Group No. 23103

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Kineto-Electric Conversion Treadmill

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Key Words

Alternative energy
Lithium batteries
Electric power
Treadmill

Abstract

Egypt is currently dealing with several issues that are seriously impeding its progress, including climate change, improving the scientific environment, using alternative energy sources, and more. Chiefly, these considerations are energy-related issues. Numerous environmental and human activities end up in the trash without being fully utilized. As a result, Ways to take advantage of these actions and turn them into useful electricity began to be considered. Next, the module was devised this method, exemplified by a treadmill, which converts the kinetic energy generated by walking into electrical energy. Running on the treadmill causes a human to move a metal tube, which in turn causes the treadmill's built-in generator to move and produce electricity. The efficiency of this solution depends on its compliance with certain design specifications. For example, it must produce 150 joules or more in five minutes or less. It also needs to be constructed with scrap or recycled materials to be labor-intensive. Once completed, it must be tested to see whether it satisfies the design specifications and is effective or not. Then, the data demonstrating the project's ability to benefit people and efficiently fulfill its goal is received. After reviewing the earlier solutions and taking notes, all these earlier steps were completed. Additionally, reliable data and a scientific study support it. It made it easier to solve problems, stay safe, and succeed.

Introduction

The Egyptian society of today faces several detrimental issues. These Issues stand in the way of its development and success. (Addressing the **population issue** and **enhancing the use of alternate energy sources** ,**growth and its ramifications**, enhancing everyone's access to **science and technology**, and mitigating and adjusting to the impacts of **climate change**) are examples of these issues. Any problem requires further information before it can be solved. Let us examine these issues in general and discover their implications. Egypt lacks a considerable number of resources for renewable energy. The dearth of resources in its scientific milieu is the cause of this noticed in [3] **& fig (1)**

Egypt is now dealing with a catastrophic population inflection pandemic. This also results in a host of economic issues. [1] Furthermore, since with so many people living there, Egypt has a lot of energy-related issues. This is a result of the enormous number of people who need to have their energy demands met. Moreover, Egypt is not exempt from the disastrous consequences of global warming. Egypt's already dry climate will be further stressed by climate change, with extremes in temperature erratic precipitation, rising sea levels, land subsidence, coastal flooding, shoreline erosion, declining soil salinity, and protracted drought among the effects.

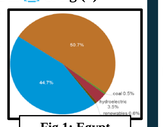
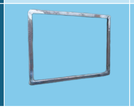
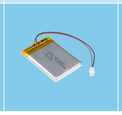
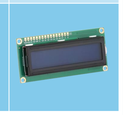


Fig 1: Egypt Energy Situation

Energy is the element that all these issues have in common, If a close look is taken at the underlying variables that contribute to them. Consequently, the energy problem is the main obstacle in this semester's capstone. This semester, the capstone project requires to harness the energy generated by the natural and human activities surrounding[7] . To accomplish this flawlessly, the team began a thorough search for the earlier solution that had been applied to a situation of this kind. The previous solutions provide you with a general understanding of the issue. Utilizing their product has major advantages for us as well. Taking what they've learned and avoiding their mistakes. These answers were discovered after doing extensive research on potential solutions. Let us start with the **Three Gorges Dam** [6] . When it comes to the ability to generate electricity, it is the biggest hydroelectric dam in the world. Situated on China's Yangtze River, it is an important component of an expansive development project designed to produce electricity, manage floods, and enhance river traffic in the area. It has a length of roughly 2.3 kilometers and a height of roughly 185 meters. It can generate up to 22.5 gigawatts of power. Clean energy is one of this solution's benefits. Production, Flood Management, and Enhancement of Water Transport. But every enterprise has its share of problems. These are a few drawbacks associated with The Three Gorges Dam. The dam's construction caused extensive flooding of wetlands and wildlife habitats, water pollution, geological risks, and social impact. Another earlier option existed, namely **Mount Signal Solar Farm** [4] . The project is a solar power producing facility situated in the United States' Southern California region. It is one of the biggest solar projects in the world and gives the local community a sizable supply of clean energy. It's in the southern region of California. Hundreds of megawatts of clean electricity are produced by it. It is dependent upon solar energy technologies, particularly solar with high efficiency. solar panels with sun tracking devices to increase the effectiveness of energy collecting. This method offers several benefits, including the production of clean energy, a decreased environmental effect, financial gains, and sustainability. But there were drawbacks as well. The high beginning costs, sporadic energy output, and resource constraints are examples of these drawbacks. The solution is obtained after carefully examining these options and weighing the benefits and drawbacks. A treadmill is the solution. Utilizing kinetic energy, the treadmill generates electrical power. Using the treadmill while walking and pushing a metal cylinder that houses a motor generator. This generator takes advantage of people walking and turns it into electricity. This was a brief synopsis of the prototype's mechanism. The efficiency of the system is dependent on certain design constraints. Prior to anything else, the prototype must be able to generate more than 150 joules in 300 seconds or less, or a maximum of five minutes. However, the prototype demands that it be constructed out of leftover or salvaged components. It must also be functional. It ought to be ecologically sustainable as well. The last is that the cost ought to be kept to a minimum.

Materials

Item	Metal Frame	Metal tubes	Generator	Ball bearing
Usage	It is the frame that everything is going to be installed on	They are those ones which will help to move	It will generate AC electricity from mechanical energy	It will be the thing the metal tubes gets supported on
Source	Recycled	Wasted	Old fan	Old wheel
Picture				

Item	Metal Gear	Chain	Nails	Lithium batteries	LCD screen
Usage	It will transfer the mechanical energy from the tubes to the chain.	It will transfer the mechanical energy from the tubes to the Generator.	They are used to install the tubes into the frame.	It used to store the electricity that produced from the generator	It used to display exercise seconds
Source	Old bicycle	Old bicycle	Supplies store	Online store (lampatronics)	FAB Lab
Picture					

Methods

The construction of the prototype followed scientific methods in the subsequent manner:

- In the beginning, Collect recycled pieces of iron and went to the smith to cut them with the required dimensions to make a metal frame
- After that, Cut the metal pipes, welded a fan motor with a gear, and connected them to a chain for 360-degree rotation, then welded another gear to another pipe as it shown in **fig(2)**.
- Then, the generator is set into motion by the rotation of pipes and gears on a treadmill, resulting in the conversion of kinetic energy into electrical energy and the production of electricity.
- Following that, electricity is collected in lithium batteries so that it can be used to charge the phone and connect the Arduino to electricity.
- Finally, rewired an old Arduino chip, reinstalled capacitors and pins, connected it to an LCD screen, LEDs, push button, and off/on button, and was programmed to count exercise seconds and light up LEDs every two minutes as it seen in **fig(3)**.

Fig 2: the actual prototype

Fig 3: 3D model of the prototype

Test Plan :-

Additionally, the prototype needed to be tested once it was completed.

- In the beginning, we must adhere to safety and protection rules, such as wearing a coat and gloves, and always be at a safe distance.
- After that, someone must get on the treadmill and run on it to run the generator
- In addition, when the generator is moving, we connect it to the batteries so that we can charge them, and to an amphometer to measure the amps and volts generated by the treadmill.
- The last step, Calculate the electricity generated by the device, and after charging the batteries, It is used to light the bulb or charge a cell phone and connect electricity to the Arduino chip to light the LCD screen and some small LED lights.

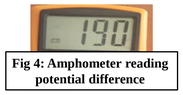


Fig 4: Amphometer reading potential difference

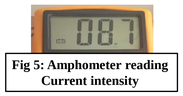
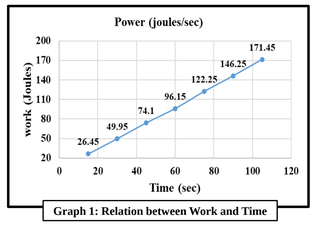


Fig 5: Amphometer reading Current intensity

Results

Time	Work (Joules)
15 sec	26.45 joules
30 sec	49.95 joules
45 sec	74.10 joules
60 sec	96.15 joules
75 sec	122.25 joules
90 sec	146.25 joules
105 sec	171.45 joules

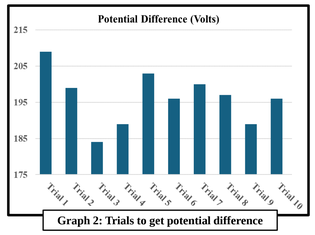
Table:1



Graph 1: Relation between Work and Time

No. of trials	Potential Difference (Volt)
Trial 1	208 ± 0.001 volts
Trial 2	199 ± 0.001 volts
Trial 3	197 ± 0.001 volts
Trial 4	189 ± 0.001 volts
Trial 5	203 ± 0.001 volts
Trial 6	196 ± 0.001 volts
Trial 7	200 ± 0.001 volts
Trial 8	196 ± 0.001 volts
Trial 9	189 ± 0.001 volts
Trial 10	184 ± 0.001 volts
Average	196 ± 0.001 volts

Table:2

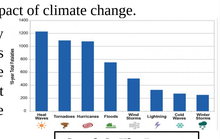


Graph 2: Trials to get potential difference

Analysis

Egypt suffers from numerous problems such as a lack of alternative energy forms, Not making the most of the surrounding environment, and vulnerability to the impact of climate change.

The dependence on one type of energy is not optimal especially if it is a fossil fuel, because if this type of energy runs out or its price becomes too expensive it will be a catastrophe for the economy. Not taking advantages of the surrounding environment is a problem, there are a lot of beneficial things in the environment that must be used, for having a good economy. [2]



Graph 3: The Impacts of Climate Change

Climate change increases the average temperature, which increases the vulnerability to more climatic disasters.

This solution helps to solve the problems mentioned above, where it would use an alternative and clean source of energy which is the kinetic energy from the student activity. In the past, the energy of students was wasted without taking advantage of them, this solution will take advantage of this wasted energy. As the source and the form of energy used in this solution are clean, the dependence on it will reduce the impacts of climate change as the dependence on it reduces the usage of fossil fuels which increases the climate change impacts.

In brief, the project is a treadmill that converts kinetic energy to electric energy. It successfully meets the specified design requirements. The treadmill's efficiency in producing energy is shown by the fact that it can produce over 150 joules of energy in less than five minutes. The project shows a dedication to sustainability and reduces its environmental impact by using waste and recycled materials in its construction.

Features of the prototype:-

Using recycled materials in construction the prototype reduces costs and encourages sustainability. Also, How effectively it generates sustainable energy encourages individuals to play sports.

However, the prototype has a few issues, such as:-

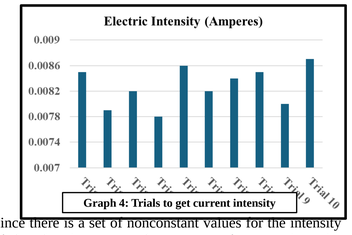
It requires continuous maintenance. Furthermore, Few people play sports. Moreover, the user's physical abilities limit the amount of energy that can be produced. In addition, The treadmill's overall efficiency may be affected by energy loss during the process of converting kinetic energy to electric energy.

To get further data about the project, it is required to obtain some additional quantities to analyze this project deeper.

The **Electric power**, which indicates how much work is done per second, is the first quantity that has been calculated, it has been indicated many times to be more accurate and it has been calculated using the following formula:-

$$Power\ (watt) = current\ intensity \times \text{Potential difference} \quad \text{(Law 1)}$$

By taking the average of **current intensity from table (3) and the average of potential difference from table (2) Then, Electric power** equals $0.00828 \times 196 \cong 1.6$ **Watt**



Graph 4: Trials to get current intensity

No. of trials	Electric Intensity (ampere)
Trial 1	0.0085 ± 0.001 amps
Trial 2	0.0079 ± 0.001 amps
Trial 3	0.0082 ± 0.001 amps
Trial 4	0.0078 ± 0.001 amps
Trial 5	0.0086 ± 0.001 amps
Trial 6	0.0082 ± 0.001 amps
Trial 7	0.0084 ± 0.001 amps
Trial 8	0.0085 ± 0.001 amps
Trial 9	0.0080 ± 0.001 amps
Trial 10	0.0087 ± 0.001 amps
Average	0.00828 ± 0.001 amps

Table: 3

Since there is a set of nonconstant values for the intensity of the electric current, the average of current intensity must be taken which equals 0.0828 ± 0.001 amps through **(Law 1)**

$$\sum I = \frac{Total\ of\ Trials}{Number\ of\ trials} \quad \text{(Law 2)}$$

$$I = 0.0828 / 10 = 0.00828\ amps$$

Now it is the time for calculating **Motor Torque**.

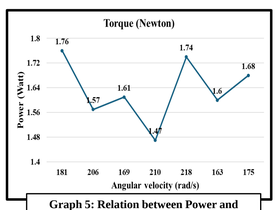
The torque of an electric motor is the amount of rotational force the motor develops., torque can optimize the generators' energy consumption, leading to more energy-efficient operation and potentially lower electricity costs, the following **law** is used to calculate it:-

$$Torque(newton) = Power\ (watt) \div Angular\ velocity\ (rad/s) \quad \text{(Law 3)}$$

The average of the torque during the whole time of the working of the device must be calculated using average of the angular velocity **(188 rad/s)** and the average of the electric power **(1.6 watt)** so the average of the torque equal **1.6 ÷ 188 = 0.0085 N** the remaining results has been plotted in **graph (5) & table (4)**

Power (Watt)	Angular velocity (rad/s)
1.76 watt	181 (rad/s)
1.57 watt	206 (rad/s)
1.61 watt	169 (rad/s)
1.47 watt	210 (rad/s)
1.74 watt	218 (rad/s)
1.60 watt	163 (rad/s)
1.68 watt	175 (rad/s)

Table: 4



Graph 5: Relation between Power and Angular velocity

As it has shown that prototype has the ability to produce **1.6 watt** so, in **300 sec** it may generate about **480 joules (output)** then the kinetic energy should be calculated to detect the efficiency of the prototype.

so kinetic energy equal $K.E = {}^1/_2 mv^2 \quad {}^1/_2 \times 70 \times 5^2 = 875\ \text{Joules}$ **(Law 3)**

Use the following law to calculate the efficiency :-

$$Efficiency_{\%} = \frac{Output}{Input} \times 100 = \frac{480}{875} \times 100 = 54\% \quad \text{(Law 4)}$$

Awareness was provided to the system before it was constructed.

In **CH.1.09** Understanding the physical properties of different materials help choose the ideal material for constructing the prototype. Also, in **CH.1.10** Percentage yield is used which identifies the efficiency of the solution by obtaining the theoretical yield and the actual yield. In **MA.107** Quadratic functions can be used to model the relationship between variables such as energy output, efficiency, required time and input parameters. In **ME.1.06** Lami's rule and can be applied. By using it, the resultant of forces acting on the treadmill can be calculated, to ensure that the treadmill endure the weight of the running person on it. Furthermore, In **ES.1.08** Understanding the properties of different earth materials can help in selecting the most suitable materials for constructing the treadmill. From **ES.1.09** The process of converting mechanical energy from the treadmill into electrical energy may involve similar principles to those used in generating electrical energy from natural resources. Understanding these principles can help optimize the energy conversion process in the treadmill. In **CS.1.09** Python can be used to develop control algorithms for the treadmill, ensuring that it operates efficiently and responds appropriately to user input and environmental conditions.

Conclusion

The prototype ought to be able to convert mechanical energy into electrical power. based on the prototype's testing and outcomes. The results demonstrate that the prototype can generate over 150 joules in less than two minutes. The power (Watt) and the number of joules is directly correlated. The number of joules also grows with time, enabling the prototype to fulfill design requirements. The generator transforms kinetic energy into electrical energy, which is necessary for producing electricity. The torque of the generator determines its efficiency. Whenever the torque increases, the power (watt) increases as well, increasing the total number of joules. After carefully examining the previous solutions, utilizing its benefits, and avoiding its drawbacks, the solution has been reached. The solution varies from previous approaches in several ways. It does not damage the environment with toxic emissions, and it has no adverse effects on the nearby creatures. Rather, it is extremely suitable for the environment. In addition, the entire construction was done with recyclable materials, making it affordable and accessible to all. It can produce a significant amount of electricity despite its small size if it is constructed more professionally and certain adjustments are made to make it practical.

Recommendation

It is believed that everything around us is being developed day by day, from a **wireless heart rate monitor** to **interactive games**, each feature contributes to our shared vision of a greener, healthier planet and more efficient project.

- **Wireless Heart Rate Monitor:** Use the energy produced by the treadmill to power a wireless heart rate monitor.
- **Adaptable Resistance:** Include varying resistance settings in the treadmill's design. Users have the option to increase the difficulty, which requires more work and power
- **Kinetic Tiles:** Replace part of the treadmill belt with kinetic tiles that generate electricity when stepped on. These tiles can be used for specific exercises or as a fun feature
- **Pedal-Powered Accessories:** Attach pedals or footplates to the treadmill frame. Users can pedal to generate additional electricity
- **Bluetooth Speaker System:** Integrate Bluetooth speakers powered by the treadmill. Users can enjoy music while exercising
- **Smartphone App Integration:** Set up an extension app that syncs with the treadmill. Users can set goals and observe their energy production.
- **Interactive Display Games:** Use the treadmill console to create interactive games. Users generate electricity by playing these games during their workout

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