Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF WATER USAGE MONITORING SYSTEM USING ARDUINO PLATFORM

MUHAMMAD AIDIL BIN MAT YUSA

Bachelor of Electronics Engineering Technology with Honours

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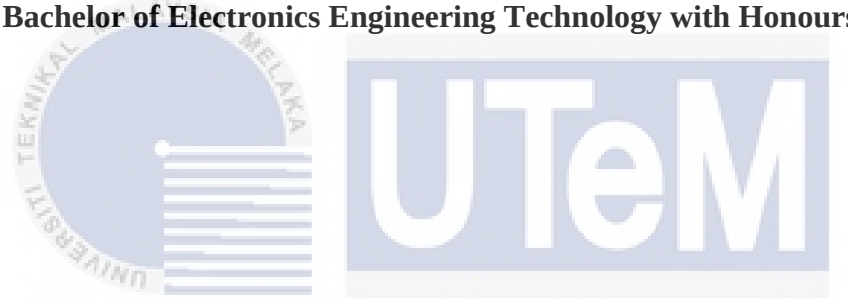
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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I declare that this project report entitled “Development of Water Usage Monitoring System Using Arduino Platform” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

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DEDICATION

In the name of Allah, the most beneficent and merciful who gave me strength and knowledge to complete this final year project. I would like to express my gratitude to the supervisor, Ts. Eliyana Binti Ruslan and Ts. Mohd Faizal Bin Zulkifli who gave me this opportunity to fulfil this amazing report on my final year project. Not to forget both of my parents, family and all friends for every single little thing that had helped me in every kind of ways.

Thanks all. I really appreciate.

ABSTRACT

Water is one of the most priceless natural resources. Humans need water to carry out their daily lives because it is an essential resource in generating various fields such as domestic, agriculture, industry, fisheries, and electricity generation. The main factor of unnecessary water consumption is a lack of awareness daily water usage. To control this issue before it worst, a water monitoring system that enabled users to monitor their water usage and recorded on a web database has been developed. This system consists of two parts. The first part is a monitoring parts consisting of Arduino Nano, water flow sensor, OLED display, GSM module, and Bluetooth module. The water flow sensor will measure the water rate pass through and send the data to Arduino Nano. Users can monitor their water consumption in three different types of output. Firstly, users can monitor directly by observed the OLED display on the system. Next, user can also monitor wirelessly by using SMS and Bluetooth with a special mobile application. In the second part, all the data obtained can be uploaded to the web database for future references and observation. After several testing was done, it can be concluded that the system has successfully fulfilled its functionality as proposed in this project.

ABSTRAK

Air merupakan satu khazanah alam yang tidak ternilai harganya. Kita perlukan air untuk menjalani kehidupan seharian kerana ia sumber yang penting dalam menjana pelbagai bidang ekonomi seperti pertanian, perindustrian, perikanan dan penjanaan sumber tenaga elektrik. Faktor utama yang menyumbang kepada berlakunya penggunaan air secara berlebihan adalah disebabkan kurangnya kesedaraan mengenai penggunaan air dalam aktiviti seharian. Bagi membendung masalah ini daripada terus menjadi parah, sistem pemantauan penggunaan air yang membolehkan pengguna untuk memantau penggunaan air dan direkod didalam pengakalan data secara atas talian telah dibangunkan. Sistem ini mempunyai dua bahagian. Bahagian pertama adalah bahagian pemantauan yang mempuyai Arduio Nano, sensor aliran air, paparan OLED, modul GSM dan modul Bluetooth. Sensor aliran air akan mengukur kadar air yang melaluinya kemudian data tersebut dihantar ke Arduino Nano. Pengguna dapat memantau penggunaan air mereka melalui tiga pilihan keluaran yang berbeza. Pertama, pengguna dapat memantau secara terus dengan memerhati paparan OLED pada sistem. Kemudian, pengguna juga dapat memantau secara tanpa wayar dengan menggunakan SMS dan Bluetooth bersama aplikasi mudah alih khusus. Pada bahagian kedua, semua data yang diperolehi boleh dimuat naik ke dalam pangakalan data web bagi tujuan rujukan dan pemerhatian dimasa akan datang. Selepas beberapa ujian dijalankan, dapat disimpulkan bahawa sistem ini telah mencapai kebolehannya seperti yang dicadangkan didalam projek ini.

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A	-	Voltage angle
GHz	-	Gigahertz
KB	-	Kilobyte
Mbps	-	Megabits per second
MHz	-	Megahertz
mm	-	Millimeter
Q	-	Flow rate/total flow of water through the pipe
V	-	Average velocity of the flow

LIST OF ABBREVIATIONS

AT	-	Attention
EEPROM	-	Electrical Erasable Programmable Read-Only Memory
FAO	-	Food And Agriculture Organization
GFSK	-	Gaussian Frequency Shift Keying
GPRS	-	General Packet Radio Service
GSM	-	Global System For Mobile
GUI	-	Graphical User Interface
HMI	-	Human Machine Interface
I/O	-	Input / Output
IDE	-	Integrated Development Environment
IEEE	-	Institute of Electrical And Electronics Engineers
IoT	-	Internet of Things
LCD	-	Liquid Crystal Display
MCU	-	Microcontroller Unit
MIT	-	Massachusetts Institute of Technology
OLED	-	Organic Light-Emitting Diode
OS	-	Operating System
PC	-	Personal Computer
PIC	-	Peripheral Interface Controller
PLC	-	Photovoltaics
PWM	-	Pulse-Width Modulation
RF	-	Radio Frequency
SCADA	-	Supervisory Control And Data Acquisition
SRAM	-	Static Random Access Memory
USB	-	Universal Serial Bus
WI-FI	-	Wireless Fidelity

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CHAPTER 1

INTRODUCTION

1.1 Background

Water is very important and has been defined as one of the most precious natural resources. Water also played an important role in the growth of communities in a certain location. There are ten countries with a higher percent of lack basic water services in this world, and most of them are from Africa. In the first place, we have Eritrea with 80.7% lack of basic water services, followed by Papua New Guinea with 63.4% lack basic water services. Most of the population in that country lived in rural areas that make it more challenging for them to access for clean water services. In 2015, World Economic Forum announced that the water crisis ranks the eighth global risk with the highest likelihood of occurring within ten years.[1] So, any unnecessary water usage should be identified and eliminate if possible by these facts.

This project is about the development of Water Usage Monitoring System using the Arduino platform. Hence, this project is also based on the Internet of Things (IoT),GSM, Bluetooth, and can be powered by DC supply also solar energy. In this new era of technology, IoT is very common and widely used nowadays. IoT is more like physical things connected to the Internet to communicate and share data conveniently.

The water flow sensor paired with wireless communication is used to transfer the data from the device to the user. This connection is made through GSM and Bluetooth in the

form of Electromagnetic (EM) Waves. Meanwhile, the data that were obtained can be upload to the database online. These features enable users to monitor the data of water usage and can be kept as future references.

All the components will be powered by DC supply or solar energy, which is the cleanest and renewable reliable energy produced to provide electricity. For this project, the user will have positive impact and can help them to monitor their water usage habits.

1.2 Problem Statement

Water is the necessity for daily life. Like electricity, clean water also plays a crucial part in carrying out daily activities such as domestic or agriculture used. Every day, the demand for clean water is increasing, especially in urban areas, coupled with the rapid development. Not only that, the source of treatable raw water is declining due to the polluted river conditions, complicating the water treatment process to be carried out. This situation becomes worst when there are still consumers who lack awareness of their water usage consumption.

The most common water usage problem in the domestic sector is that consumers were not alert with their water consumption in carrying out daily activities such as washing clothes, cooking, vehicle washing, watering plants, etc. All these activities will cause unnecessary water consumption without proper water monitoring. Meanwhile, in the tourism and agriculture industry, the main factor driving this issue is slightly different. For example, tenants usually forgot to turn off the water taps for the tourism industry when leaving the house. For the agriculture industry, plants are constantly watering without their notice. This unnecessary water consumption can be control if everyone alerts with their water used daily.

Thus, this project will overcome this problem by developing a device that can monitor water usage constantly. Moreover, this device also allows sending the data from the device to their mobile device wirelessly.

1.3 Project Objective

The objective of this thesis in completing this project will be the guidance for developing the project:

a) To study characteristics and functionality of water usage monitoring system
b) To design and develop of water usage monitoring system that can connect wirelessly to our device
c) To analyze in term of functionality
d) To monitor the flow of water through the mobile application

1.4 Scope of Project

IoT or the Internet of Things is the internet networking that connects any smart or physical devices to the cloud or was called as Internet. The smart devices can access the data from anywhere as long there is an Internet connection. Besides that, controller connected to water flow sensor to measure the flow, and the data were transmitted using GSM or Bluetooth.

For this project, Arduino Nano was used as a controller to manage the operation of the whole system. The sensor that used is the water flow sensor YF-S201. This sensor will measure the water that flows through it and will be paired to OLED SSD 1306 display to

allow the user to read directly from the device. Then, this project also equips with GSM SIM800L and Bluetooth v2.0+EDR module to retrieve the data and upload it to the database. The solar energy also can be used to powered up the whole system.

1.5 Thesis Organizing

The project is about the water monitoring system against the IoT system and database. This thesis consists of five main chapters. For chapter 1, it will simply introduce the project. This chapter will cover the introductions, problem statement, objective, and scope of the project. Next, chapter 2 is about reviewing previous research papers or studies relevant to the project title. Then, any findings, similarities, or improvements were also stated in this chapter. For chapter 3, this part will include all the methods and procedures used for the development of this project based on the project objective. Next, in chapter 4, the results and analysis will be shown to prove the data recorded for this project. Lastly, this chapter 5 will explain the recommendations for future works against this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter examines and evaluates previous experiment work that is relevant to this project. The information and data gathered provide an additional source of data for researching and constructing more successful work. In addition, a few literature studies were conducted to have a better knowledge of the project's research. This literature review also consists a few improvement that can be made from the previous project.

2.2 Previous Project Research

Based on literature review that can be summarize by on research and finding information that related with my project through the existing resources such as Internet, books, journals etc. So, by this method, understanding of project can be achieved.

2.2.1 IoT and Cloud Computing Based Smart Water Metering System

According to [2], the water crisis is often attributed to a lack of planning on the government side, increased corporate privatization, human and industrial wastage. This problem usually occurs, especially in a populated area, due to a lack of metering and unidentified water leakage. By the year 2050, 1.6 billion people were expected to reach, which will worsen their problem. The main objective for this project to develop and

implement the methodology of intelligent water meter based on the Internet of Things (IoT) and cloud computing equipped with machine learning algorithms.

Node MCU act as the central controller for this project that has equipped with a Wi-Fi system. This controller received data from the YF-S201 water flow sensor that sits on the main pipeline to measure water flow through it. The entire system was powered by solar energy to ensure this system can work independently without any external power source. Moreover, due to the internet connection put off for some time, this system is also equipped with a small memory unit that can store data temporarily until the internet connection is restored. The data obtained were transmitted to the ThingSpeak Cloud platform in real-time to be accessed through the mobile device.

The result on Figure 2.1 shows all the data recorded in detail from time to time. ThingSpeak will generate some graphical interface from the data obtained for the user to monitor and analyze the system's water consumption to make any future decision.

The main objective for this project was achieved, but some parts still can be improved to increase the effectiveness of the project, so it works more conveniently to use. YF-S201 water flow sensor was considered one of the best options to use in this project due to its performance meeting the price range. This sensor contains a pinwheel sensor to measure the volume of liquid passing through it by generating an electrical pulse with every revolution.

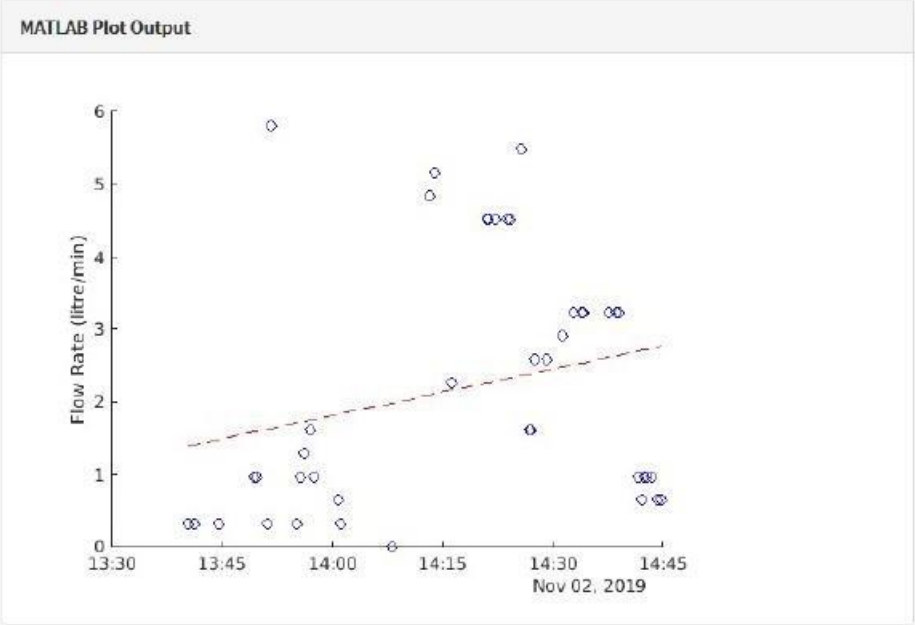

Figure 2.1: Result from ThingSpeak

2.2.2 Smart Water Meter System for Under-Centric Consumption Measurement

In South Africa and most other countries, analog and manual meter reading still used widely by the water services provider. This method is labor-intensive and sometimes can cause inaccurate reading because there is a lag in time and estimated based on historical data [3]. To improve their water services system, this paper has proposed implementing a smart water management system to obtain real-time data for real-time analysis.

This system is divided into three main components which are, the meter interface node, gateway device, and back-end system. The meter interface node connected directly to the digital meter through the Reed switch on the Dizic module (transmit module). This Dizic module is an IEEE 802.15.4 that used ZigBee supporting network. The obtained data from a digital meter that connected to Dizic module were transmitted to the gateway device. The gateway device is their main component in a communication system to ensure the transmitted and received data between sensor node and back-end system. The data were sent to the back-end system (web-based monitoring application) for further analysis and

visualization. The data were visualized in various graphs to ensure users can analyze the system in real-time, daily, or monthly.

Since this water monitoring system is installed in a company, the generated graph on Figure 2.2 shows that the water consumption occurs mainly between working hours (8:00 16:30) Monday to Friday. Moreover, from 17:00 to 7:00, as expected, there is no consumption due to no one available in the office. This system was also able to compare the data between two different days.

The purpose of this project is to develop a smart monitoring system have been achieved. Since this project used wireless communication through ZigBee as their main component in communicating between meter interface mode and back end, it has many advantages. This is because the type of communication used is short-range, low-cost, and low-power, so it is very suitable for battery-powered devices. Unfortunately, due to this factor, the device only covered a small area that makes it a bit challenging if the location of the gateway and meter interface node far away. The best option that can be done is replacing the Dizic module with components with medium-range communication such as AX8052f143 RF-microcontroller with the same function but a different communication range.