DEVELOPMENT OF A PORTABLE MICRO-HYDROPOWER GENERATION SYSTEM FOR RURAL AREA

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Abstract of the project presented to the Senate of Management & Science University in partial fulfillment of the requirements for the degree Bachelor of Science in Mechanical Engineering (Hons.)

DESIGN A PORTABLE MICRO-HYDROPOWER GENERATION SYSTEM FOR RURAL AREA

By

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June 2022

Faculty of Information Sciences and Engineering

Abstract

The energy demand continues to rise, followed by the growth in the number of people and technological advances. The use of affordable, sustainable, and cheap renewable energy is a choice to meet the world's energy needs, especially for communities in rural areas. Thus, this paper presents a portable micro-hydropower generation system using floating turbine mechanisms. During this research, the turbine converts the current flow into mechanical energy. The mechanical energy then rotates the dc motor to generate electricity, which later will be stored in a 12V rechargeable battery.

In addition, an online monitoring system based on IoT has been synergized using the Blynk application to provide real-time power monitoring. The result obtained that the floating turbine prototype generates 2.2V to 7.1V depending on the current flow. The electricity generated will charge a battery with a capacity of 20Ah and can be used to power up the led lamp and charge small electrical devices.

Abstrak tesis yang dikemukakan kepada Senat Management & Science University sebagai memenuhi sebahagian keperluan untuk ijazah Sarjana Muda Kejuruteraan Mekanikal (Kepujian).

DESIGN A PORTABLE MICRO-HYDROPOWER GENERATION SYSTEM FOR RURAL AREA

Oleh

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Abstrak

Permintaan tenaga terus meningkat, diikuti dengan pertumbuhan bilangan orang dan kemajuan teknologi. Penggunaan tenaga boleh diperbaharui yang mampu milik, mampan dan murah adalah pilihan bagi memenuhi keperluan tenaga dunia, khususnya bagi masyarakat di kawasan luar bandar. Oleh itu, kertas kerja ini membentangkan sistem penjanaan kuasa mikro hidro mudah alih menggunakan mekanisme turbin terapung. Semasa penyelidikan ini, turbin menukar aliran arus kepada tenaga mekanikal. Tenaga mekanikal kemudian memutarkan motor dc untuk menjana elektrik, yang kemudiannya akan disimpan dalam bateri boleh dicas semula 12V.

Selain itu, sistem pemantauan dalam talian berasaskan IoT telah disinergikan menggunakan aplikasi Blynk untuk menyediakan pemantauan kuasa masa nyata. Keputusan diperolehi bahawa prototaip turbin terapung menjana 2.2V hingga 7.1V bergantung kepada aliran semasa. Elektrik yang dijana akan mengecas bateri dengan kapasiti 20Ah dan boleh digunakan untuk menghidupkan lampu led dan mengecas peranti elektrik kecil.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Electricity consumption in Indonesia continues to rise in line with economic and population growth, posing future energy supply challenges [1]. As an archipelagic country, Indonesia is surrounded by oceans and tropical rainforests, making Indonesia abundant with natural resources. Despite the technological advancements and the modernizing era we now live in, many residents in remote and rural areas still lack access to electricity. The rough terrain and geographical condition make the Installation of new power lines face many difficulties, resulting in high electricity costs in rural areas [2].

Although Indonesia possesses numerous renewable energy sources, the government still struggles to meet its energy development goals. Non-renewable energy sources such as fossil fuels, natural gas, and coal continue to meet most of Indonesia's electrical energy needs. [3]. As a result, 96% of electricity is produced by fossil-based fuels (48% oil, 30% coal, and 18% gas), while renewable energy resources are still used in tiny amounts. Steam power plants provide the most energy, accounting for 46.7% of total energy consumed, followed by gas and steam power plants (19.3%) and diesel power plants (11.6%). Meanwhile, electricity consumption from the renewable energy power plant is still low: hydropower accounts for 9.9%, geothermal accounts for 2.6 percent, mini-hydropower accounts for 0.2 percent, and micro-hydro power accounts for 0.1 percent. As energy usage grows, CO2 levels in the atmosphere rise, and the world's fossil fuels become depleted, new renewable energy sources are required [4].

Indonesia is located along the equator, which means Indonesia only has dry and rainy seasons. The rainy season, which lasts from November to March, is marked by excessive humidity. As a result, several water streams (rivers, waterfalls, and lakes) are formed. Renewable energy, such as micro-hydro power generation, can be massive potential for Indonesia due to its geographical location [5].

Micro-hydropower installations can be placed on a fast-flowing river or irrigation canal. As a result, the energy from the flowing water spins the turbine and converts the mechanical energy into electricity [6].

Although many articles and research are being published on clean energy utilization based on water resources, there is still a lack of experiments in the scope of micro-hydropower generation. This research presents an affordable, clean, and cost-effective power generation system based on a floating turbine mechanism. Applying a floating turbine model as an electricity generator mechanism provides multiple features: zero-emission, no regular maintenance, low cost, lightweight, portable, and not interfering with environmental factors.

1.2 PROBLEM STATEMENT

Limited access to electricity in rural areas is nothing new. Installing a new electricity grid and lines is expensive and makes electricity costs higher in that area. Without electricity, people will do their daily work inefficiently. Residents can't do many activities at night. Furthermore, children can't study without good lighting. So, a device that can produce cheap, affordable, and sustainable electricity that is accessible to everyone is necessary.

1.3 OBJECTIVES OF THE PROJECT

The objectives of the study under our scope are as follows:

1. To design a portable micro-hydropower generation that can provide affordable and clean energy.
2. To monitor the produced voltage through LCD Display and mobile application.

1.4 SCOPE OF PROJECT

The Project Portable Micro-hydropower generation system that the author developed is a tool that can generate electricity 24/7 by utilizing the flow of water. The focus of this project is to be able to provide cheap and affordable electricity for

rural residents. Using a turbine as a driver and also a dc motor (alternator), this tool can generate electricity needs for basic electronic device needs. However, for further development, this tool can be used in emergency conditions such as when a flood occurs and the electricity goes out, this tool can generate emergency electricity.

1.5 SIGNIFICANCE OF THE PROJECT

To provide a portable micro-hydro power generation that is low-priced and accessible in rural areas. This device can generate electricity 24/7, storing it in the battery. Once the battery is full, residents can use the available electricity for lighting at night, study, entertainment, and other needs. This project aims to derive creativity, grow the economy, and prosperity for rural residents.

In addition, the significance of this project is to support the implementation of the Sustainable Development Goal 7 (SDG 7) program calls for “affordable, reliable, sustainable and modern energy for all” by 2030, and SDG Goal 13 calls for “Take urgent action to combat climate change and its impacts.” There are three main targets: Ensure universal access to affordable, reliable, and modern energy services, increase the share of renewable energy in the global energy mix substantially, and double the global rate of improvement in energy efficiency.

1.6 LIMITATIONS

The limitation of the project is:

1. The generated electricity depends on the velocity of the water flow. Faster the flow, higher output electricity can be generated.
2. 775 DC Motor can only produce a maximum of 12 V of voltage for this prototype.

CHAPTER 5
CONCLUSION

5.1 CONCLUSION

In this rapid technological and population growth era, the inadequate access to electricity in rural areas needs a concrete solution. This research has carried out a study of an intelligent power generation system using a floating water turbine mechanism. This floating turbine can be placed on water flows with strong currents, such as rivers, irrigation canals, dams, and floods. Utilizing the Blynk Mobile Application as an IoT-based online monitoring system with NodeMCU ESP8266, users can monitor the voltage generated automatically and in real-time. During the test process, the value of the generated voltage varies depending on the swift current of water that rotates the turbine. The 12V 20Ah battery is used to charge smartphones, turn on led lights, and turn on the electrical system in the control box.

5.2 RECOMMENDATION

There are still many things that can be upgraded and improved in this project for the future. Considering that this is the first-generation prototype, the current features, design, and systems are still not operating at highest capacity.

In the current prototype, the float used styrofoam material. Styrofoam is lightweight, but it has poor stability. It can be improved by replacing it with a pipe or other types of float which have good stabilization. In addition, this prototype must be tied to a bridge or tree to keep it in place. The improvisation that can be done is to use anchors or ballast so that the floating turbine is stable and steady.

Moving to the control box, at this current prototype, the only sensor used is a voltage sensor used to measure the generated voltage from the motor. Of course, this is not enough to create a complete monitoring system. This could be improved by adding power, current, and other essential sensors. Likewise, the mobile application as a monitoring tool needs to be improvised in terms of the user interface and also the existing features. Last but not least, the selection of turbine model and generator motor is also important to generate higher electricity.

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