



Faculty of Engineering

## **DEVELOPMENT OF AN EFFECTIVE METER READING SYSTEM**

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Bachelor of Engineering with Honours  
(Electronics and Telecommunications Engineering)  
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# **DEVELOPMENT OF AN EFFECTIVE METER READING SYSTEM**

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This project is submitted in partial fulfillment of  
the requirements for the degree of Bachelor of Engineering with Honours  
(Electronics and Telecommunications Engineering)

Faculty of Engineering  
UNIVERSITI MALAYSIA SARAWAK  
2006

## **DEDICATION**

For my most beloved parents.

## **Acknowledgement**

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## **Abstrak**

Sistem meter utiliti seperti meter elektrik, meter air dan meter gas di sesetengah tempat di Malaysia merupakan alat pengukuran yang dipasang hampir di semua bangunan di negara ini. Setiap bulan, bil-bil utiliti akan dikenakan kepada para pelanggan oleh ibu pejabat pembekal elektrik, air dan gas melalui kutipan bacaan meter-meter di premis-premis yang berkenaan. Walau bagaimanapun, pembacaan meter secara manual sering membazirkan masa dan tidak begitu efektif.

Projek ini dibahagikan kepada dua bahagian yang utama: untuk meneroka teknik-teknik pembacaan meter melalui teknik wayarles atau teknologi komunikasi melalui talian kuasa elektrik; dan untuk membangunkan satu sistem pembacaan meter secara automatik yang paling berkesan untuk pasaran tempatan. Pembacaan meter secara automatik sering dikaitkan dengan sistem “Automated Meter Reading” atau “AMR” di sesetengah negara.

Laporan ini meneroka asas operasi and keunikan sistem-sistem pembacaan meter secara automatik. Ini bertujuan untuk membangunkan satu sistem yang sesuai untuk kegunaan pasaran tempatan. Selain daripada sistem bacaan meter, laporan ini juga membincangkan teknik-teknik pengutipan bacaan meter melalui meter-meter elektrik, air dan gas. Kebaikan dan keburukan sistem wayarles dan teknik komunikasi melalui talian kuasa elektrik akan dibandingkan dan sistem yang terbaik akan dibangunkan.

## **Abstract**

Utility metering system refers to metering devices installed in almost every building throughout the country, such as kilowatt-hour meter, water meter and gas meter in some places in Malaysia. Through meter reading, the utility offices are able to measure the amount of power, water and gas consumptions per month and collect respective charges. However, manual meter reading is both time consuming and ineffective.

This project consists of two parts: to explore different methods of remote meter reading, using either wireless or communication over power line technology; and to develop the most effective remote metering system suitable for local market. Remote meter reading also refers to automated meter reading (AMR) in some countries.

This paper studies the fundamentals and characteristic of different meter reading acquisitions systems, in order to develop the most suitable system for local applications. Apart from data acquisition, the paper also discusses the fundamentals of power, water and gas metering system. Advantages and disadvantages of both wireless and power line communication are compared and the most effective meter reading system for local market is developed.



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## List of Abbreviations

AC	Alternating Current
ADC	Analogue-to-Digital Converter
AM	Amplitude Modulation
AMR	Automated Meter Reading
ASK	Amplitude Shift Keying
AT&T	American Telephone and Telegraph Corporation
BCD	Binary Coded Decimal
DCU	Data Collection / Concentrator Unit
DSP	Digital Signal Processor
FSK	Frequency Shift Keying
IC	Integrated Circuit
IF	Intermediate Frequency
KWh	Kilowatt-hour
LAB	Lembaga Air Bintulu
LAK	Lembaga Air Kuching
LCD	Liquid Crystal Display
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
PCB	Printed Circuit Board
PLC	Power Line Carrier
PLL	Phase Locked Loop
PSK	Phase Shift Keying

RF	Radio Frequency
SESCo	Sarawak Electricity Supply Corporation
TIU	Telemetry Interface Unit
USA	United States of America
UTU	Utility Terminal Unit
VR	Variable Resistor



## CHAPTER 1

# INTRODUCTION

### 1.0 Project Background

In Malaysia, there are basically three types of utility companies: electricity, water and gas. The main method of electricity generation in the country is from hydro powered turbines, supplemented by diesel generators. Electrical power is distributed throughout the country by national grid system. Treated water is supplied from rivers and dams. Petroleum gas or cooking gas is distributed from the natural gas plant to the customer's premises via pipes or in gas cylinder form.

Utility meters installed at premises are used for recording consumption, for monthly billing purposes. Utility company employed their own personnel to collect consumption readings every month from meters at customer's premises. This manual method often consumes a lot of time and effort. Besides, not all areas are covered each month. Most of the time, consumption for a particular premise is estimated in alternate month.

In Sarawak, electricity is supplied by Sarawak Electricity Supply Cooperation (SESCo) and the treated water is by Lembaga Air Kuching (LAK) in Kuching, Lembaga Air Bintulu (LAB) and etc. The employees from the respective companies will visit their customer's premises every month to carry out meter reading. Equipped with handheld computers, utility bills are printed on site and

given to the customers. Prone to weather issues as well as attacks from wild pets, manual meter reading is ineffective in the long run.

## **1.1 Objectives**

The main objectives of the final year project are:

- To investigate the knowledge obtained throughout the offered course in a realistic exercise in the practice of engineering at a professional level.
- To give the opportunity for individual or group study and for the development of personal and technical skills.
- To develop technical skills of communications, both oral and written.

The main objective of this project is to study on viability of different automated meter reading methods and propose a suitable and effective meter reading system, for local market. The first stage is to develop the student's knowledge and understanding of different methods of Automated Meter Reading (AMR) systems. The second stage of the project is to design and develop the hardware. In this project, the student is required to simulate or develop the proposed AMR system.

## **1.2 Final Year Project Report Outline**

This report is organized in a systematic way to present the development stages of the project. The final year project is divided into 2 parts: FYP 1 and FYP 2. FYP 1 covers the first stage: Chapter 1 Introduction, Chapter 2 Literature Review and Chapter 3 Methodology. Chapter 4 Hardware Implementation, Chapter 5 Analysis and Discussion as well as Chapter 6 Conclusion and Future Developments are carried out in FYP 2.

Chapter 1 introduces the project and discusses the objectives. Chapter 2 describes the studies and researches that have been carried out on the fundamentals of metering systems, AMR methods and techniques. The comparison between wireless meter reading and communication over power line technology is discussed in the Chapter 2. Chapter 3 discusses the method used to carry out the project and design the hardware.

In FYP Part 2, three more chapters are added to complete the report. Chapter 4 describes the circuit implementations of the design while Chapter 5 discusses the testing results and analysis. Conclusion and future developments for this meter reading system are further discussed in Chapter 6.

## CHAPTER 2

# LITERATURE REVIEW

### **2.0 Introduction**

This chapter discusses about the background, concepts and technical data regarding different types of metering systems, as well as Automated Meter Reading (AMR) methods. Comparisons are made between AMR methods, to obtain the most suitable implementation to replace manual meter reading for domestic market.

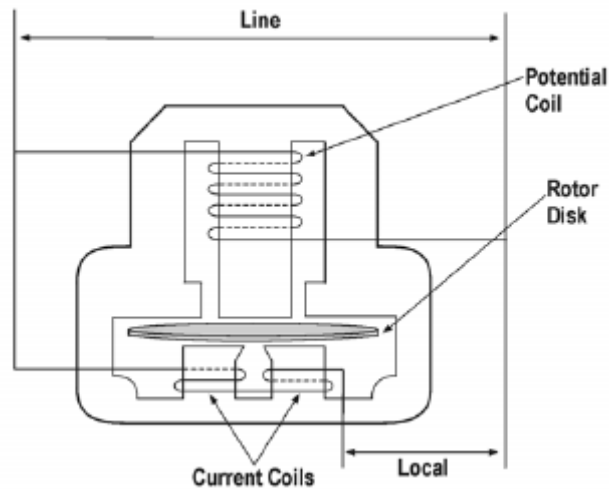
### **2.1 Types of Utility Meters**

Basically, there are three types of utility meter available: kilowatt-hour or electricity meter, water meter and gas meter. Each type of meter utilizes different mechanisms to record the consumption.

#### **2.1.1 Kilowatt-hour meter**

Also known as electricity meter, the kilowatt-hour meter is used to measure the amount of electricity consumptions. The most common type of kilowatt-hour meter in Malaysia is the electromechanical induction [1] type. The kilowatt-hour meter consists of an aluminum disc which is acted upon by two coils, as shown in figure 2.1.1a in the following page.

The upper coil produces a magnetic flux proportional to the voltage (potential) and the lower coil produces magnetic flux proportion to the current [1].



**Figure 2.1.1a Inner structure of a kilowatt-hour meter**

As a result, an eddy current is produced on the disc, where a force is being exerted on the disc in proportion to the product of voltage and current. This causes the disc to spin.

When there is no power consumption, the disc stops rotating. This is due to the permanent magnet, located below the disc, which exerting an opposite force to stop the rotating disc. Figure 2.1.1b in following page shows the type DD28 kilowatt-hour meter commonly found in the country.



**Figure 2.1.1b DD28 Single phase kilowatt-hour meter**

The rotating movement drives the registers, a series of dials which records the power consumptions. Newer power meters utilize solid state devices [1] and Liquid Crystal Display (LCD) instead of registers. LCD meters provide better accuracy compared to conventional meter due to no moving parts.

### **2.1.2 Water meter**

Water meter measures the volume of water consumed by a household in cubic meter. Similar to the electricity meter, the water meter utilize a small turbine or impellor to turn the register. The rotation of the turbine is directly proportional to the flow rate of the water. Figure 2.1.2 in following page shows the typical water meter installed.



**Figure 2.1.2 Water meter**

### **2.1.3 Gas meter**

Only available in certain places in Malaysia, a gas meter is used to measure the flow of fuel gas, such as natural gas supplied to the households and commercial premises by the natural gas company [2]. Unlike liquid petroleum gas (LPG) available in drums for domestic market, the natural gas is supplied by the Liquid Natural Gas (LNG) facility to the premises via gas pipes.

The most common type of gas meter is the diaphragm meter. Inside the meter, there are two chambers formed by two moving diaphragms [2]. Natural gas fills the two chambers directed by valves. As the diaphragms expand and contract, levers mechanically connected to the crank rotates the register wheels. The registers are similar to those electricity and water meter. Figure 2.1.3 in following page shows the diaphragm type gas meter. The gas chambers are located right below the registers.



**Figure 2.1.3 Gas meter**

## **2.2 What is Automated Meter Reading (AMR)**

Automated meter reading refers to the collection of meter data at a central location [3], such as utility offices remotely at a customer premises using telecommunication technology. Unlike conventional meter reading, AMR is a state-of-art technology that eliminates the need of physically visits and manually read the meter at customer premises. In short, human involvement is not required for meter reading activities by using AMR system.

### **2.2.1 History of AMR**

The technology is first tested 30 years ago by American Telephone and Telegraph Cooperation (AT&T) in cooperation with a group of utilities companies. The experiment was successful whereby AT&T offered to provide phone system - based AMR services at \$2 per meter [4]. However, the early development of AMR