UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRIK
SEMESTER 2 SESI 2012/2013

LAPORAN PROJEK

SARJANA MUDA

DESIGN AND DEVELOP AN INTEGRATED UTILITY SYSTEM (WATER METER)

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Bachelor of Electrical Engineering (Industrial Power)

May 2013

"I hereby declare that I have read through this report entitle "Design and Develop an Integrated Utility System (Water Meter)" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature :……..

Supervisor Name :……..

Date :……..

DESIGN AND DEVELOP AN INTEGRATED UTILITY SYSTEM
(WATER METER)

SUNDRAM A/L RAMAHLINGAM

A report submitted in partial fulfillment of the requirements for
the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MAY 2010

"I declare that this report entitle "Design and Develop an Integrated Utility System (Water Meter)" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :……..

Supervisor Name :……..

Date :……..

To my beloved mother and father

ACKNOWLEDGEMENTS

The Integrated Utility System's (IUS) Water Meter could not be successfully achieved solely by me in a brief period of 9 months but together with the joint help from everyone around me who were great contributors both mentally and financially. Thus, first and foremost I would like to send my token of appreciation for their undivided guidance and positive encouragements for, without their strong support from the start, this project could not have reach its successful ending today.

I would like to sincerely thank En. Mohd Ruzaini Bin Hashim (ruzaini@utem.edu.my), supervisor of this project for helping me in many ways to make the IUS' Water meter project a great success. My special thanks go to my former lecturers for their innovative ideas and kind advices regarding my project work.

I would also like to thank my fellow batchmates and UTeM's staff members for their ever ready help and support throughout my project work. My small thanks also go to my dear roommate, Mohan for his help in my report right up.

Furthermore, I would like to take this golden opportunity to thank my family members who gave me lots of moral support in the completion of my studies. And finally God, for giving me a good sole, mind and for protecting me from harm and danger in the entire process of my project doing.

Thank you everyone.

ABSTRACT

Analog water meter is commonly used by water utilities department in order to calculate the amount of water usage per house in residential area. Traditionally the utilities company will hire an employee to take the reading and print a bill for the respective houses. The Traditional system has few complications which needed improvisations. Usually, it is said to be imprecise in taking meter readings due to mechanical damage or any other physical malfunction. This project is design as solution to improvise the current tradition system. This is made to improvise the present analog water meter towards more precise digital water meter where it has the ability to show amount of the current usage with its corresponding instantaneous utility charge. This function will benefit the consumer where they can monitor and control the water usage. This project has ability to generate its own DC power supply by using the small scale water hydro generator which converts water usage of the consumer (water flow in the main pipe) into electrical energy. This energy will be stored by using an electrical energy storage device. Eventually, this method will contribute towards the Green Technology as this issue is widely emphasized throughout the nation to increase the usage of renewable energy. Moreover, this project acts beneficially to the utility corporate whereby it cuts down the time taken to take reading on the water meter which supplies water to the user because this system will integrate with another utility system which is the energy meter (electric meter) to manage the water supply readings by using wireless system such as XBEE. With further modification of the current system, this project can be upgrade its application by using motorize valve to cut off the water utility supply for the consumer whom didn't not settle bill payment.

ABSTRAK

Meter air analog biasanya digunakan oleh syarikat bekalan air untuk mengira jumlah penggunaan air setiap rumah di kawasan perumahan. Mengikut cara tradisi, syarikat bekalan air selalunya akan mengupah para pekerja untuk merekod bacaan dan mencetak bil bagi setiap rumah. Sistem bil tradisional ini mempunyai beberapa kekurangan tersendiri yang memerlukan penambahbaikan. Biasanya, pengunaan meter air analog menyebabkan kesusahan kepada para penguna untuk mengangar pengunaan semasa sehingga mereka menerima bill bulanan. Oleh yang demikain.projek ini telah direka bentuk sebagai penyelesaian untuk menambahbaikkan lagi sistem bil tradisi yang sedia ada ke arah meter digital yang mempunyai keupayaan untuk menunjukkan jumlah penggunaan semasa dengan caj utiliti serta-merta yang berkaitan. Keupayann fungsi ini amat memanfaatkan para pengguna, di mana mereka boleh memantau dan mengawal penggunaan air seharian. Lebih-lebih lagi, projek ini mempunyai keupayaan untuk menjana bekalan kuasa arus terus dengan menggunakan penjana hidro kecil yang boleh menukarkan air yang telah digunakan oleh para pengguna (aliran air di paip utama) kepada tenaga elektrik. Tenaga elektrik ini akan disimpan didalam peranti penyimpanan tenaga elektrik iaitu, bateri. Akhirnya, kaedah ini akan menyumbang ke arah isu Teknologi Hijau yang diberi kepentingan yang tinggi secara meluas bukan sahaja di Negara kita malah di seluruh dunia, dengan tujuan bagi meningkatkan lagi penggunaan tenaga yang diperbaharui. Tambahan, projek ini juga akan membawa keuntungan kepada para utiliti korporat; di mana, masa yang diambil untuk mengambil bacaan pada meter air yang membekalkan air kepada pengguna boleh dijimatkan. Hal ini demikian kerana, sistem ini akan mengintegrasi dengan system yang lain iaitu, meter tenaga (meter elektrik) untuk menguruskan proses merekod bacaan bekalan air dengan menggunakan sistem tanpa wayar seperti XBEE.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

IUS	-	Integrated Utility System
PLC	-	Power Line Communication
GSM	-	Global Standard of Mobile communication
L	-	Liters
KWh	-	Kilowatt hour
ms	-	millisecond
NRW	-	Non Revenue Water
LCD	-	Liquid-Crystal Display
ID	-	Identification data
Q	-	Flow rate
V	-	Volume
t	-	Time
F	-	Frequency
SLA	-	Sealed Lead-Acid
Ni-Cd	-	Nickel-Cadmium

Ni-MH	-	Nickel-Metal
Li-Ion	-	Lithium-Ion
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
V&V	-	Verification and Validation
PIC	-	Peripheral Interface Controller
TTL	-	Transistor-Transistor Logic
ADC	-	Analog to Digital Converter
DL	-	Destination Address Low
MY	-	16-bit Source Address
UART	-	Universal Asynchronous Receiver/Transmitter

LIST OF APPENDIXES

CHAPTER 1

INTRODUCTION

This project is about designing a wireless digital water meter which is a part of the Integrated Utility System (IUS). The wireless digital water meter will use the HALL type flow sensor in order to measure the flow rate in the pipeline and then convert it to water usage in liter. This meter has the ability to generate DC power as the power supply for its circuitry. The Digital Water Meter will also send the meter reading data to the IUS's Energy Meter in order to be displayed on the LCD display in liter (L) and also in its corresponding charges (RM). After displaying the water usage on LCD, the IUS's Energy Meter will send the meter reading to the terminal computer by using the Power Line communication (PLC). PLC is a method of data transmission using the domestic power supply cable.

As the development of new housing areas are growing rapidly, the need for a new and simplified version of water utility billing system is essential. The Development of the Integrated Utility System (IUS) is based on the meter reading problems faced by the Malaysian utility companies and the water usage predicting problem faced by the consumer. The digitalized water meter has two main advantages over the conventional analog meters which involves the precision in calculating the water flow and transmission capability of the calculated data. The transmission medium can be either through a wireless system or through cables where can be done by laying cable from each meter individually.

1.1 Problem Statement

Conventionally, the traditional analog meters system faces few drawbacks which need to be solved with the invention of the new digital water meter system. The drawbacks encountered are as following:

1. The workers of the utility cooperates face difficulty in recording the measurement of the water meter from each and every house in the entire country at the same time monthly. Because of this cumbersome job, the utility company only takes water meter reading once in two months where the actual meter reading and its payment of the first month and the estimation meter reading of the following month.

2. In some places, the utility workers have no choice but to enter into the consumer's house or premise in order to record the readings on the analog meter and this can at times appear as an invasion of the consumer's privacy [3].

3. In the end, consumers become unaware of their utility usage until the utility bill of the particular month has been issued by the utility company's workers. Thus, the consumers face difficulties in predicting, controlling and managing their own water usage [4].

4. Non Revenue Water (NRW) is defined as the difference between supplied water from water treatment plant and metered quantity to the consumers. The average NRW level recorded nationwide is 36.63% [15]. NRW components consist of physical and commercial losses (water consumed but gives no revenue). This is because of the water leakage and water theft commonly happens around us and plenty of the water supply is wasted before the utilities cooperates realize the leakage or have been reported by public. Currently the world is facing global warming problem where it leads the water supply source to be drastically reduced and imbalanced. So the problem creates an urge to the utility companies in order maintain the efficiency of the water supply with less leakage or water theft.

1.2 Motivation of The Project

The main motivations which give drives to develop the Integrated Utility System's Water Meter are such as:

1. Since the developments of housing area are growing rapidly, the utility workers in Malaysia face difficulties in taking water meter reading from house to house. This problem can be overcome by using the latest communication technology such as Power Line Communication (PLC) and XBEE wireless communication. [3]

2. The utility customers in Malaysia are face difficulties in managing and controlling their utility usage without knowing the exact utility usage in more easier and measurable amount because usually the utility meters shows meter reading in 8 digit numbers. This problem can be overcome by using the latest communication and digital technology in which the meter would have the features to display the total usage amount with its corresponding charges in RM which makes user to understand the usage value easier. [4]

3. The utility companies face difficulties in managing their utility resources without knowing the real-time information of the customer's utility demand which leads the utility cooperates to bare the cost of the non-revenue resources such as high spinning reserve for the electricity and Non revenue water (NRW). This problem can be overcome by using the latest communication technology in which the utility companies get the real-time data of customer utility supply demand. [15, 4]

1.3 Objective of The Project

The main objective of this Integrated Utility System (water meter) is to:

1. design a digital water meter by using the water flow rate sensor which able to calculate the total water usage in liter (L) with the error less than 5%.
2. establish the communication between UIS's Water Meter and UIS's Energy Meter in order to display the water usage data on the LCD display at the UIS's Energy Meter and transmit the water usage data to the terminal computer.
3. develop a computer aided data logger system by using the LabVIEW program for the terminal unit of the Integrated Utility System (IUS) in order to reduce the cost and the time taken to do the water meter reading.

1.4 Scope of the Project

Scopes of this research as stated below:

1. Development of digital circuit that calculate total water usage by measuring the water flow in a pipe line.
    - Analyze the signal produce by the water flow sensor and then produce the related equation of the water flow. From the equation, the corresponding digital circuitry is developed in order to measure the water flow precisely. Then the output of the circuit is fixed at the microprocessor to execute the programmed algorithm in order to the water usage by the customer in the pipe line.

2. Develop a charger circuit in order charge the nickel cadmium battery.

    - The charger circuit uses the micro hydro in order to charge the nickel cadmium battery and also as power supply. The nickel cadmium battery will act as the power storage supply device for the digital water meter circuitry. The nickel cadmium battery able to produce stable voltage during uneven rotation of micro hydro and also as the backup power supply when the hydro not able to produce power when the supply water is not flowing in the pipe.

3. Establish the communication between IUS's Water Meter and the IUS's Energy Meter.
    - Use the communication medium in order to establish the integration between the IUS's water meter and the IUS's energy meter. The IUS's water meter system should able to send the water usage value from time to time upon the meter reading data change. The IUS's Energy Meter will display the data of the water usage in liter (L) and its corresponding charges in Ringgit Malaysia (RM). After displaying the data on

the LCD display, the IUS's Energy Meter will send the water usage data through the power line communication (PLC).

4. Develop the computer aided data logger system by using the LabVIEW software.
   - The computer aided data logger will be function as the data logger that can initiate the data communication between all the IUS's meters. It also functions as the data logger to store all the data from the IUS's Energy Meter with its corresponding house account data. This system should able to analyze the incoming data from the PLC circuit in which consist of the unique identification data (ID). The software will identify the ID and store the incoming data to its corresponding account ID in the database stored initially.

5. Development the full prototype of IUS system and do the prototype performance evaluation which includes installation of sensors, battery and controller programming.
   - Develop the full prototype of the IUS's water meter in a compact PCB board together with all the circuit and the sensors. The battery will acts power storage device of the IUS's water meter circuitry. Test the performance, functionality and the durability of the IUS's water meter prototype and do troubleshooting in case of any problem occur.