DESIGN AND DEVELOPMENT OF SMART WATER METER POWERED BY ELECTROMAGNETIC GENERATOR

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

I dedicate this research work to my beloved and cherished father and mother who have always support and gave encouragement to me throughout my education journey, my beloved lecturers who have not felt tired giving guidance and knowledge throughout my education and my precious sibling who have always been supportive and helped through the hardships which I went through. Of course, not to forget my fellow friend who I cherished helped me throughout my studies and research.

ABSTRACT

The smart water meter powered by an electromagnetic generator is a device that uses the energy generated by the flow of water to power a wireless sensor and a wireless communication module, it is designed to provide real-time information on water usage, while also generating electricity. The smart water meter can be integrated with a smart grid infrastructure, to improve the overall efficiency and sustainability of the energy system.

The design and development of the smart water meter is a multi-stage process that involves conceptual design, simulation design and detailed design, Additionally, simulations and analyses such as AC analysis, DC analysis, turbine analysis, open circuit resistor analysis, and capacitor charging and discharging analysis are performed to understand the performance of the converter and turbine under different conditions and optimize their performance.

The smart water meter has the potential to reduce the reliance on external power sources, decrease the carbon footprint, promote water conservation and reduce water waste, and integrate with smart city infrastructure.

ABSTRAK

Meter air pintar yang dikuasakan oleh penjana elektromagnet ialah peranti yang menggunakan tenaga yang dijana oleh aliran air untuk menggerakkan penderia wayarles dan modul komunikasi wayarles, bertujuan untuk memberikan maklumat masa nyata tentang penggunaan air sambil turut menjana elektrik. Meter air pintar boleh disepadukan dengan infrastruktur grid pintar bersepadu untuk meningkatkan kecekapan dan kemampanan keseluruhan sistem tenaga.

Reka bentuk dan pembangunan meter air pintar ialah proses pelbagai peringkat yang melibatkan reka bentuk konsep, reka bentuk simulasi, dan reka bentuk terperinci, di samping simulasi dan analisis seperti analisis AC, analisis DC, analisis turbin, analisis rintangan litar terbuka, dan pengecasan kapasitor. Dan lakukan analisis nyahcas untuk memahami dan mengoptimumkan prestasi penukar dan turbin di bawah keadaan yang berbeza.

Meter air pintar mempunyai potensi untuk mengurangkan pergantungan kepada sumber kuasa luaran, mengurangkan jejak karbon, menggalakkan pemuliharaan air dan mengurangkan sisa air, dan menyepadukan dengan infrastruktur bandar pintar.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT: Internet of Things

°C: Degree Celsius

Kg: Kilogram

S: Second

Wi-Fi: Wireless Fidelity

ESP: Espressif

L/Min: Litres per Minutes

V: Voltage

P: Power

I: Current

Vin: Input Voltage

Vout: Output Voltage

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The chapter mainly emphasises the background and problem statement of the project, including the objective and scope that have been recognized. Which are also not limited with the discussion of the solution which has been proposed.

1.1 Background of the project

Water is an essential resource for human life and is used for many purposes, including drinking, bathing, cooking, irrigation, and industrial processes. It is necessary to accurately measure and manage water use to ensure it is used efficiently and sustainably.

Traditional water meters are mechanical devices that measure water flow through a pipe and display the total volume of water consumed. These meters must be manually read and recorded by a meter reader, who visits each location to record the reading on the meter. This process can be time-consuming and prone to errors, and it also requires regular visits by a meter reader to each location. In addition, traditional water meters may not provide real-time data on water consumption, making it difficult to detect and address leaks or other issues on time.

Smart water meters offer a solution to these problems by automating the measuring and recording of water consumption. These devices use electronic sensors and communication technology to measure water flow and transmit the data to a central location for analysis and billing purposes. Smart water meters can provide real-time data on water usage and enable early detection of leaks and other issues, improving the efficiency and sustainability of water management.

However, many smart water meters require an external power source, such as a battery or electrical connection, which can be a limiting factor in terms of installation location and maintenance. In particular, this can make it challenging to install smart water meters in remote locations or areas without access to electrical power.

The development of a smart water meter powered by an electromagnetic generator offers a solution to these issues by providing a self-powered device for an automatic meter reading. Electromagnetic generators use electromagnetic fields to generate electricity, which can be used to power the device without the need for external power sources. Electromagnetic generators use magnetism to convert mechanical energy into electrical energy. They have been used for many years to generate electricity and have several advantages over traditional generators, including high efficiency and the ability to generate power in various settings. Furthermore, water flow in the pipe, on the other hand, offers a constant supply of energy.

Given the density of water, the amount of energy that can be captured should be sufficient to power all of the essential sensors and data transmission equipment.

1.2 Statement of purpose

This project aims to design and develop a smart water meter powered by an electromagnetic generator. The device will measure and record water consumption in a home or building and transmit that data to a central location for analysis and billing purposes. Using an electromagnetic generator to power the device will allow it to be installed in remote locations or areas without access to electrical energy, making it a more flexible and versatile solution for an automatic meter reading. The project aims to create a device that is accurate, reliable, and easy to install and maintain, with a long lifespan and low cost of ownership.

1.3 Problem Statement

One of the main problems with traditional water meters is that they require manual reading and recording of water consumption. It can be time-consuming and prone to errors, and it also requires regular visits by a meter reader to each location. In addition, traditional water meters may not provide real-time data on water consumption, making it difficult to detect and promptly address leaks or other issues. Smart water meters offer a solution to these problems by automating the measuring and recording of water consumption. However, many smart water meters require an external power source, such as a battery or electrical connection, which can be a limiting factor in terms of installation location and maintenance. The development of a smart water meter powered by an electromagnetic generator addresses these issues by providing a self-powered solution for an automatic meter reading. The use of an electromagnetic generator allows the meter to be installed in remote locations or areas without access to electrical power. It eliminates the need for regular battery replacements or maintenance. It makes the device more flexible and cost-effective to install and maintain.

Moreover, the electromagnetic generator only works with a high volume of water. Therefore, the water turbine generator must be characterized to know more about the working principle of the water turbine. Furthermore, the power produced by the generator won't be enough to power up all sensors. So before assembling all sensors, take note of power usage for each sensor and ensure the generator produces more than enough.

One problem with using energy harvesting technologies, such as electromagnetic generators, for smart water meters is that these technologies may not consistently generate sufficient electricity to power the device. It can be due to factors such as variations in the strength of the electromagnetic field, changes in ambient conditions, or the degradation of the energy harvesting components over time. To overcome this problem, optimizing the design of the electromagnetic generator and the overall system for energy harvesting and storage system in the smart water meter. It could involve techniques such as selecting appropriate materials and components, optimizing the layout and form factor of the device, and implementing effective maintenance and repair processes. Another potential problem is that energy harvesting technologies may be less efficient at generating electricity than other power sources, such as batteries or electrical connections. It could result in a longer payback period for the initial investment in the smart water meter and may make the device less attractive to potential users. To address this issue, optimizing the energy harvesting system to maximize efficiency and minimize the cost of ownership may be necessary. In summary, the main problem with using energy harvesting technologies, such as electromagnetic generators, for smart water meters is the potential for reliability and efficiency issues that may impact the performance and cost-effectiveness of the device.

1.4 Objective

a) To develop a new energy harvesting system that converts the hydrokinetic energy of natural water flow into usable energy.

b) To investigate the relationship between fluid flow and the proposed harvester.

c) To analyze the integration proposed harvester with a Node MCU module.

1.5 Research Question

a) What materials and components are suitable for the smart water meter, including the electromagnetic generator, flow meter, and communication module?

b) What are the most effective ways to store and use the electricity generated by the electromagnetic generator in a smart water meter, considering factors such as power demand, battery life, and efficiency?

c) How does the performance of electromagnetic generators compare to other energy harvestings technologies, such as solar panels or kinetic generators, for use in smart water meters?

1.6 Scope of Work

The scope of work for integrating ThingSpeak, a cloud-based platform for the Internet of Things (IoT) data analysis and visualization, with energy harvesting technologies for a smart water meter could include the following activities:

1. Research and selection of appropriate materials and components for the smart water meter, including the electromagnetic generator, flow meter, and communication module.
2. Research and selection of an appropriate Power management circuit and energy storage system.

3. Research and characterize the specific of the electromagnetic generator with water flowrate sensor.
4. Research and characterize the specific power management circuit with the electromagnetic generator.
5. Design and development of a prototype of the smart water meter incorporating energy harvesting and storage technologies, as well as a communication module for transmitting data to ThingSpeak.