social fabric and identity of Bhutan, held close to the hearts of its people.

The gho and kira worn especially on special occasions are hand woven. Thagzo, the art of weaving, is a cherished tradition that involves several intricate steps, with the pre-weaving process demanding considerable time and effort to prepare threads before weaving. The weavers use a variety of yarns with rich, vibrant colours which are obtained either from chemical or natural dyes. The entire process of weaving a fabric right from spinning of yarn, dyeing and weaving is carried out manually.

The main processes before weaving is yarn preparation. It involves yarn selection, dyeing, and rolling and twisting fibers. This project focuses only on the rolling and twisting fibers process.

Rolling and twisting fibers: This step ensures the creation of strong, consistent yarns, which are pivotal for the quality of the final woven textiles. The rolling of yarn using spinning wheels and the twisting of fibers using drop spindle, are a labor-intensive process The time spent on these tasks also depends on the intricacy of the design and desired yarn thickness, reflecting the weaver's skill and dedication.

Rolling yarn using a spinning wheel

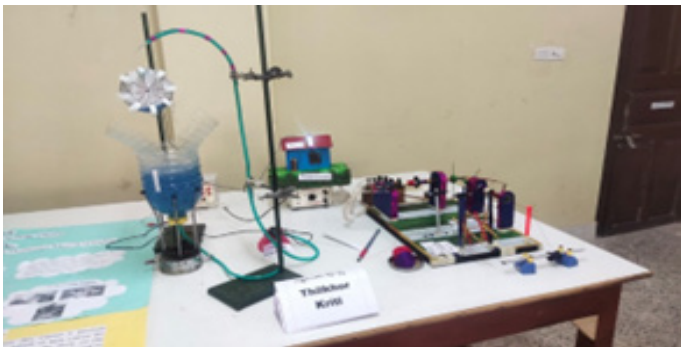
Twisting thread with a drop spindle

The traditional process followed using spinning wheel and spindle upholds traditional weaving methods and are said to ensure superior quality but takes a long time. There is a necessity for mechanization in Bhutanese weaving to significantly enhance production speed, meet the growing demand for Bhutanese textiles, and alleviate the physical strain on weavers. It also has the potential to attract the younger generation to the craft.

Recognizing the need to achieve a balance between mechanization and the preservation of traditional techniques to maintain the authenticity and uniqueness of Bhutanese weaving, this model Thuel-khor Kriti was ideated. The model attempted to mechanize the pre-weaving phase of preparing threads, making it easier, efficient and more convenient for the weavers with the hope that it ensures a promising and sustainable future for Bhutanese weavers.

Thuel-khor Kriti focuses on three key aspects: spinning threads into balls, mixing threads, and making the threads finer (twisting). It utilizes a low-powered DC motor and the perpetual motion of water to streamline the spinning and mixing of threads, as well as the production of threads from raw materials.

It operates on the principle of energy conversion, transforming electrical energy into mechanical energy. The semi-perpetual motion of water drives the mechanized spindle wheel, making it an eco-friendly approach that aligns with Bhutan's commitment to environmental conservation.



Thuel-khor Kriti model

Presentation of the model during Science Fest

In this system, water stored in a reservoir flows through a narrow pipe and is then propelled back into the system using a low-powered DC motor pump. Importantly, the water used in this process is recycled back into the reservoir, minimizing waste.

The generated power serves as the energy source for the primary machine, which includes another low-powered DC motor responsible for spinning yarn. Additionally, connected to the opposite end of this motor is a Y-shaped component, known as the movable spinner, which functions as a drop-ball spindle. This spindle is used for spinning, twisting, or blending yarn, allowing for the creation of finer yarn or the combination of yarns with different colors.

The model brings numerous advantages, fostering a promising future for Bhutanese weaving. By reducing the time required for thread preparation, it significantly boosts productivity, contributing to the growth and sustainability of the weaving industry. Automating the pre-weaving process may allow the weavers to strike a healthier work-life balance, cherishing precious moments with their families and attending to household chores. It aims to empower weavers to focus on the creative aspects of their craft, nurturing their artistic endeavors while preserving the tradition.

The Thuel-khor Kriti represents a leap towards a sustainable and prosperous future for Bhutanese weaving. Continued advancements and a focus on eco-friendly practices will shape the evolution of Bhutanese weaving, blending tradition with innovation. So, get ready to weave your way into the future with the Thuel-khor Kriti!

Swinging in Sync: Exploring the Fascinating World of Wave Motion and Energy Transfer through the Pendulum Wave Model

Lhawang Nima Dorji
Pema Dhendup
Sangay Wangmo
Ugyen Pem (Advisor)

The aim of this pendulum wave model is to explain the principle of wave motion and energy transfer and to demonstrate the beauty of the interplay between them. The model demonstrates wave motion and energy transfer in a visually captivating way. The pendulum wave model is created using a set of 16 simple pendulums of different lengths denoted by A,B,C,...., P oscillating at different frequencies but in a synchronized way.

Construction

To construct the pendulum wave model, a step-by-step process was followed as follows.

1. First, we determined the length of the first pendulum to be 0.23 m. This was based on the desired amplitude of the wave and the available space for installation.

2. We calculated the lengths of the remaining pendulums using the following formula
   L=g[T_max/(2π(k+n+1))]^2,

Where L is the length of the pendulum in meters,
g is the acceleration due to gravity,
Tmax is the desired time for the wave pattern to persist, and
n is the position of the pendulum in the arrangement.

3. The lengths of each pendulum are tabulated as shown in Table1.

Table 1. Finding the length of pendulum

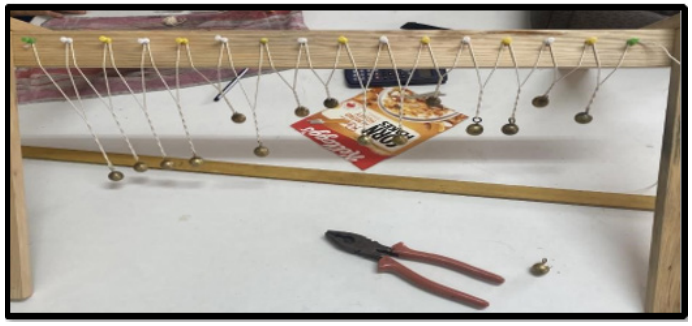
Position of the pendulum (n)	Length of the pendulum (L) (in meters)
1st (A)	0.23
2nd (B)	0.211
3rd (C)	0.196
4th (D)	0.183
5th (E)	0.17
6th (F)	0.159
7th (G)	0.142
8th (H)	0.140
9th (I)	0.131
10th (J)	0.124
11th (K)	0.117
12th (L)	0.110
13th (M)	0.105
14th (N)	0.099
15th (O)	0.094
16th (P)	0.089

4. The length of each thread were measured to the calculated length before passing it through the hook of the pendulum bobs. *(Note that all the pendulums were connected by the same single thread).*

5. We started the pendulum wave by pulling one of the bobs to the side and releasing it.

6. Finally, we observed the wave pattern and made adjustments to ensure that all pendulums were synchronized and swinging in the same direction.

The construction is as shown in the figure



Pendulum wave model

Working

Upon assembling the pendulum wave model, we observed a clear and synchronized wave

pattern as the pendulums oscillated back and forth. The wave pattern persisted for 24 seconds, as determined by the value of Tmax that we set during the calculation of pendulum lengths.

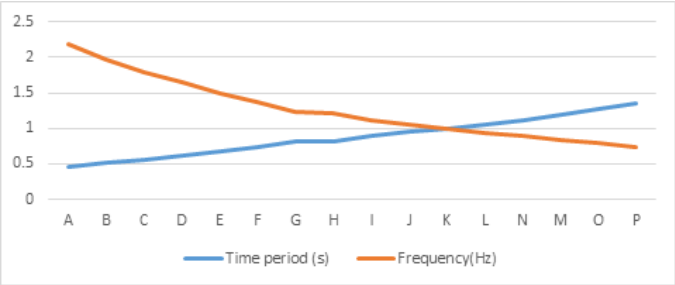
To analyze the data further, we measured the time period of each pendulum's oscillation using a stopwatch. We recorded the time for 10 oscillations of each pendulum and then calculated the average time period for each one.

The results of our measurements and finding frequencies are shown in Table 2.

Table 2: Time period and frequencies of all the pendulums at different position in the pendulum wave model

Pendulum position	Time period (s)	Frequency(Hz)
1st (A)	0.46	2.18
2nd (B)	0.51	1.96
3rd (C)	0.56	1.79
4th (D)	0.61	1.64
5th (E)	0.67	1.49
6th (F)	0.73	1.37
7th (G)	0.81	1.23
8th (H)	0.82	1.22
9th (I)	0.89	1.12
10th (J)	0.95	1.05
11th (K)	1.00	1.00
12th (L)	1.06	0.94
13th (M)	1.12	0.89
14th (N)	1.19	0.84
15th (O)	1.27	0.79
16th (P)	1.36	0.74

Graph1. Variation of time period and frequency w.r.t to pendulum positions



The graph 1 indicates that the time period of each pendulum's oscillation increased as its length increased. This relationship between pendulum length and time period is in accordance with the theoretical equation for simple pendulum motion. Also, the frequency of each pendulum's oscillation decreased as its length increased. This relationship between pendulum length and frequency is also in accordance with the theoretical equation for simple pendulum motion.

During the STEM FEST, the pendulum wave model garnered considerable attention from various groups of students and teachers from Samtse lower and higher secondary schools, exhibiting a notable fascination towards its intricate wave patterns and the concept behind the model. Overall, the Pendulum Wave Model project has demonstrated the potential of interactive teaching tools in science education. By incorporating such models into teaching, we can engage students, promote learning, and inspire the next generation of scientists and engineers.

Anti-Sleep Sensor

Geley Wangchuk
Sobit Pradhan
Dr. Karma Utha & Tandin Penjor (Advisor)

Driver fatigue is a prevalent issue in road safety worldwide and refers to the state of tiredness or drowsiness experienced by drivers due to prolonged driving, lack of sleep, or other factors. Fatigued drivers are at an increased risk of reduced attention, slower reaction times, impaired decision-making, and ultimately, an increased likelihood of accidents. Road accidents resulting from driver fatigue can have serious consequences, leading to injuries, fatalities, and significant economic and societal costs.

In Bhutan, a small landlocked country located in the eastern Himalayas, road safety is a growing concern. Bhutan's unique geography, with its challenging terrain and winding roads, adds to the complexity of road safety issues. The country has experienced a rise in road accidents, and driver fatigue is recognized as one of the contributing factors. Bhutan's road crash fatality rate as of 2022 is 6.3 for every 10,000 vehicles. As per the statistical report from the Ministry of Information and Communications, the number of road accidents was 745 in the year 2021.

The importance of addressing driver fatigue in Bhutan cannot be overstated. By implementing measures to prevent and manage driver fatigue, the country can significantly reduce the occurrence of road accidents, injuries, and fatalities. This includes preventing the risks of driver fatigued by using technology such as anti-sleep sensors.

The anti-sleep sensor is an innovative system aimed to address the critical issue of driver fatigue and prevent accidents caused by drowsy driving. By harnessing advanced sensor technology and the versatility of Arduino, this project offered a comprehensive solution to enhance road safety.

The principle of operation behind the Anti-Sleep Sensor project revolved around the continuous monitoring of the driver's eyeblink patterns. By utilizing an Infrared (IR) sensor, the system could detect if the driver's eyes had been closed for more than two seconds, indicating drowsiness.

When the IR sensor detected prolonged eye closure, it triggered a series of alerts to ensure the driver's wakefulness. In the initial stage, a loud and attention-grabbing buzzer was activated to immediately wake up the driver. If the driver remained unresponsive and their eyes remained closed, the Arduous system engaged a motor wheel, gradually bringing the vehicle to a stop. This proactive approach ensured the safety of the driver and others on the road.

The circuitry of the Anti-Sleep Sensor project comprised several essential components:

IR Sensor: This component continuously monitored the driver's eye blink patterns, effectively detecting signs of drowsiness.

Relay: Serving as a control switch, the relay was triggered when the IR sensor detected prolonged eye closure. It initiated the alert mechanisms

.

Buzzer: The audible alarm produced by the buzzer acted as an immediate wake-up call for the driver. It ensured their attention was captured and prompt action was taken.

Motor Wheel: In the event that the driver failed to respond to the initial alerts, the motor wheel was engaged by the Arduous system. This gradual stopping mechanism ensured the safety of the driver and prevented potential accidents.

Arduino Nano: As the central control unit, the Arduino Nano processed the input from the IR sensor and controlled the output to the relay, buzzer, and motor wheel. Its real-time monitoring and decision-making capabilities played a crucial role in preventing accidents caused by driver fatigue.

Battery: The battery provided the necessary power to the Arduino Nano and the entire system, ensuring uninterrupted operation and portability.

Demonstration of anti-sleep sensor during the STEM FESTIVAL

The Anti-Sleep Sensor project offered numerous uses and benefits in the realm of road safety:

Road Safety Enhancement: By effectively

preventing accidents caused by driver fatigue, this project significantly contributed to enhancing road safety. Drowsy driving was a leading cause of accidents globally, and this project served as a valuable tool in combating this issue.

Commercial Fleets: Companies operating commercial fleets could integrate this system into their vehicles to prioritize driver safety and reduce the risk of fatigue-related accidents. This ensured the efficient and secure transportation of goods and personnel.

Personal Safety: Individual drivers could install the Anti-Sleep Sensor project in their vehicles, particularly during long drives or when engaged in occupations demanding extended periods of vigilance. This enabled them to prioritize their own safety and prevent potential accidents due to drowsiness.

Awareness and Education: The project served as an educational tool, raising awareness about the dangers of drowsy driving and promoting responsible driving habits. By emphasizing the importance of staying alert on the road, it contributed to a culture of safe driving practices.

Conclusion

The Anti-Sleep Sensor Arduino project showcased the effective integration of advanced sensor technology and Arduino's capabilities in addressing a critical safety concern. By continuously monitoring the driver's eyeblink patterns and providing timely alerts, this project had the potential to save lives and prevent accidents caused by driver fatigue. It represented a valuable addition to the field of road safety, emphasizing the significance of driver alertness and responsible driving.

Meet Edison: Robotics for all

Kinley Wangmo
Torbjorn Hansson

Edison V2.0 is a programmable robot designed by Microbric and his team in South Australia in 2014. Its design focused on making robotics and coding education more approachable for students of various ages and skill levels. It was designed to be affordable and functional, making it an excellent tool to assist children in learning basic programming.

In line with Bhutan's significant education reform, which emphasizes digitization (Royal Kasho on Education Reform: The Bhutanese, 2021), the use of Edison V2.0, a programmable robot capable of

demonstrating various scientific concepts such as robotics, programming, electronics, and engineering, was exhibited during the STEM Fest. Our aim was to demonstrate the diverse programming capabilities of the Edison V2.0 robot and encourage audience participation.

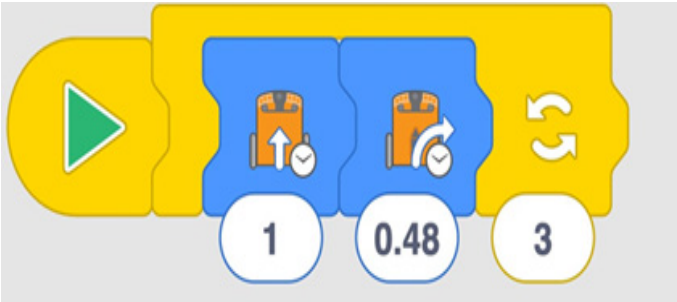
Firstly, we demonstrated a programme designed in Edblocks, followed by a challenging activity where the audience predicted the shape of the path that the robot would make. This approach was designed to be both informative and enjoyable, ensuring the participants were engaged throughout the exhibition.

Design

The Edison V2.0 robot can be programmed using a variety of methods, including a simple barcode and three programming languages: EdBlocks, EdScratch, and EdPy. After careful consideration of the participants' prior knowledge of coding, we decided to use barcodes and EdBlocks to programme the Edison V2.0 robot for the exhibition. EdBlocks, an icon-based programming language with a drag-and-drop block-based system, was chosen for its ease of use.

The student participants from Samtse Higher Secondary School and Samtse Lower Secondary School were challenged to predict the shape of the path the robot would make based on the designed codes in a worksheet.

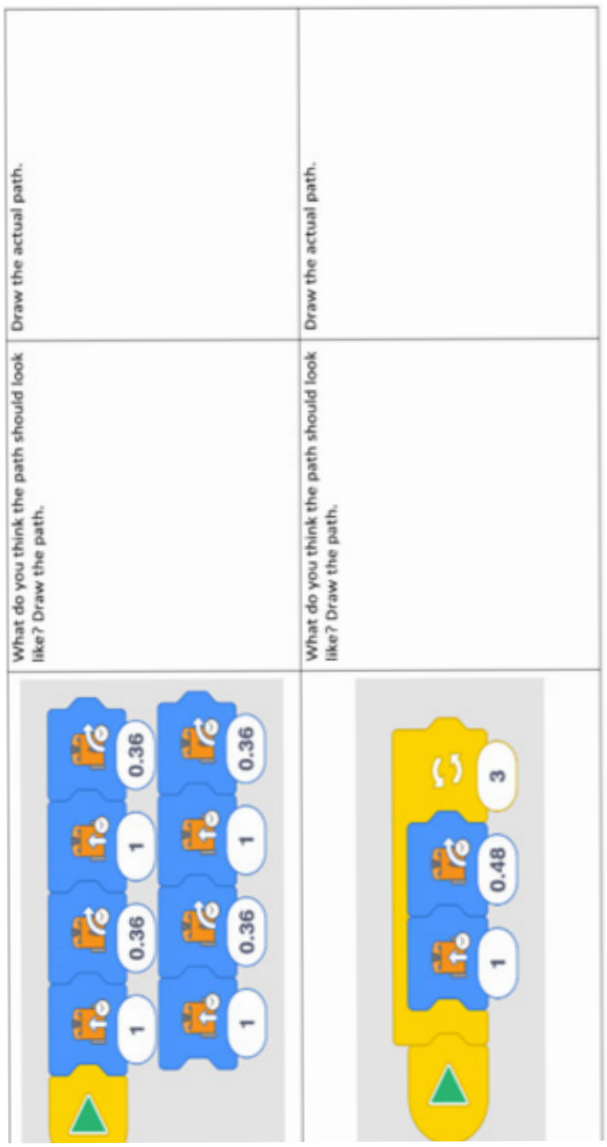
Barcode



EdBlocks

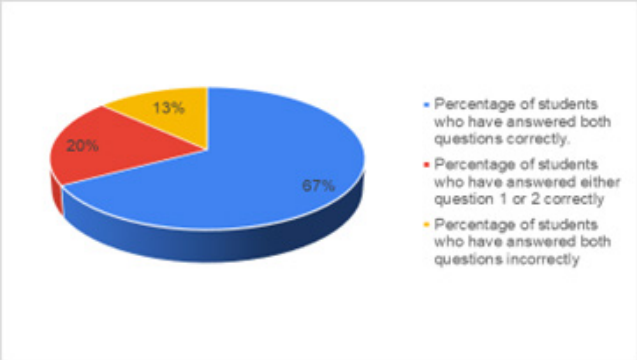
Students' interaction with Edison V2.0 robot

The students were asked to predict the expected shape of the robot by reading the codes from the worksheet. Their predictions were evaluated based on the display of the path taken by the robot, and they drew the actual path taken by the robot in a separate column, as shown in the following worksheet.



Worksheet for the students to predict and for evaluation

Results



Analysis of the worksheets

A total of 39 students participated in answering worksheets, as shown in the pie chart. Majority of the students have answered both questions correctly by tracing the path of the Edison V2.0 robot. On the other hand, 13% of students failed to predict the path traced by the robot reading the codes.

Conclusion

The Edison V2.0 robot serves as excellent teaching material in schools. By leveraging the capabilities of the robot, students can develop a deeper understanding of science and technology and cultivate the skills they need to succeed in the near future.

Additionally, programming the Edison in various languages can expose students of different levels to programming and familiarize them with the language of coding. It can help cultivate a greater interest in fields such as Robotics and programming, which are increasingly important in the digitized world.

STEM Education Newsletter
Special issue on STEM Fest

Samtse College of Education
AUTUMN 2023

"We must make STEM subjects part of their (children/students) everyday language….In preparing our youth for the future, we must take advantage of available technologies, adapt global best practices, and engineer a teaching-learning environment suited to our needs. Technology is the argument of our time and a major indicator of social progress. The irony in our context is the absence of technology in classrooms for a generation of students who are exposed to, and live in the digital age. To ensure that teachers are not disconnected from their students, professional development of teachers should integrate technology, digitalization, artificial intelligence, and automation."

(His Majesty King Jigme Khesar Namgyel Wangchuck, 2020)