Fabrication of Energy Harvesting by Rowing Machine

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***Abstract*— Since the pandamic outbrake attacked humanity, Many people are unable to attend their usual workout classes due to the covid outbreak. We may now look past this adversity and perceive an opportunity to build a covid-free home workout equipment. We wanted to emphasize the significance of being healthy and safe at home in this project by presenting the Rowing Machine, which delivers a great upper-body cardio workout. This report's progress shows our progress toward project completion for current and future work.**

Keywords: Adversity, Perceive, Science, Workout Equipment, Emphasize.

I. INTRODUCTION

Electricity has become one of the most important needs in our daily lives, but many places still face power shortages, high energy costs, and limited access to reliable electricity. At the same time, environmental problems such as pollution, climate change, and the overuse of fossil fuels are encouraging the world to look for cleaner and more sustainable energy sources. In this situation, human-powered systems offer a unique and practical solution because they do not depend on fuel, sunlight, wind, or any external resource. One such system is the pulley rowing mechanism, which uses human effort to generate electricity. This project focuses on understanding how a simple rowing motion can be transformed into electrical energy using basic mechanical parts. The idea behind this mechanism is very straightforward. When a person performs the rowing action, they pull a handle backward and forward. This motion is known as reciprocating motion. However, a generator needs rotational motion to produce electricity. To convert this back-and-forth movement into a spinning motion, a crank and lever mechanism is used. As the person rows, the crank turns a shaft, and this rotating shaft becomes the main source of mechanical power. To increase the speed further, a belt and pulley system is added. By using pulleys of different sizes, the speed of rotation can be multiplied, allowing the generator to spin fast enough to produce a useful amount of electricity.

II. PROJECT IDEA

Develop a machine that is similar to a rowing machine or another form of equipment that produces energy. We can extend energy collecting in gym and kayaking players if there is enough demand.

III. PROJECT OBJECTIVE

Our project" An Energy Harvesting by Rowing Machine" was design for learning about how generator and harvesting energy work
The sub-main object as following:
-Harvesting energy and store in an energy storage system.
-Turn human power generation by exercise.
-One of a renewable energy source in a future house.
-To gain muscle for kayaking players.

IV. PROBLEM IDENTIFICATION AND STATEMENT

In the development of a power generation pulley rowing machine, the primary problem identified is the suboptimal conversion of human mechanical energy into electrical energy. This inefficiency results in lower power output and limits the machine's effectiveness in energy harvesting. The problem statement for this project is to enhance the efficiency of energy conversion by optimizing both the mechanical design of the pulley system and the electrical components involved, aiming to achieve a higher and more reliable power output.

V. PROJECT OVERVIEW

A. Initial Study and Background Study

In this project, we choose the 3-phase synchronous generator which is a washing machine motor to be our generator to receive energy from rowing machine. We use battery to store our electricity.

B. Biomechanical Energy

Biomechanical energy in a rowing machine is retrofitted with a 3-phase synchronous generator connected to human power transmission and a DIY 3-phase rectifier, then the output is connected to MPPT solar charge (Power conversion unit). Biomechanical energy will be transferred to the battery. Induced current is used by generators to generate electric power. We can also add other Renewable energy such as photovoltaic, wind turbine or hydro power generator.

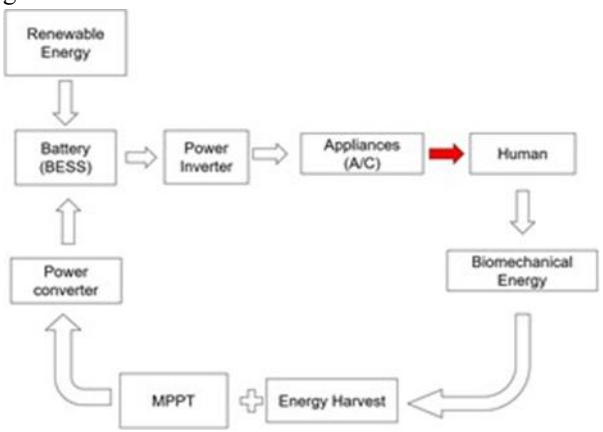

Fig. 1: Recycling energy

C. Time Constants

Time constants is the parameter that describes a first-order linear system's response to a Ramp function.

D. Mechanical Time Constant

At first, when we pull it, it rotates, and when we stop pulling it, the generator stops rotating instantaneously. we got 0.7 seconds before we remove rubber and add iron weight indicating that our system is non-linear, with no moment of inertia and no way to control the current that goes into the battery. To improve our mechanical time constant, we add 15-kg iron weight, which called" Flywheel". After We added 15-kg iron weight, mechanical time constant increase upto 6.4 seconds which is enough to make our system linear and MPPT can detect the current also.

E. Electrical Time Constant

We can increase our mechanical time constant however, we can increase electrical time constant by using choke and capacitors. For capacitors, we connected parallel with circuit when we recovery generator will not create power, capacitors will release current which stored when we drive. For choke, we connected series with circuit whem drive choke will store voltage and release at the recovery session. From our experiment, electrical time constant will slightly increase and it also prevent rectifier from damaged.

F. Marketing

We intend to take our equipment to the Sports Authority of Thailand (SAT) and gyms where there are a lot of kayaking players, as well as athletes with a lot of biomechanical power that can be used to generate energy. We can reduce our payback period if we have a large number of this equipment.

Table 1: Cost

Number	Equipment	Cost(Baht)
1	Iron Rowing Machine	2,000
2	Pulley	500
3	Elastic Robe(Rubber Connected with Chain)	100
4	Chain	100
5	Gear Free Wheel	200
6	Electricals	500
7	Battery	1,200
8	Genarator	400
	Total	**5,000**

VI. LITERATURE REVIEW

Several studies and projects have explored the idea of generating electricity through human effort, highlighting its value as a clean and reliable alternative for small-scale power needs. Earlier research on human-powered energy systems mainly focused on bicycle-based mechanisms, where pedaling motion drives a generator to produce electricity. These studies showed that human mechanical power, when properly converted, can be an effective source of renewable energy for lighting, charging devices, and emergency use. Researchers also examined pulley and belt systems to understand how mechanical advantage and speed multiplication can improve energy output. Findings suggest that using different pulley sizes helps increase the rotational speed of the generator, even when the input motion is slow. This concept is directly applied in pulley-based rowing systems. Other studies on reciprocating-to-rotational conversion mechanisms

reported that crank and lever systems are simple, efficient, and easy to maintain, making them suitable for low-cost energy projects.

VII. SYSTEM

A. Rowing Machine

Rowing machine that simulates watercraft rowing as an exercise. It has the ability to gain upper and lower body mass. Our rowing machine is designed for athletes.

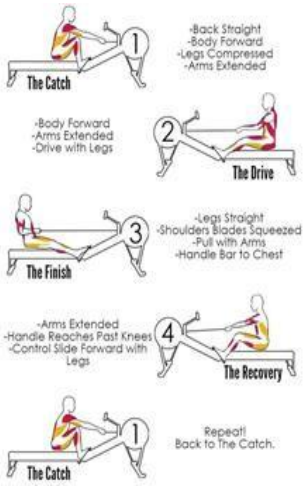

Fig. 2: Proper post for Rowing machine

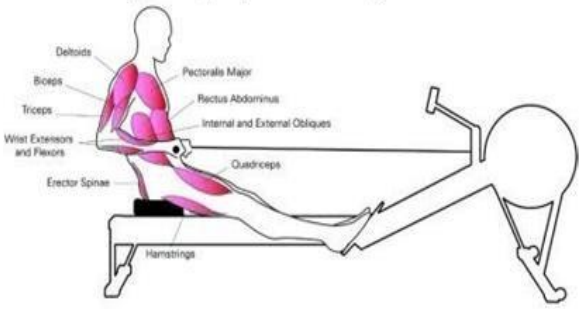

Fig. 2.1: Rowing machine muscle gain

B. Battery (Energy Storage System)

The automobile battery is a 12V lead acid battery. Every car with a combustion engine uses these enormous, heavy batteries. We use it as a Battery Energy Storage System or BESS. We use old battery because of it is cheap and it proper for our prototype.

`-Brand/Model : Hitachi MF-Series
-Voltage : 12V(Norminal Voltage)
-Battery Type: Acid
-Battery Capacity: 73 Ah

VIII. RESEARCH AND METHODOLOGY

The main goal of this project is to design and test a human-powered electricity generation system using a pulley rowing mechanism. The research begins with a literature review to understand previous work on human- powered generators, pulley systems, and energy conversion techniques. Based on this, a simple mechanism is designed using a crank–lever arrangement connected to a pulley and belt system. The rowing motion applied by a person is converted into rotational motion, which drives a DC generator to produce electricity.

The following steps are as follow:

a) Setup Mechanism: Construct the frame, crank, pulley system, flywheel, and attach the DC generator.

b) Convert Motion: Rowing action moves the crank, which rotates the pulley and drives the generator.

c) Generate Electricity: Rotational energy from the pulley system powers the DC generator to produce electricity.

d) Measure & Optimize: Record voltage and current, adjust pulley ratios for better efficiency and smooth operation.

IX. DESIGN AND FABRICATION

A. Mechanical Design

The mechanical design of the pulley rowing mechanism focuses on converting human rowing motion into rotational motion efficiently to drive a generator.

B. Components

Fig. 5.1: Chain Sprocket

Fig. 5.2: DC Motor

Fig. 5.3: Pulley and Belt

Fig. 5.4: Bearings

Fig. 5.5: Chain

Fig. 5.6: Battery

Fig. 5.7: Shaft and Bearing

X. MODIFICATIONS CAN BE MADE

XI. RESULTS AND DISCUSSION

- The system successfully generated electricity using human rowing motion.
- Output was sufficient for small devices like LEDs, mobile phones, and small batteries.
- Increasing rowing speed and optimizing pulley ratios improved power output.
- Crank and pulley system effectively converted back-and-forth rowing motion into rotational motion.
- Flywheel helped smooth out fluctuations, producing consistent and stable electricity.
- Simple, low-cost, and easy to maintain system suitable for educational and rural applications.

XII. CONCLUSION

This project successfully demonstrates the concept of energy harvesting using a rowing machine, converting human biomechanical energy generated during exercise into usable electrical energy. The developed system effectively integrates a rowing mechanism with a 3- phase synchronous generator, rectification circuit, MPPT charge controller, and battery energy storage system. The results show that human effort during regular workout sessions can be utilized not only for physical fitness but also for sustainable power generation.

The inclusion of a flywheel significantly improved the mechanical time constant, making the system response more stable and linear, which enhanced power generation and battery charging efficiency. Additionally, the use of electrical components such as chokes and capacitors helped in improving the electrical time constant and protecting the rectifier circuit. The use of a low-cost, readily available washing machine motor and lead-acid battery proves that the system is economical and suitable for prototype development.

Overall, this project highlights the potential of integrating renewable energy concepts with fitness equipment, especially in gyms, sports training centers, and home workout environments. While the generated power is limited, large-scale implementation with multiple machines can contribute to energy savings and promote awareness of sustainable energy practices. With further improvements in efficiency, storage, and power management, energy-harvesting exercise equipment can play a meaningful role in future eco- friendly and self-sustaining systems.

REFERENCES

[1] An exercise bikes assisted main energy source in DC distributed power system: https://ieeexplore.ieee.org/abstract/document/825046 1
[2] Rowing machine: https://en.wikipedia.org/wiki/
[3] Verma, A. (2019). Human-Powered Mechanical Energy Systems for Small-Scale Electricity Generation. Renewable Energy Research Journal, 12(3), 45–52.
[4] Li, T. (2020). Design and Performance Analysis of Pulley-Based Energy Conversion Mechanisms. International Journal of Mechanical Engineering,

18(2), 89–96.
[5] Khan, R. (2021). Rowing Motion Conversion Techniques for Sustainable Power Generation. Journal of Green Technology Innovations, 9(1), 33– 41.
[6] Sharma, P. & Patel, M. (2022). Development of Low- Cost Human Energy Harvesting Devices. Proceedings of Emerging Energy Systems Conference, 112–118.
[7] Roy, S. (2023). Efficiency Improvement in Manual Energy Generators Using Multi-Stage Pulley Systems. Mechanical Design and Applications Review, 15(4), 60–67.