Faculty of Electrical and Electronic Engineering Technology

Investigation of Tampering Detection Device for Energy Meter by GSM Module

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Bachelor of Electrical Engineering Technology with Honours

2021

Investigation of Tampering Detection Device for Energy Meter by GSM Module

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

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled "Investigation of Tampering Detection Device for Energy Meter by GSM Module" 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

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DEDICATION

To my beloved mother, Mary Sinnappan, and father, Soosai Mariadass,

and

To siblings, family, and friends

ABSTRACT

Energy meter is the critical part of power supply framework whose dependable working is vital for precise charging, controlling, and checking of power utilization. The primary goal of this proposed design is to identify and prevent tampering of energy meter and to guarantee appropriate billing is continued. Energy meter is incorporated with the framework in a such a manner that on the off chance that anyone opens the front of the meter, IR sensor will send logical signals to the microcontroller Arduino Uno. The Arduino Uno faculties the consistent part from the IR sensor, and it will convey message to the GSM module. When the GSM module initiated will send a programmed text message (SMS) to the assigned cell phone which has been programmed in the control memory. Additionally, a buzzer will be activated to alert the surrounding of the energy meter being tampered. This proposed configuration has been summed up acknowledgment of location of tampering of energy meter and making an impression on a portable, through programming proteus and equipment arrangement. In this task, a useful model will be created and gathered. The model will go through testing stage dependent on the investigation that built by the researcher. This model will be tried to research its expected capacity just as its reasonableness from the client outline. Sufficient plan of a wearable gadget will be produced and the one that suits the task needs will be chosen. From that point onward, a further interaction will be led onto the plan to conquer the issues experienced along these lines the venture destinations can be attainable. This plan will give a more extensive utilization of the wearable gadget just as its other capacity in TNB industry.

ABSTRAK

Meter tenaga adalah bahagian paling utama dari kerangka bekalan kuasa yang pekerjaannya dapat diandalkan sangat penting untuk pengisian, pengendalian, dan pemeriksaan penggunaan tenaga yang tepat. Matlamat utama reka bentuk yang dicadangkan ini adalah untuk mengenal pasti dan mencegah gangguan meter tenaga dan untuk memastikan penagihan yang sesuai diteruskan. Energy meter digabungkan dengan rangka sedemikian rupa sehingga jika tidak ada orang yang membuka bahagian depan meter, sensor IR akan menghantar isyarat logik ke mikrokontroler Arduino Uno. Arduino Uno menggunakan bahagian yang konsisten dari sensor IR, dan ia akan menyampaikan mesej ke modul GSM. Apabila modul GSM yang dimulakan akan mengirim pesan teks terprogram (SMS) ke telefon bimbit yang ditetapkan yang telah diprogramkan dalam memori kawalan. Selain itu, buzzer akan diaktifkan untuk memberi amaran di sekeliling meter tenaga yang diusik. Konfigurasi yang dicadangkan ini telah disimpulkan sebagai pengakuan tentang lokasi gangguan meter energi dan membuat kesan pada portabel, melalui pengaturcaraan proteus dan pengaturan peralatan. Dalam tugas ini, model berguna akan dibuat dan dikumpulkan. Model akan melalui peringkat pengujian bergantung pada penyelidikan yang dibina oleh penyelidik. Model ini akan dicuba untuk meneliti kapasiti yang diharapkan seperti kewajarannya dari garis besar pelanggan. Rancangan yang mencukupi untuk alat yang dapat dipakai akan dihasilkan dan yang sesuai dengan keperluan tugas akan dipilih. Dari saat itu dan seterusnya, interaksi lebih lanjut akan dibawa ke rancangan untuk mengatasi masalah yang dialami di sepanjang jalan ini, tujuan usaha boleh dicapai. Rancangan ini akan memberikan penggunaan alat yang boleh dipakai secara lebih luas seperti kapasiti lain dalam industri TNB

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, TS. Dr.Zulkifli Bin Ibrahim, for his precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and Yayasan Tenaga Nasional for the financial support through this pandemic which enables me to accomplish the project. Not forgetting my fellow colleagues, for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents, siblings and family members for their love and prayer during the period of my study. An honourable mention also goes to my lectures for all the motivation and understanding throughout this year of studying.

Finally, I would like to thank all the staffs at the Faculty of Electrical & Electronic Engineering Technology, fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

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LIST OF SYMBOLS

δ	-	Voltage angle
	-	
	-	
	-	
	-	
	-	
	-	
	-	

LIST OF ABBREVIATIONS

IR Sensor	-	Infrared Sensor
GSM	-	Global System for Mobile Communications
SMS	-	Short Messaging Service
IOT	-	Internet of things
RMR	-	Remote Meter Readers
AMR	-	Automatic Meter Readers

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CHAPTER 1

INTRODUCTION

1.1 Background

Power Energy Meter is the most essential device for an electrical circuit. This device is installed in the electrical circuit to measure and calculate the energy used by the certain premise. Energy meters have dials or LCD screens to display the energy used by the premise to help the electricity provider to prepare billing statements for the consumer to pay the company back. This also ensures the monitoring of the energy meter to prevent any faults during energy supply. Energy meter plays a very big role by connecting both consumers and the energy provider. Without this device it would be a difficult process for the energy suppliers to earn their return of investment. Although, a bigger problem energy supplier throughout the world are facing in getting back their return or revenue of the company is meter tampering. Meter tampering is a serious crime which in recent times is trending at all countries. This is an irresponsible act to avoid proper billing and paying the right amount of money to the energy supplier. It is now being a crucial concern and problem for both government and consumers due to the increase in electricity cost.

Tampering is a method of slowing down the meter measuring process or even stopping the complete measuring process. This benefits the consumer in a wrong way by reducing their monthly bill to pay the energy consumer. This is the biggest factor holding up a countries revenue in energy industry. This leads to a serious gap in between demand and supply which is expanding slowly. To overcome this problem TNB has come up with several ideas and upgrades modified in the energy meter. Even though upgrades and modifications

has been done, new methods on tampering are still being invented by some groups of irresponsible individuals. Energy meter developers face a big issue in identifying the tampering method and a solution to avoid the tampering to happen again. One of the solutions to prevent meter tampering was inventing smart meter. Smart meters recognize all the energy consumption of the certain premise, and the data will be stored in the smart meter memory. This solution did not prolong for a very long time and meter tampering did continue as usual.

The main reason for customers to tamper the meter is to prevent themselves from paying the cost of the energy they used. Tampering allows the meters to produce false reading which is comparatively lesser than the actual reading of the energy meter. Consumers who perform these thefts only pays bill for a lesser amount than they used. The meter produces a lesser reading in mechanical meters because DC current in the energy meter will stop the coil of the energy meter from producing eddy current between the coil and the rotating disk making the disk to rotate slower and reduces the rotations and leads to lower bills. Besides, reverse motion method is also used by consumers to tamper the meter. This method is done by connecting the capacitive load and inductive load which leads to reverse motion. Meter tampering is categorized as offences under Section 37(1) of the Electricity Supply Act 1990. Frauds and thefts such as this leads to severe actions taken by the law like discontinuing the electricity supply under Section 38(1) of the Electricity Supply Act 1990.

Taking note of the increasing electrical theft, companies are finding enduring solutions to prevent energy meter tampering to take place. Electronic meters such as smart meters and computerized meters have a self defence system and counter measures programmed to avoid meter tampering. This also helps to solve various problems such as

power distribution problems, faulty energy meters etc. Besides, companies are also intent to install remote reporting meters which is able to detect any type of tampering and discover the theft. The main aim of the smart meters is to concentrate on meter tampering and prevent it. Yet the total cost of installing a smart meter is pretty much high and would not be able to be owned by many of them. Therefore, companies are still in a search of building a save cost tampering detection system to prevent meter tampering and to ensure proper billing is done.

1.2 Problem Statement

There are several factors that contribute to electrical theft such as meter tampering. The first factor contributing for this problem is, consumers bravely tamper their meter to avoid themselves paying high bills to the energy provider. Consumers who have high usage of electrical energy consumption tend to tamper their meter to pay less money than the amount of energy they have used. In addition to that, increase in tampering cases and not upgraded security system of the energy meter affects the country's revenue in the energy consumption field and energy suppliers not receiving their returns of the service they provide. Countries that face many meter tampering cases eventually lost a big portion of their annual revenues. Besides, the next factor is, there are many ways of meter tampering is done to avoid billing and reduce billing. Such as reverse motion method, current bypass method, external earthing method etc. These methods lead to a serious issue creating a big void between demand and supply chain making electricity cost to increase consequently.

1.3 Project Objective

The main purpose of this project is to propose a secured system to avoid meter tampering to happen. Specifically, the objectives are as follows:

a) To identify methods of meter tampering based on literature study and researchers.

b) To develop an affordable and low-cost security system to avoid the energy meter tampering by sending alert message notification.

c) To improve the security of energy meters by producing an alarm sound in the event of energy meter mis-operation.

1.4 Scope of Project

The scope of this Tampering Meter Detection project are shown to have the following attribute:

a) This project mainly focuses on avoiding tampering happening in energy meter by not allowing people to open the energy meter box unnecessarily.

b) The alert message is sent to the consumers using GSM based technology on the opening of the energy meter box.

c) The alert message contains the location of the energy meter box is being opened and buzzer sound is created to notify publics in the event of energy meter mis-operation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is about researching and reviewing all the related aspects which includes history and origin of the material and articles that connect within the field of this project is done. This chapter mainly helps in adding knowledge of the project which is been chosen. It provides a wider perspective of the existing problem and the steps taken to overcome it. By doing research and reading articles and research papers like this will assist in understanding the theoretical facts and calculations of a certain topic. This can be achieved by reading and reviewing the previous related works to this project. Besides, this chapter will also allow researchers to upgrade and modify their own project and brainstorm new ideas. The research papers and articles will be accessible for the researcher through some online portals such as Research Gate, IEEE Xplore, Google Scholar etc.

2.2 History of Energy Meter

The Energy meters are a the most important part of an electrical installation for a property which uses electricity. Energy meter is also known as Watt-Hour meter. It measures the consumption of the electrical energy. We can find this electrical device in front of our domestic houses, companies, industrial buildings typically where the power lines get into the building to calculate and display the amount of electrical energy used by the loads presented in the construction such as fans, lights, refrigerator etc. The unit used to calculate the energy consumption is Watt [1]. As mentioned above electrical energy is calculated by

the total amount of Power used loads which is in a simple formula where Power (P) is equals to the product of Voltage (V) and Current (I) P=IV. The principal of this energy meter is to make sure to produce proper billing and monitoring for the total amount of energy is being used by the dedicated construction. The basic construction of the energy meter is shown below:

Figure 2.1 Analog Energy Meter [1]

During end of 1800s, electricity was wide available as gas energy. This is where the beginning of electrical meters. Initially energy was calculated using the number of lamps per month, as it gradually changed into a proper billing system to avoid over usage of electricity with lesser amount of money to be paid. DC meters was the 1st type of electrical meter invented by Thomas Edison in which he developed an electrochemical meter [2]. This meter calculated energy using an electrolytic cell by summing the total current consumption. Although, this energy meter was not well received by the customers because of its long process of removing and weighing of plates before generating the bill.

Later, understanding about energy meters the United Kingdom introduced an upgraded version of electrochemical meter which used mercury to determine the value of energy consumption. This meter was named as the Reason Meter [2]. This meter used the same technique of calculating the energy by recording ampere hours. As the mercury rans out the consumers would have to contact the agents to invert the meter and reset it back by paying them. By this, consumers are allowed to use electricity. Dr. Hermann Aron was the 1st person to patent the most accurate DC meter in the year 1883 and this meter entered the market in the year 1888 by British General Electrical Company Hugo First. Aron's meter consists of clock dials to indicate the recorded total charge used over time [2].

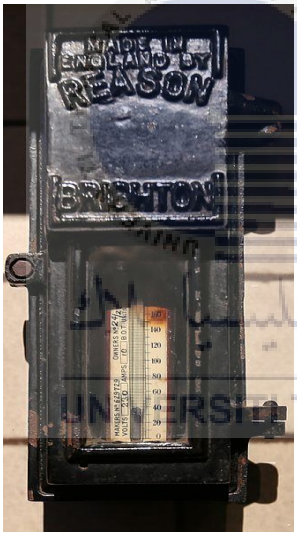

Figure 2.2 Aron's Meter [2]

Figure 2.3 Aron's Meter [2]

In this modern era, we are using meters which are electromechanical based. These meters consist of a rotating aluminum disk rotating and calculate the total consumption of electricity in that particular property. This conductive and non-magnetic rotating disk is placed between dual electromagnets. The energy consumption is dependent on the number of rotations did by the disk. As the disk rotates a set of dials will display the number of turns

did by the disk. As for the disk, it rotates faster when more supply of current is sent through the disk. In summary, the higher the current, the faster the disk rotates resulting to a higher energy consumption [3].

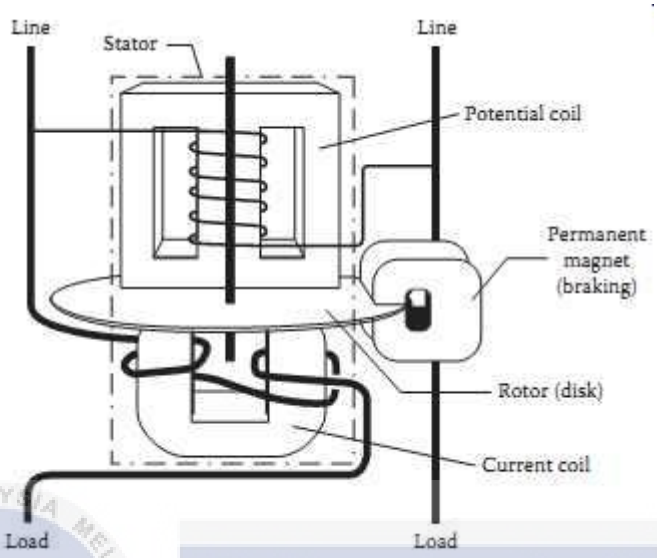

Figure 2.4 Schematic Diagram of Energy Meter [4]

Working principle of the energy meter has not been changed for 100s of years. The working principle includes Shunt magnet, series magnet, coils, and braking magnets [4]. In simple, the live line and the neutral line is respectively connected to both shunt magnet and the series magnet. The shunt magnet consists of a thicker and larger number of turn of coils across the magnet. Whereas the series magnet only consists of smaller number of turns. Both these magnets when supplied with current supply it will produce a magnetic flux and forces the disk between them to rotate by using eddy current. The disk's speed is also monitored by the braking magnets placed in the meter. This maintains the stiffness of the disk and allows the disk to rotate in a balanced position. Besides, when the supply is cut off immediately, the braking magnets stops the disk to rotate and prevents the disk to move with the help of inertia. This type of energy meter is very precise and accurate in calculating the total energy consumptions [4].

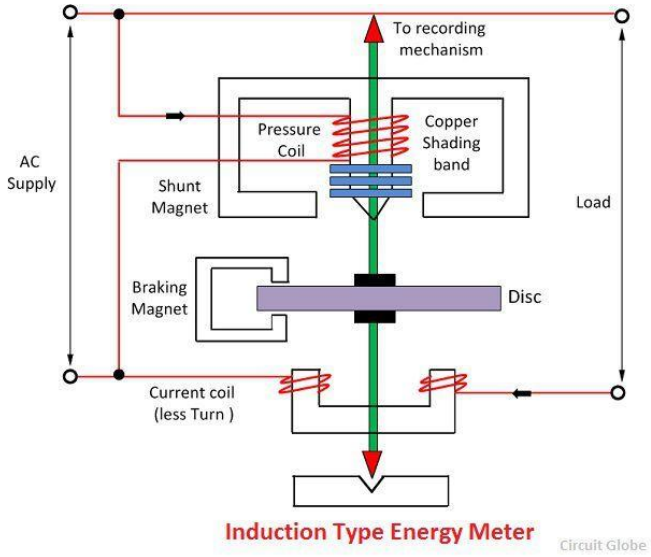

Figure 2.5 Current Flowing Path [4]

2.3 History of Global System for Mobile Communication (GSM)

We can hardly think of our days without mobile communications in this era. The little of wonders makes us get in connected to people all around the world. This connection is all made possible with the help of Global System for Mobile Communications (GSM). Mobile phones and network communication devices use GSM technology to transfer voice calls, texts all type of data etc. In the year 1970, Bell cooperation developed GSM technology using mobile radio system [5]. Currently according to the database GSM is supporting more than 1 billion mobile networks around the globe. GSM tech operates in different level of frequency bands from 850MHz to 1900MHz [6]. Every data transmitted through GSM is converted into digital binary form of 0s and 1s. All the data is transmitted through a channel in its own time slot.

GSM modem is a device that used to make a communication contact between computers or any other programmable devices with a network. GSM modems can be represented by mobile phones or a simple modem. This modem requires a SIM card to be activated and connects the network within the registered network range by the network operator. There are basically 3 main pins in the GSM module, which are the power supply pin, transmitter pin and the receiver pin [7]. The power supply pin is the pin connects to the power supply and turns on the GSM module. Generally, a 12V DC supply would be given to activate this GSM module. The transmitter pin is the pin that transmits all the commands from this GSM module to the other module in the receiver hand. Finally, the receiver pin. This pin receives all the data transmitted from the GSM module which is registered under a network operator. This GSM modules can be connected with a microcontroller processor and send out serial communications [7]. The microcontroller reads and converts the serial binary data into human language. This data can be received and viewed through a computer or a mobile phone.

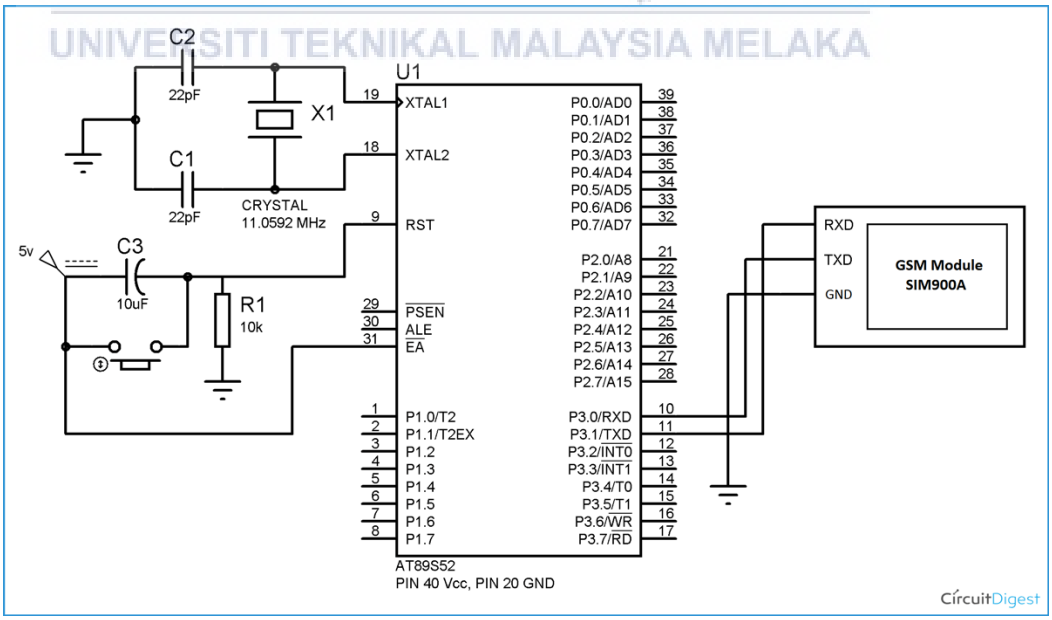

Figure 2.6 Interface Using GSM Module [8]

2.4 Power Theft Through Illegal Tapping

In this current time, electricity theft are common cases found throughout the world. This is a very serious criminal act where the whole world is depending on electricity. Irresponsible peoples who perform this act by steal electricity can cause serious shortage of electricity and can affect the countries revenue. As per studies it is stated that the total cost of electricity stolen around the world is approximately 90 billion US dollars. There are several types of electricity theft, this includes Cable hooking, tampering energy meter, fitting foreign material into energy meter, physical obstruction and ESD attack on electronic meter.

2.4.1 Cable Hooking Method

Cable hooking method is simply about tapping the power line cable right before the power lines enter the energy meter. This method is the biggest reason for a country to lose its revenue from electrical theft. This is because all the energy used by the load which is connected through the tapped cable will no longer be calculated by the energy meter. Because the current supply is going through the meter but pass over the meter without any detection so the current will be unmeasured [9].

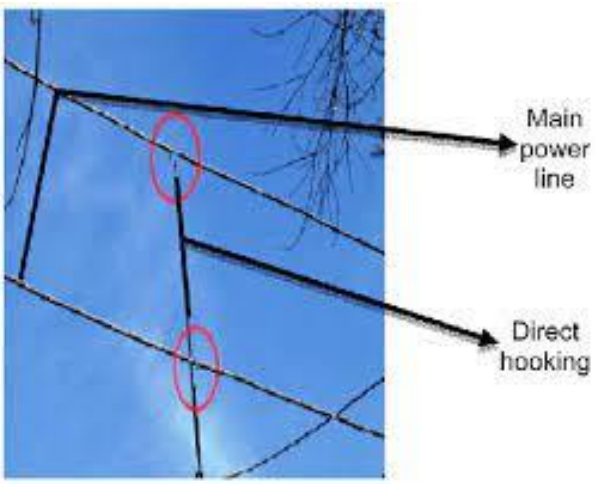

Figure 2.7 Direct Hooking from Cable [9]

2.4.2 Meter Tampering Method

Meter tampering is a commonly used method for power theft. This method is performed by involving the terminal points of the energy meter. This prevents the energy meter to register the amount of electricity been used in that particular property. There are several methods of current tampering can be done. For example, neutral current reverse method. In this method the neutral terminal is grounded externally. This causes the meter not been able to calculate the phase shift angle of the coils and hence the power could not be able to be determined [9].

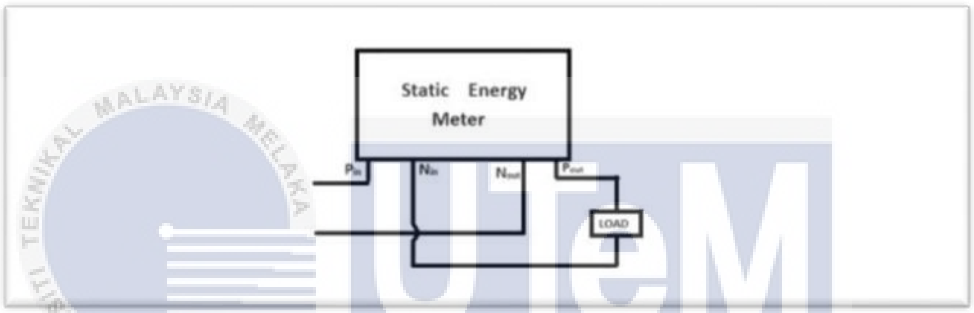

Figure 2.8 Neutral Cable Grounded Externally [9]

2.4.3 Current Bypass Method

In this strategy, current is skirted from stage contribution to stage yield, presently the current won't go through the shunt. For instance: measure of current provided to stack can't be estimated and subsequently power can't be estimated, and the meter won't show power devoured by load [9].

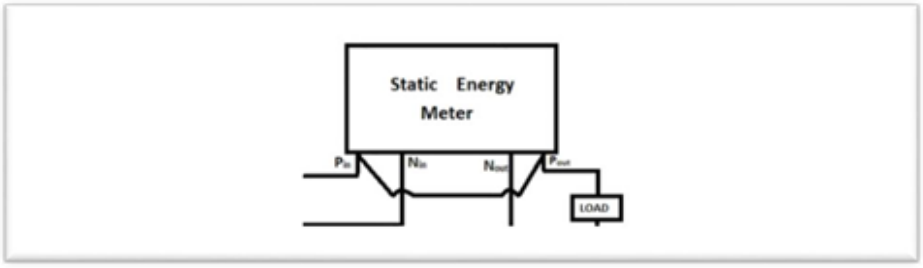

Figure 2.9 Current Bypass Method [9]

2.4.4 Neutral Current and Phase Reversed Method

This technique for altering, Current is provided straightforwardly from stage contribution of the meter to stack, and the load is remotely grounded. Thus, current does not pass from shunt for example current cannot be estimated. Additionally, since load is remotely grounded so there is no reference highlight measure voltage so voltage can likewise not be estimated and, in the end, power cannot be resolved, so meter won't show power devoured.

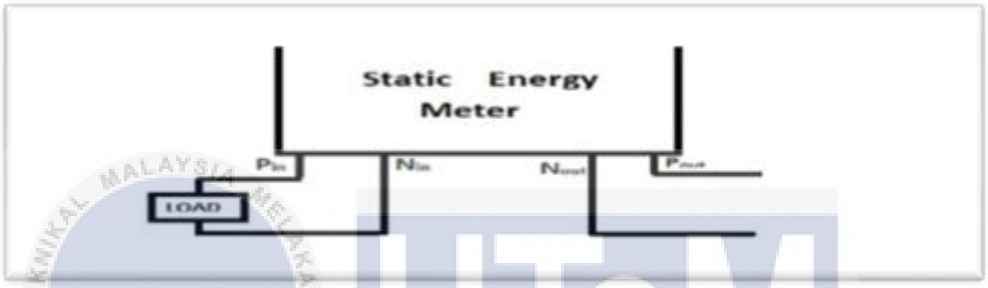

Figure 2.10 Neutral Current and Phase Reveresed Method [9]

There are several cases have been reported in Malaysia regarding electricity theft and meter tampering. Our Malaysian energy provide Tenaga Nasional Berhad (TNB) have taken several charges upon citizens who have attempted meter tampering. This can be clearly in the case which has been reported in the year 2018 where TNB inspected the meter's installations at the premises of the consumer [10]. They found out that an owner of a premise has tampered the energy meter, and this cause the meter not to record and produce any accurate data of the premise. The supply of the premise was disconnected following the law of Electricity Supply Act 1990 under Section 38(4). Besides, there was also another case was reported on the 9th of October 2020 in which a shop lot owner was severely ordered to pay TNB a penalty of RM 18000 due to meter tampering in his shop lot [11]. The shop owner found guilty under Section 37(1) of the Electricity Supply Act 1990 [12].

2.5 Energy Theft Detection and Controlling System Model Using Wireless Communication Media

This paper proposes a way to detect electrical theft which is growing in Sri Lanka. The project has been initialized to reduce the electrical theft whole over Sri Lanka because it is directly affecting the revenue of the country. The Ministry of Power and Energy of Sri Lanka claims that number of electricity theft occurred in the year 2016 and back is increasingly widely. To overcome this high trending problem the paper also proposes a method to detect the ongoing theft without having any human interactions directly but involving completely electronics and some calculations. The objective of this project is to determine the correct location and distribution line of the tapping done. Besides, the purpose is also to enable remote controlling and monitoring of electrical theft so that government could reduce huge amount of manpower monitoring the sites and save cost spent on their salaries. Finally, this paper also aims to cover the loses which have been made by the previous thefts and maximize the revenue of the company [13].

As the paper says, there are two different methods which will be implemented in two different locations of the theft which is occurring. The 1st method is to prevent theft occurring at home. Residences of the home sidestep the energy meter by adding a piece of wire into the energy meter. By adding a piece of wire, it will bypass the current supplied and the meter fails to read the accurate reading of the current supply. To avoid this method of tampering, the author has installed a hidden electronic device into the energy meter. This electronic device detects any attempts of electrical theft and sends an alert message to the people on authority using GSM technology. The detection is done by comparing the power sent to the consumer and the power delivered by the consumer. If the sent power data is higher compared to the delivered data, the microcontroller inside the energy meter sends an

alert message to the electricity board which includes the differences of the power data and the identification of the consumer.

Mathematical equation:

$\Sigma Psent = \Sigma Pconsumed + Loss \longrightarrow$ No Energy Theft

$\Sigma Psent \neq \Sigma Pconsumed + Loss \longrightarrow$ Energy Theft Occurs

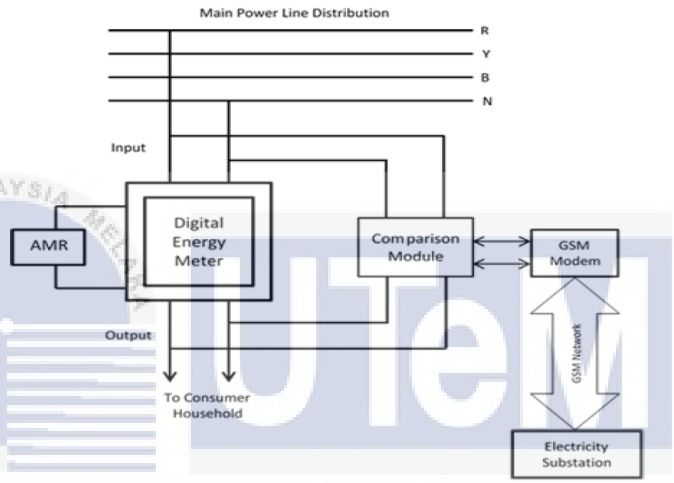

Figure 2.11 Theft Detection Energy Meter at Residence [13]

The other method of electrical theft detection is done at the distribution pole at housing areas. This detection is also similar to the previous method, but this method involves distribution poles and loads. Energy meter which is installed at the loads record the energy received by the energy meter over a time. A similar energy data recording device will be also installed at the distribution pole. Theoretically, neglecting the power loss along the cables the power received by the energy meter and the power sent from the distribution pole should be same. If a big difference is detected by the microcontroller inside the device at the distribution pole, particularly when the reading is high at the distribution pole compared to

the load a theft signal is sent to the nearest substation by power line communication technique [13].

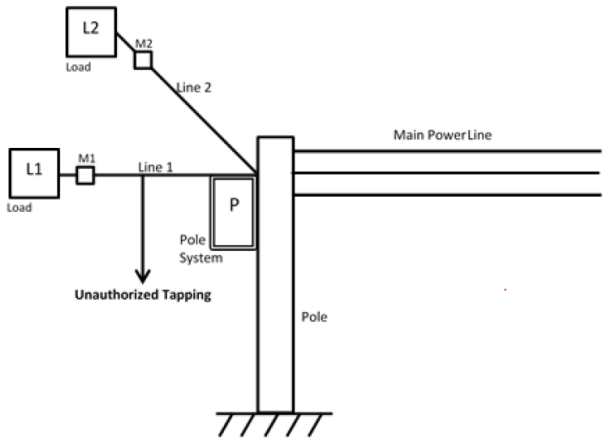

Figure 2.12 Theft Detection at Distribution Pole [13]

2.6 Electrical Power Line Theft Detection

This paper proposes [14] a theft detection method which can be used to identify power theft between distribution poles. This type of theft is categorized as cable hooking method, where theft is done by tapping the distribution cables and getting the desired supply from it. The objectives of the proposed project are to build a theft detection system with no human involvement, besides to ensure a simple way to detect the theft with minimal cost. Additionally, to also detect any failures between the distribution poles. The methodology of the project is by adding current transformers between two to three points of a distribution pole [14]. The theft will be detected by the total amount of current reading is measure in the current transformers. For instance, if the 1st current transformer reads a certain value and the 2nd transformer fails to read the same value precisely a lesser amount of value tampering is detected. This reading will be recorded throughout the distribution pole. At the same time if one of the current transformers is not able to read any readings and records a value of zero

fault is detected at the location of the current transformer. All these readings and records are sent to the authorized company/ government via GSM technology. A GSM modem is fitted together with the current transformer and if any unusual situation is encountered such as power theft or fault an alert message is sent to the electrical board which includes the location and reason of the message sent [14].

2.7 Energy Meter Using GSM Technology

The paper debates over the use of automatic meter reading facility using GSM technology [15]. As the world is moving forward by replacing electromechanical energy meters into electronic smart meters the researcher has proposed an idea of modifying an energy meter to record its own energy consumption with high accuracy and fasten the billing process via GSM technology. The objective of this project is to produce high accurate energy meter reading, to store data over a long time, calculated the energy consumption in various conditions such as lagging and leading and to interlink the measurements with GSM technology [15]. There are 3 phases involve in this project. The 1st phase calculating the energy consumption of the meter using dedicated sensors such as current sensor and potential sensor. Both the sensors will measure the voltage and the current sent to the load through the energy meter. The readings then will be sent to the Active Energy Meter IC (ADE7756) to perform the calculations and send the data to the microcontroller. The calculation performed is the product of current measured and the voltage measured which equals to the total power consumed with various power factors involved. The following stage is to display the energy consumption through the LCD display in real time and make the system compatible with the microcontroller. The final stage is to send the energy consumption data and other data need by the energy suppliers through the GSM module and receive the billing state to the dedicated mobile subscriber [15].

2.8 NTL Detection of Electricity Theft and Abnormalities for Large Power Consumers in TNB Malaysia

This paper basically talks about approach to detect the electrical thefts which is been occurring in big industries and plants in Malaysia [16]. These consumers are classified as Large Power Consumers (LPC) by the energy provider TNB. LPC contributes a very big part for a country's revenue. Electrical thefts or in other words non-technical losses (NTL) is these big industries affects the annual turnover of the energy provider so do the country. In the year 2004, TNB recorded a big amount of revenue loss as high as 229 million USD because of NTL. NTL can occur due to several issues such as electrical thefts, billing errors and faulty meters. These activities can be explained in detail for example tampering meter to produce less bill compared to the original billing or bribing meter readers to arrange wrong and cheaper bills, making illegal connections, and bypassing the current [16].

To overcome this problem, the author has proposed an idea to detect the NTLs in LPC. LPC make up a total of 80,000 Low-voltage (LV) consumers and 6000 High-voltage (HV) consumers. In all these 86,000 premises, remote meter readers (RMR) will be installed in order to monitor their power usage for a one-month period. In this 30 days TNB will thoroughly monitor the total energy consumptions of the premises. This monitoring will also involve regular meter checking from the authorization, reporting unusual phenomena and settling unpaid bills. The meter readings will be recorded for every 30 minutes interval and all the data will be transmitted wirelessly to the TNB Metering Service Database. Faults such as power down, voltage cut, reverse current etc during these 30 days interval will be also recorded to ensure that no data will be missed out in this period of time [16].

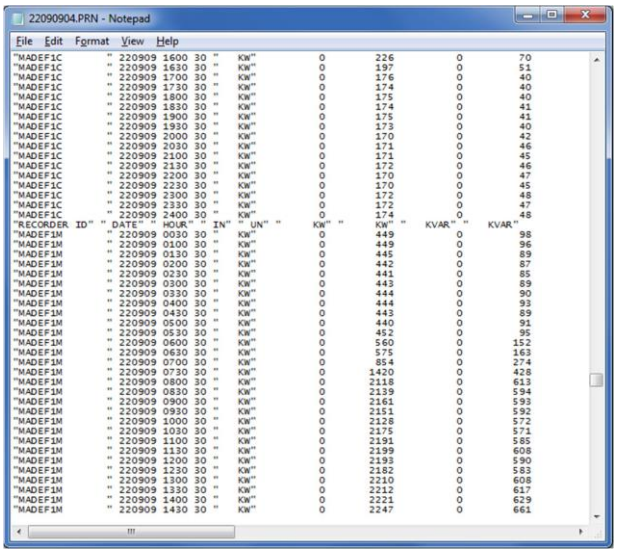

Figure 2.13 Data Log of RMR [16]

All the data collected for this period of 30 days will be set as a reference for the NTL detection framework. With the aid of the data and intelligence, 5 types of NTL detection categories are formed to detect the NTL detection framework. These 5 categories are situations of the consumers would hardly go through if any unusual meter readings would be detected.

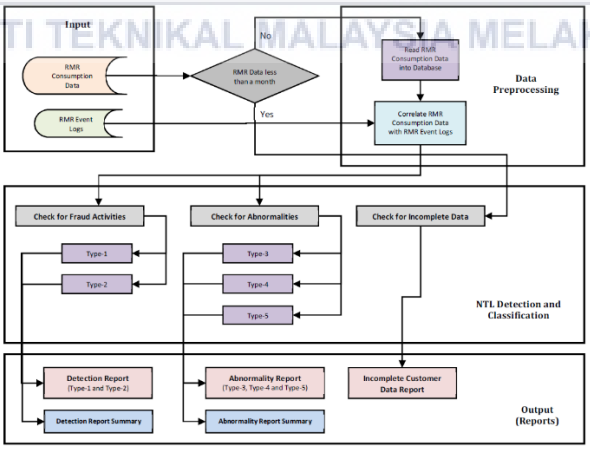

Figure 2.14 NTL Detection Framework [16]

2.9 A Technique for Electrical Energy Theft Detection and Location in Low Voltage Power Distribution Systems

The paper proposes a method of using algorithm and calculations to detect most types of power theft which is happing in a street of Nigeria [17]. The purpose of this project is to identify types of electrical thefts and way to innovate the algorithm with certain electrical laws. The theft detection is identified in an overhead radial network which starts from the 11kV transformer to the last pole connected with to the distribution network. This also includes the smart meter which is installed in the premises. The parameters taken note in the papers are impedance between poles, impendence between pole and energy meter, number of poles, voltage at each pole and the voltage at energy meter. The basic law used to succeed this project is Kirchhoff's Current Law (KCL) *Iin=Iout*. Several types of theft cases are listed in this project. The 1st type is electrical theft identified at the customer branch, in other words, energy meter tampering.

This is identified by calculating the voltage of pole the using the reported consumer current and compare the readings with the true pole voltage which is been recorded earlier. The second type is tapping wires directly from the pole. This can be identified by using the algorithm and calculations used in the 1st type. The next type of theft is theft done between the node poles. This theft is recognized using the current difference which is measured between the both the poles. The final type of theft is theft happens at the final pole. This theft is difficult to be identified. This is because there is no continuation to other poles. Therefore, this pole's theft is calculated using the total power of the complete distribution. All the data collected will be transmitted to the board of electric through several ways using GSM technology, optic fiber, radio frequency waves etc [17].

2.10 Automatic Meter Reading and Theft Control System by Using GSM

In this paper author have proposed method on preventing electrical theft and Automatic Meter Reading system (AMR) [18]. This electrical theft control system is basically a security system which will be installed inside of the energy meter to prevent energy meter tampering. The AMR system is to read the meter readings automatically using current transformer to measure the accurate total power usage of the certain premises [19]. This AMR system can be both installed in household levels and also industrial fields. AMR system only records the reading to monitor the average electrical usage of the certain meter and does not any prepare billing facilities for the energy consumption. A PIC microcontroller in the energy meter then receives the calculated meter reading from the current transformer. The readings received by the PIC microcontroller will be sent wirelessly to the electrical board using GSM module technology. This data transfer will take place every 60 days from the day installed. Authorized people in the electrical board will be responsible to monitor the average energy consumption of the premises. Any misinformation or misuse of the energy meter detected further actions will be taken.

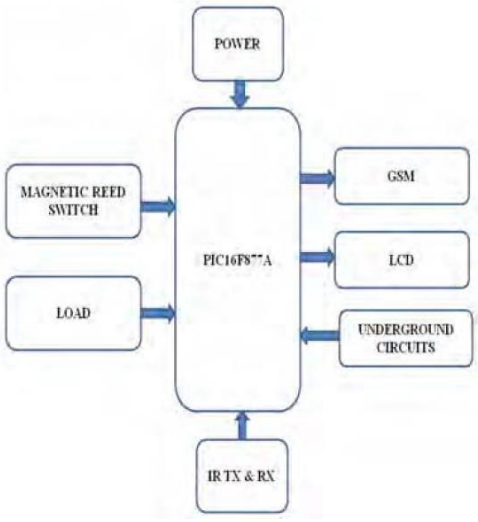

Figure 2.15 Block Diagram of ARM System [18]

Besides, the theft control can be effectively detected by the theft control detection system which will be also installed inside of the energy meter. To perform any theft control involving energy meter, the energy meter should be 1st tampered. To tamper the meter, the cover of the meter will be opened. Therefore, an IR (infrared) sensor will be placed inside the screw hole of the meter cover. When the screw of the meter cover been removed the IR sensor will detect the tapering of seal. Once the theft is detected the IR sensor will send commands to the PIC microcontroller and the microcontroller will send an alert message to the energy supply provider with the aid of GSM module which is already installed in the energy meter. Moreover, to prevent theft which takes place outside the energy meter, such as underground theft, an IR sensor is installed along the underground power cable. If there is any interruptions detected, such as cutting of power cable the connection of IR sensor will be also disconnected. This leads to no data transfer between circuit. Once the PIC microcontroller receives the information of this interruption it generates as alert message to the officials in electrical board for further actions to be taken [18].

Figure 2.16 Design of GSM Module with ARM/Power Station [18]

2.11 Surveillance Energy Meter

According to the researcher, this project has proposed an idea of preventing overload and detecting tampering of the energy meter [20]. Energy is being used in high rates in recent times due to need of the faster running world. The demand and supply rate are increasing rapidly in various sectors such as industrial companies, agriculture plants, transportations etc. Waste of energy is also increasing as the supply is getting higher. Besides, overloading is also a problem that should be solved immediately. The proposed idea from the researcher in modifying the energy meter on controlling the energy consumption of a certain premise helps to solve all the problem which includes electrical thefts. The project involves current transformer, relay, transistor etc.

The current transformer acts as sensor whereas the transistor is placed to control the circuit. This circuit also includes variable resistor to determine the tripping of the circuit [20]. When overloading is sensed by the current sensor which is initially set by the variable resistor, the voltage across the sensor will also increase allowing it to trigger the transistor which controls the relay on cutting "off" the circuit connection. This will also detect the tampering with the help of the variable resistor which has been set to a dedicated value and if the value exceeds the circuit will not be able to connect with the loads. This framework would give a straightforward method to distinguish an electrical force burglary with no human interface. It would demonstrate definite zone and circulation line on which unapproved taping is done continuously [20].

2.12 Energy Meter Tempering and Power Tapping Detection System for Effective Power Theft Control

Safety of a premise using electricity is equally important as the prevention of electrical theft which is being trending in recent times. Companies tend to improvise energy saving methods a lot compared to energy meter safety and security. To break the odds, this project has been proposed to improve both security and safety of the energy meter [21]. This project consists of a theft detection circuit together with over voltage and overload detection circuit. The theft control circuit consist of a current sensor where it detects the current value entering and leaving the energy meter. This current sensor can withstand voltage measures as low as 5V up to 230V AC. Which shows that this project can be only implemented for simple household energy meter installed in a single-phase circuit. The values measured by the current sensor will be recorded by the differential amplifier to compare the values and generate any actions based on the data received. If very high difference is detected neglecting the current losses an alert message will be generated to the energy supplier [21].

Besides, a seal breaking sensor switch is also installed into the energy meter. This sensor prevents consumers to tamper the meter. This is possible because when a meter is going to be tampered the consumers should open the energy meter seal. When any seal is being tried to open the sensor sense the act and send a signal to the microcontroller installed. The microcontroller then generates the input and triggers the GSM module to send an alert message to the authorize person about the seal breaking. The GSM module will also receive replies from the other side and once the reply is received the microcontroller generates the reply and disconnects the energy meter supply. As for the safety matters, 2 different components are being used to detect over voltage and overload of the energy meter and the loads connected to the energy meter. A Zener diode is installed in the energy meter. This

Zener diode-based transistor is only compatible with AC voltage only. When input voltage increases unusually the Zener bias voltage also varies and activates the relay to disconnect the input supply. In the other hand, an overload circuit is built with current sensor. This sensor will detect the overload situations and alerts the consumers by triggering the buzzer. Optocoupler prevents the high voltage from affecting the loads connected to the energy meter [21].

2.13 IoT Based Energy Meter with Tampering Detection and Power Saving

This research proposes a method on improving Automatic Meter Reading system together with tampering detection functionality based on Internet of Things (IoT). The researcher believes the future of the world is on completely internet and proposes a system that improves the electrical field [22]. The system proposed is to modify an energy meter by making is to automatically calculate the power consumptions and detect any faults happening in the energy meter. Besides the energy meter is also be modified to prevent tampering from being happening. The aim of this proposed idea is to ease the process of billing and measuring the energy meter consumption. This will be also helpful in detecting tampering and thefts from unrecorded customer. The whole process involves some sensors, microcontrollers [22]. The sensors calculate the total consumptions of the certain premise and send the data to the Arduino microcontroller. The data from the Arduino is then transmitted to the energy supplier board to prepare the billing and send it back to the users through IoT. Whereas the tampering of the meter is also detected using the help of sensor by calculating the energy entering the energy meter and after the energy meter. If the value of both the calculations did not match the data tampering is detected. The data is sent to the electrical board and further actions will be taken down.

2.14 A Smart Prepaid Energy Metering System to Control Electricity Theft

The paper talks about a highly secured tampering detection system which involves GSM modem and module [23]. The researcher has identified ways of tampering is done and have come out with several ways on detecting and preventing the tampering from happening. The objective of the project is to prevent tampering and ensure correct amount of billing for the energy has been used [23]. Prepaid system is used in this project to achieve the objective of the project. The researcher has proposed a method of buying electrical units using the same method of recharging mobile prepaid phones. For instance, if a premise needs 200 units of electricity, the consumer will have to buy scratch ticket and send the secretive pin number to the energy supplier through SMS. Once the supplier gets the text message verifications will be done and the information will be sent to the GSM modem installed in the energy meter and the meter will be activated. After arriving to the limit consumers will have to recharge by repeating the steps again.

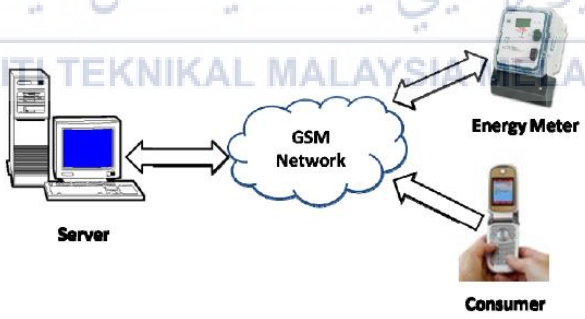

Figure 2.17 Prepaid Metering System [23]

To achieve the rest of the objective researcher have modified the energy meter with some components installed together with the energy meter [23]. For the 1st type of tampering which is shortening the phase line or disconnecting the neutral line, the current sensor and the potential sensor installed in the meter will play a big role. When the phase line is

shortened the current sensor will not be able to measure and current value and the microcontroller will directly trigger the relay and cuts the connection between the energy meter and the load. At the meantime, an alert message through the GSM modem to the server will be sent.

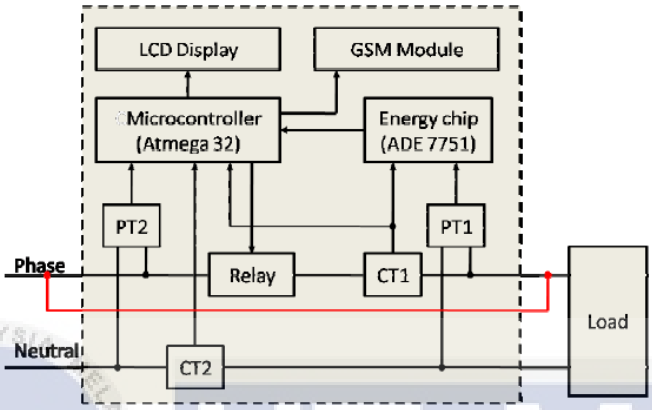

Figure 2.18 Phase line Shortening [23]

The 2nd method is bypassing the whole meter [23]. To perform this tampering the whole meter should be disconnected from the supply. The phase line and the neutral line will be directly connected to the household. During this process the energy meter records no reading. The sensors will be supplied with backup battery. Yet the sensor will be unable to record any readings. The situation will be noted by the Arduino and the Arduino requests electricity status of the surrounding area of the energy meter to the server. If the server replies back with an unfavorable reply with the situation the meter than immediately disconnects the connection between the load of the household and informs the electricity board of the meter tampering.

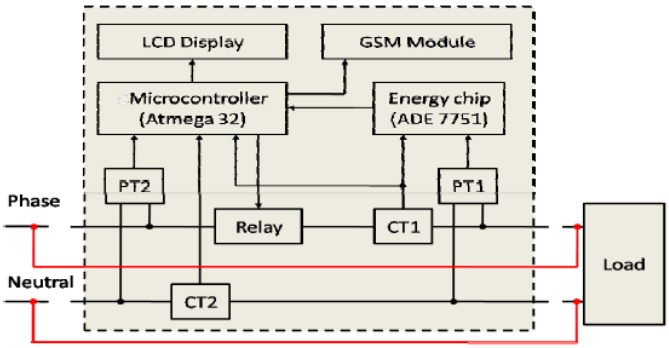

Figure 2.19 Energy Meter Bypassing [23]

2.15 Comparison Between Methods

At the end of this chapter, it has been identified several effective methods which was implemented to prevent and solve electrical theft. A comparison can be carried out to identify the most effective and cost-saving method to develop the tampering detection method which have been proposed.

Table 2.1 Methods Comparison

Types of Tampering	Methods of Tampering	Prevention Method	Communication Type
Energy Meter Tampering	Current Bypass Method	Adding Current Sensor into energy meter to compare Pin and Pout. If difference identified alert message sent to the energy supplier.	GSM
Cable Hooking	Tapping Current directly from distribution cable	Adding Current sensor at distribution pole and before load. Monitor the power if difference noticed inform to nearest substation	GSM

Energy Meter Tampering	Neutral Current and Phase Reverse	Adding current sensor and potential sensor to monitor the total current and voltage used and calculate power consumption. Produce and monitor accurate reading of power consumption	GSM
Cable Hooking & Energy Meter Tampering	All types of Low Voltage electrical theft	RMR installed in all premises. Monitoring and inspection process takes places for every 30 minutes for 30 days. Record the data. Data collected will be referred to identify electrical theft.	IoT
Energy Meter Tampering and Power Tapping	Current Bypass Method	Current sensor is installed in the energy meter to compare the current input and current output of the energy meter. If difference is noticed alert message is sent to the enegy supplier. Seal breaking sensor is added to prevent tampering from happening	GSM

2.16 Summary

As a summary, all the article which have been reviewed and researched gives a wider perspective of power theft and energy meter tampering. This gives me a better chance in understanding several methods of tampering and a deeper information about energy meters. Besides, it has also provided a better clarification of working of the energy meter which is very important to take note in this proposed design. This chapter have also made me understand several actions and the penalties was taken if any meter tampering detected in this country. The research made have answered the purpose and necessity of my project. The research made in all the articles stated above made clearly solved the problems in several different methods. The steps taken in all the research have provided much easier idea in upgrading and modifying the proposed design in my research. In conclusion, this chapter will be very helpful in completing my proposed idea on avoiding energy meter tampering due to the ideas which have been brainstormed in the above articles.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter will introduce the various stages of the design process from brainstorming to final product design. The first step involves understanding the various functions and specifications of the product or service that is being designing. Besides, this chapter is also requires including input and the output of the and detailed explanations of workflow for the proposed design. Moreover, the expected cost, flowchart, block diagram and initial results of the project will be added.

3.2 Materials

There are several materials which will be very useful in creating this meter tampering detection system. These materials will be divided into 2 parts. The first part includes components needed to design the hardware of the detection system and the second part includes the software used in this design in order to make the hardware produce the desired output. Examples of the hardware needed is microcontroller, movement sensors, GSM modem etc. As for the software, a coding software is needed to program the microcontroller and a designing software is needed to check the workability of the proposed design.

3.2.1 Hardware Requirement

3.2.1.1 Arduino UNO Microcontroller

A microcontroller is a similar thing to a computer. A computer has several parts to do its functionality, same goes to a microcontroller which consists of several parts integrated into such as CPU, memories, and the serial interface etc. There are many types of microcontrollers boards are available in the market. The most common microcontroller board which also be used in this project is Arduino UNO microcontroller. Arduino UNO is open-source electronic prototyping board which is able to be programmed using Arduino IDE. The program language used is C or C++ making it easier to program. The type of microcontroller installed in this board is Atmega328P. The program written using the IDE will be uploaded to the microcontroller through USB port in the Arduino board. The board also consists of analog and digital pins. These pins can act as both input and output sources. All the components used in this project will be connected to the Arduino UNO board in order to control and generate desired output [24].

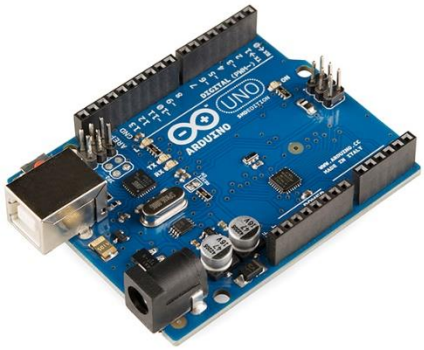

Figure 3.1 Arduino UNO Microcontroller [24]

3.2.1.2 Infrared Sensor (IR Sensor)

IR sensor is the acronym of infrared sensor [25]. This sensor senses the infrared radiations in the surrounding of the sensor. There are two types of IR sensor available which are active IR sensor and passive IR sensor. Active IR sensor could emit and receive infrared radiations whereas the passive sensor is only capable of receiving infrared light radiation from the surrounding. IR sensor consists of several important parts which includes, photodiode, light emitting diode, LM 358 (OP-Amp) and resistors. The light emitting diode acts as the transmitter of the IR sensor when certain amount of voltage is given. Then photodiode acts as a receiver of the IR sensor. The whole operation is controlled by the LM 358 (OP-Amp). The working principle of the sensor involves both the emitting and the receiving diode. The infrared light rays are emitted from the transmitter diode for a certain distance calculated in centimeters. If the rays are interfered by any object in the certain distance the rays will get reflected to the receiver diode of the IR sensor. This situation states that the IR sensor detects the presence of an object. Whereas if the receiver is not able the receive any infrared ray from a certain distance show that there is no object is present in that distance. This principle is used in this project where, during the meter cover is remain close the IR sensor will be able to sense the cover of the energy meter. If the cover is removed or opened, the sensor will not be able to receive any rays and it will trigger the Arduino [25]

Figure 3.2 Infrared Sensor (IR Sensor) [26]

3.2.1.3 GSM SIM 900A

GSM modem is a device that used to make a communication contact between computers or any other programmable devices with a network. GSM modems can be represented by mobile phones or a simple modem. This modem requires a SIM card to be activated and connects the network within the registered network range by the network operator. There are basically 3 main pins in the GSM module, which are the power supply pin, transmitter pin and the receiver pin. These 3 pins are connected to the Arduino UNO pins. For instance, if the program has declared pin 10 of the Arduino as the input, the receiver pin RD should be connected to pin 10. Same goes for the receiver if pin 9 is declared as the output the transmitter pin, Txd should be connected to pin 9. Finally, the ground of both the boards should be connected. If the connection is successful, the module will be able to send and receive messages with an active SIM card [27].

Figure 3.3 GSM SIM900A [27]

3.2.1.4 Buzzer (5V)

Buzzer is an integrated design of DC supply and electronic transducers. This component is normally found in alarm clocks, kids' toy, cellphones, and more things which use produces sound. The function of buzzer is to emit sound when the component is triggered. There are 2 types of buzzers available in the market: active buzzers and passive buzzers. Active buzzer basically generates own sound by just connecting the pins to the right port in the Arduino. Whereas the passive buzzer requires an external sound signal to control the sound. This action is done by connecting the pins to the PWM port of the Arduino board. The buzzer used in this project is the active buzzer. Pins are declared in the IDE program and the connections are made. The buzzer consists of 3 pins: VCC, I/O, GND. The VCC is connected to the power pin (5V) of the Arduino, the GND is connected to ground of the Arduino and the I/O is connected to the declared digital pin of the Arduino board [24].

Figure 3.4 Buzzer 5V [28]

3.2.1.5 Jumper Wires

Jumper wire is also known as DuPont wire. This is a current conductive wire used to connect electrical components. Current pass through these wires from one end to another to complete the current circuit. Jumper wires are also included with a connector in both sides of the wire. This eases the connections between components which are placed in the breadboard or to solder the ends of the wires to the specific components. Jumper wires are very helpful in modifying a circuit or to even diagnose a problem of a circuit.

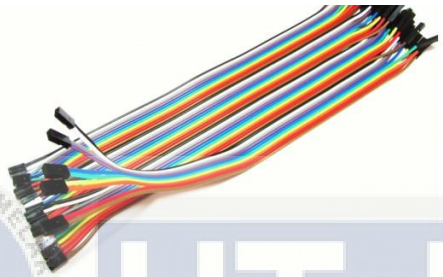

Figure 3.5 Jumper Wires [29]

3.2.1.6 12V Adaptor

A 12V AC adaptor is an external power supply for electrical components which use DC input. This adaptor converts AC voltage into DC voltage. This adaptor is commonly used to power up electrical devices such as smartphone batteries, Television etc. In this project, the adaptor is used as power supply for the GSM SIM 900A module and the Arduino.

Figure 3.6 12V Adopter [30]

3.2.1.7 Liquid Crystal Display

Liquid Crystal Display (LCD) is a component vastly used in the arduino world. This is a component which is uses plane panel display technology. This can be mostly seen in billing machines, ticket counter machines and etc where only a small amount of number and text is required to be displayed. The LCD type used in this project is 16x2, where is consists of 16 columns and 2 rows. Therefore a total of 32 characters can be displayed at a single time which includes alplabets, numbers and special characters. In this project LCD is used to display texts that will be programmed with the help of Arduino UNO.

Figure 3.7 LCD 16x2 [30]

3.2.2 Software Requirement

3.2.2.1 Arduino IDE

The Arduino Integrated Development Environment is a cross-platform application which is written in the programming languages such as JAVA. The IDE software is used to write and upload programs into the Arduino board. This IDE is support in all the computer software such as Window, Mac OS, and LINUX. The language used to write the programs is basically C or C++. Arduino IDE is used in this project because the interface of the program is simple, and it can support mostly all types of Arduino board which includes Arduino UNO board. IDE includes a built-in library. Using this library, we are able to program all types of components available in the library such as buzzer, GSM SIM900a modem etc. Pins will be declared in this program to ensure the correct input and output of the project. The functionality of the program will be tested first using a simulation software which will be used in this project. This ensures the user to correct or modify the program to the desired output easily. Once the program has been completed writing and testing, it will be then uploaded into the Arduino board via using a USB cable which connects the board to the computer [24].

Figure 3.8 Arduino IDE Interface [24]

3.2.2.2 Proteus Software

There are multiple amounts of software available to construct a simple electrical schematic circuit. Proteus software is one of the application available. Proteus applications is mainly used for designing a circuit diagram or constructing a PCB design. The purpose of this software is used to design the prototype working schematic diagram of the proposed project. The library of the applications consists of all the components which will be used in this project, such as Arduino UNO, IR sensor, buzzer etc. Certain libraries will be installed to enable the use of rare components such as GSM SIM900a Module. Proteus design is also very compatible with Arduino IDE. Programs written in IDE can be easily uploaded into Arduino UNO in Proteus software. Besides, this software will be also helpful in determining the workability and functionality of the circuit and allows the users to improve or modify the circuit without any direct interaction to electricity [31].

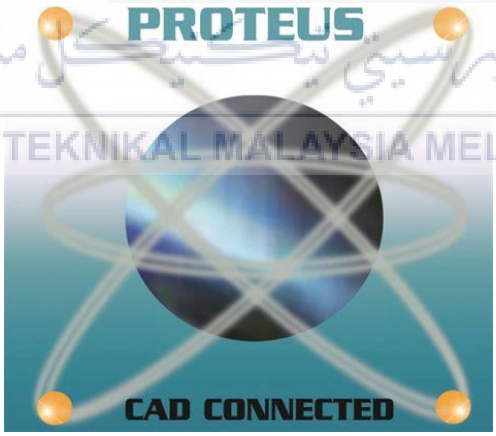

Figure 3.9 Proteus Software [31]

3.3 Flow Chart

Flow chart is one of the most essential methods on explaining the workflow of a project. This talks about the steps and process will be done to get the desired output of the project. By using the graphical reference, viewers will be able to understand the process and the workflow of the project. This is because flowchart is built using different shapes which represent different commands of the project, such as decision making, display, merging, etc. In this project, the workflow as follows: The IR sensor installed in the energy meter will detect the cover opening of the meter and sends signal to the Arduino microcontroller. The microcontroller then processes the signals and sends AT commands to the GSM module to send an alert message to the owner of the location and the TNB authorize person. Parallelly, Arduino also sends digital signals to the buzzer to create an alarm sound to notify people around the energy meter about the tampering.

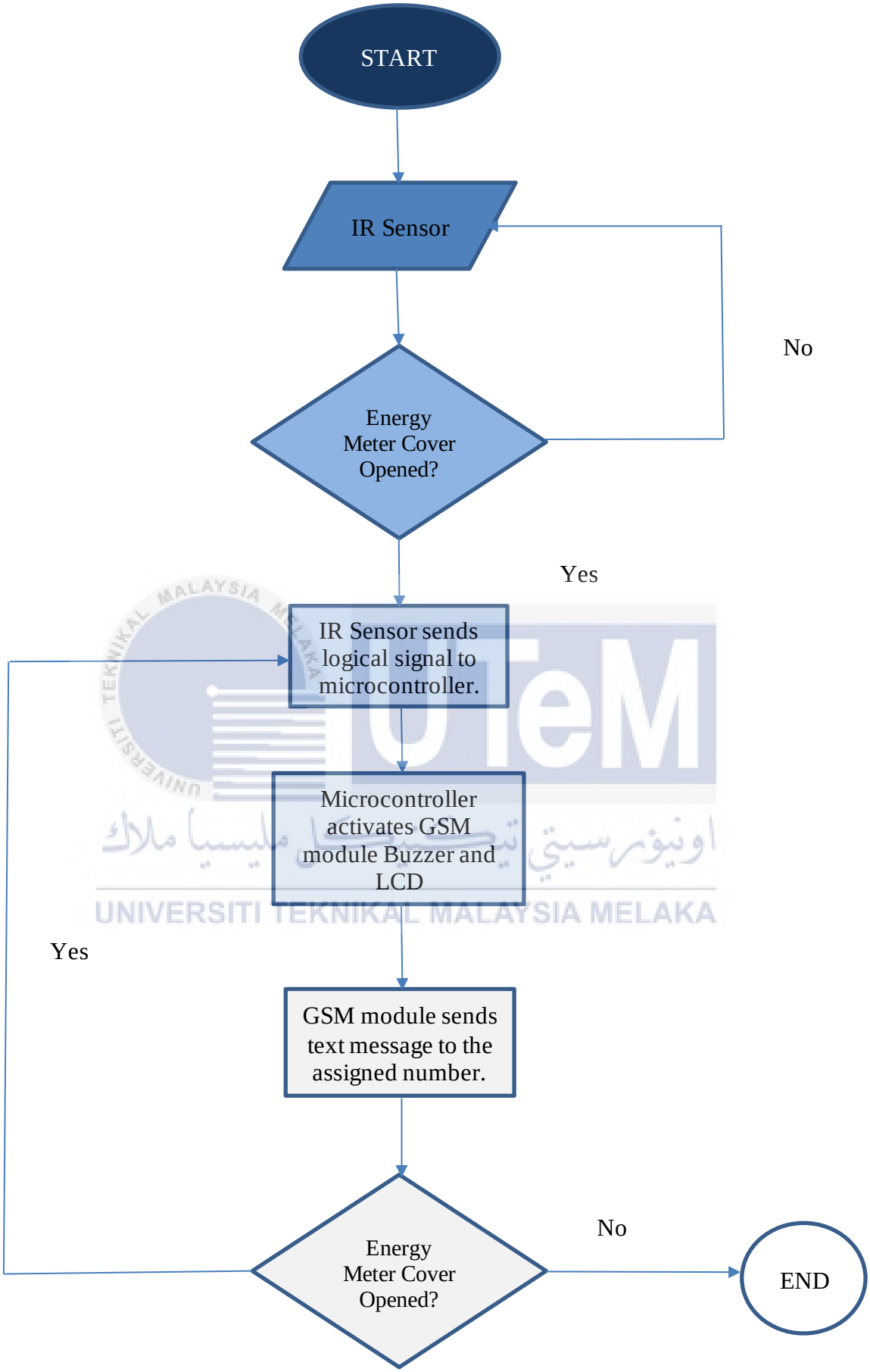

Figure 3.10 Flow Chart

3.4 Circuit Design

Circuit design is a process of constructing a design through a dedicated software. This ensures the workability and functionality of the circuit without any direct interactions to the circuit. Circuit design software is very helpful by making the constructor to notice the fault in the circuit and modifying it without any hazard. Any upgrade to the circuit can be also easily done.

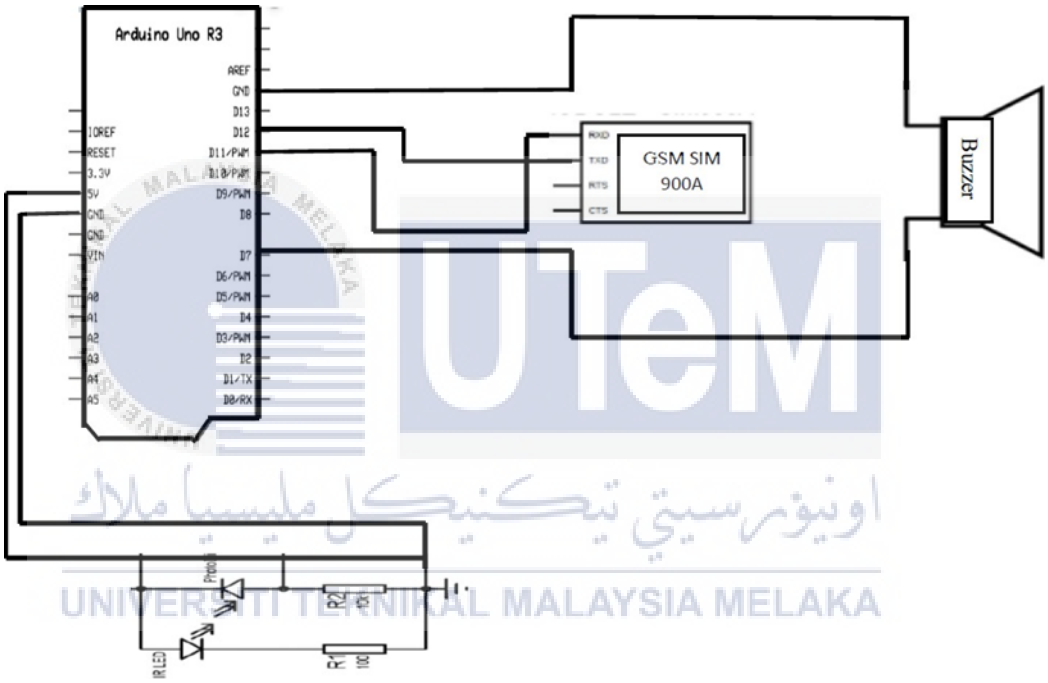

Figure 3.11 Circuit Diagram

3.5 Block Diagram

Block diagram basically refers the working of a proposed project. Block diagram includes all the input and output of the project. This does not explain the workflow but gives a wide view of the components and roles of the components been used. Block diagram are basically considered as the simpler version of schematic or layout diagrams. The block below shows the input and output of the project and will be elaborated in detail on the working of the project done.

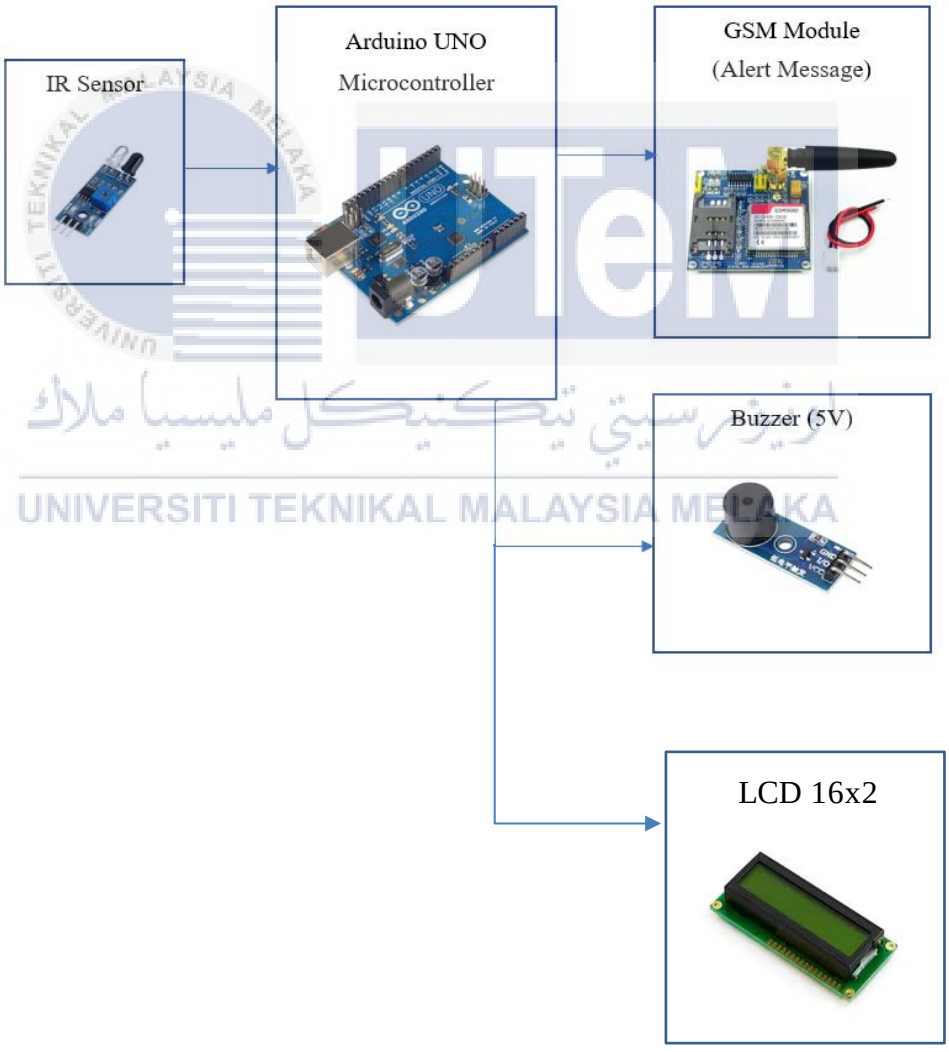

Figure 3.12 Block Diagram

3.5.1 Block Diagram Explanation

The block diagram above illustrates the input and the output of the project. As mentioned, the input of the project is Infrared Sensor (IR sensor). Whereas the outputs of the project are alert message generated from the GSM module and buzzer. The purpose of this project is to detect and prevent tampering from taking place. This project improves the security system of the energy meter. To tamper an energy meter, the wiring connection inside the energy meter should be modified to make the meter to produce false measurements. This can be only done by opening the meter cover because the measuring system is protected by the cover.

Therefore, an IR sensor will be pre-installed in the energy meter cover. Supposedly, the meter cover is being opened the IR sensor will detect the difference in the environment and immediately sends a logical signal to the Arduino Uno. The microcontroller then processes the signals and send an alert message to the owner and the authorized person in TNB through the GSM module. In the meantime, microcontroller will also send high signal to the buzzer to make the buzzer create an alert sound to the surrounding and the LCD will display a warning text. The alert message sent through the GSM module will contain the location of the energy meter cover is opened. This helps the owner and the authorized person in TNB to take immediate action towards the situation created. In simple, whenever the cover is opened buzzer sound and the alert message will be created. This improves the security of the energy meter and avoids consumers to tamper their meter because their act will be under a serious surveillance.

3.6 Cost Analysis

Table 3.1 Cost Analysis

No.	Components	Quantity	Cost per Unit	Total Cost
1.	Arduino UNO	1	RM 109.00	RM 109.00
2.	IR sensor	1	RM 7.00	RM 7.00
3.	GSM SIM900A	1	RM 45.00	RM 45.00
4.	Buzzer (5V)	1	RM 5.00	RM 5.00
5.	Jumper Wire set	3	RM 4.00	RM 12.00
6.	12V adaptor	1	RM 15.00	RM 15.00
7.	LCD 16x2	1	RM 15.00	RM 15.00
			Overall Cost	**RM 193.00**

3.7 Gantt Chart

Table 3.2 Gantt Chart

FINAL YEAR PROJECT 1		MARCH 2021			APRIL 2021				MAY 2021				JUNE 2021		
		15.3 – 2.4			5.4 – 30.4				1.5 – 28.5				31.5 – 18.6		
NO	TASK	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	• Project proposal • Project approval														
2	• Discuss and improve project idea. • Writing Project report Chapter 1														
3	• Chapter 1 project report correction- scope and problem statement • Make draft for Project Report Chapter 2 • Research on methods of energy meter tampering														
4	• Writing Project report Chapter 2 • Presentation of work progress.														
5	• Research on hardware and software to be used.														

6	• Chapter 2 project report correction														
7	• Writing Project report Chapter 3														
8	• Project Simulation														
9	• Project progress 2														
10	• Presentation and Submission														
FINAL YEAR PROJECT 2		October			November				December				January		
		4.10 – 29.10			1.11 – 30.11				1.12 – 22.1				29.12 – 14.1		
NO	TASK	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1	• Designing circuit and writing coding.														
2	• Conducting project design analysis.														
3	• Buying required components														
4	• Constructing circuit														
5	• Implementation on hardware to see results.														
6	• Record results														
7	• Completing Chapter 4														
8	• Completing Chapter 5														
9	• Project progress 3														
10	• Presentation/Submission														

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will discuss about the results which will be obtained by implementing this project. The hardware and software of this project is designed and built using the components mentioned in the earlier chapter. The effectiveness and the preciseness of the project is ready to be test in field in terms of the hardware and software. The data acquired from the test will be utilized to make alterations to the designed circuit if required.

4.2 Hardware Design

Figure and figure shows the designed prototype of the project which reassambles the energy meter. This shows the real time connections and placements which has been designed. The IR sensor as decided have been placed right under the energy meter box opening in order to sense the enviromental change which is the opening and closing of the energy meter box. The GSM module and the buzzer is placed inside the energy meter to ensure the safety of the components. Besides placing the buzzer in a closed space compared to open space helps in producing greater volume of sound. As for the LCD, it is placed on the cover of the meter where users are able to read the text written in the coding, such as a warning text when the cover is open. The heart of the project which is the Arduino UNO microcontroller is also placed inside the prototype to protect it from any hazards such as enviroment or human interactions

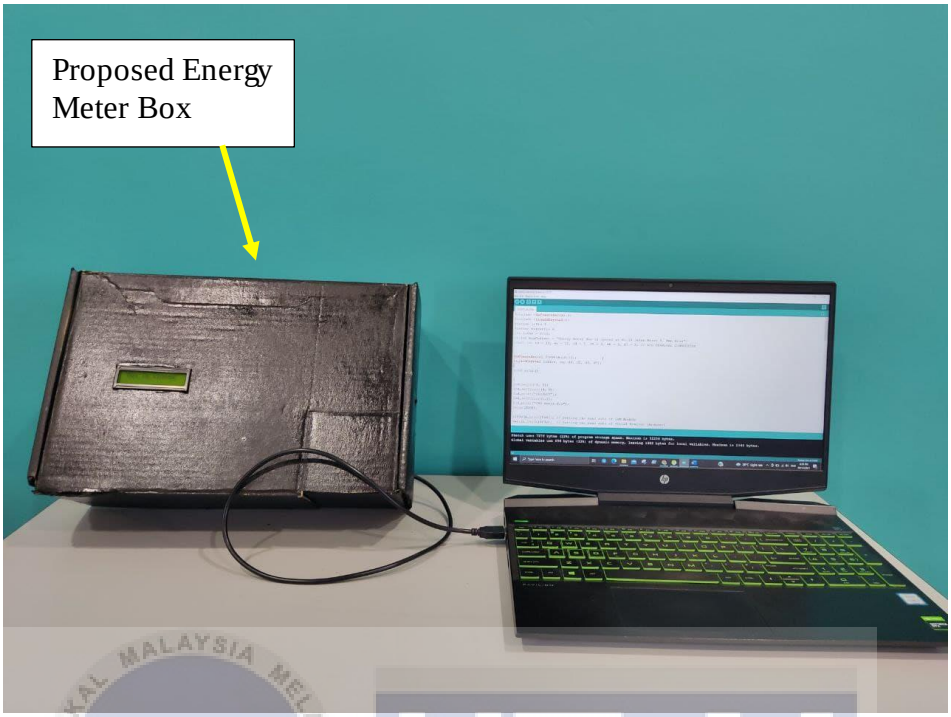

Figure 4.1 Proposed Prototype of Engery Meter Box

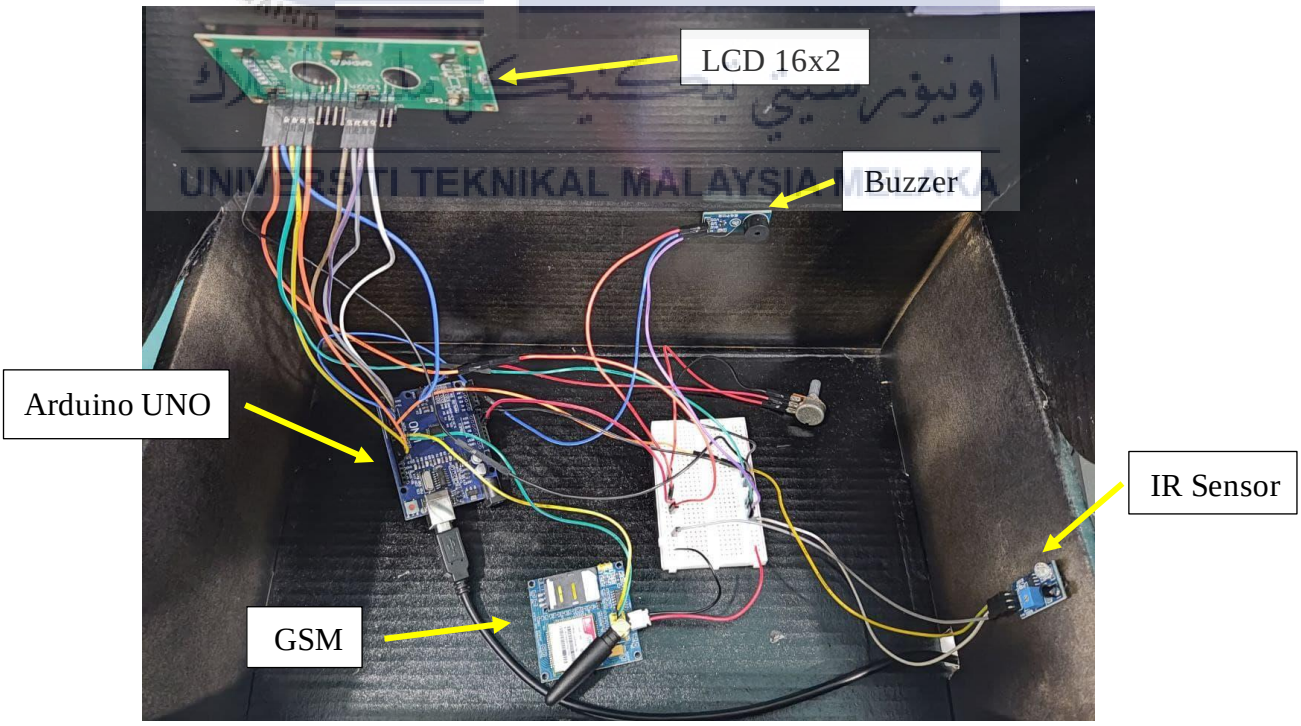

Figure 4.2 Distribution of Components

4.3 Software Design

As mentioned in the previous chapter, software used to design this project are Arduino IDE and Proteus. All the components used in this project are programmed via Arduino IDE. The coding is then uploaded into Proteus to test the workability and the functionality of the coding. After testing the program, the coding is then tested by uploading it to the Arduino UNO microcontroller. Each component is programmed to their specific function which complies the project design.

4.3.1 Arduino Instruction Programming for IR Sensor

The IR sensor is the input of the entire project. The IR sensor sense the change in the circumstances which is the opening and closing of the energy meter box. The IR sensor is programmed in a reverse mechanism where, when the IR sensor is input is high the entire operation will be null. Once the IR sensor sense the change in the surrounding the input is low and Arduino takes on the following steps and actions to be done.


```
if (irVar == LOW)
{
Serial.println("IR : Box Close");

lcd.clear();
lcd.setCursor(1, 0);
lcd.print("IR : Box Close");

digitalWrite(buzzerPin, HIGH);
delay(1);
}

else
{

Serial.println("IR : Box Open");
lcd.clear();
lcd.setCursor(1, 0);
lcd.print("IR : Box Open");
```

Figure 4.3 IR Sensor Coding

4.3.2 Arduino Instruction Programming for IR Sensor

The GSM module the main output of the project. The GSM module plays an important role by sending alert messages to the number programmed using the Arduino IDE. The GSM continuously sends messages to the dedicated numbers until the IR sensor is turned into high input. Once the IR sensor sense the box is closed GSM module will stop sending alert messages to the dedicated numbers. Once the GSM module has established connection with the network serial monitor will print "SIM 900A Ready". As the IR sensor sends signals to the Arduino GSM module will generate the text message which has been programmed in the coding. The serial monitor will print the entire steps and procedure done by the GSM module during that period.

```
void SendMessage()

{
Serial.println ("Sending Message 1");

SIM900A.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
delay(1000);
Serial.println ("Set SMS Number");

SIM900A.println("AT+CMGS=\"+601133528103\"\r"); //Mobile phone number to send message
delay(1000);

Serial.println ("Set SMS Content"); SIM900A.println(msgContent);// Messsage content     NUMBER 1
delay(100);
Serial.println ("Finish");

SIM900A.println((char)26);// ASCII code of CTRL+Z
delay(1000);
Serial.println (("Message has been sent"));
```

Figure 4.4 GSM Module 1st Number Coding

```
void SendMessage2()

{
Serial.println ("Sending Message 2");

SIM900A.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
delay(1000);
Serial.println ("Set SMS Number");

SIM900A.println("AT+CMGS=\"+601133071570\"\r"); //Mobile phone number to send message
delay(1000);

Serial.println ("Set SMS Content"); SIM900A.println(msgContent);// Messsage content     NUMBER 2
delay(100);
Serial.println ("Finish");

SIM900A.println((char)26);// ASCII code of CTRL+Z
delay(1000);
Serial.println (("Message has been sent"));
```

Figure 4.5 GSM Module 2nd Number Coding

4.3.3 Arduino Instruction Programming for Buzzer and LCD

Buzzer and the LCD represents as the output of this project. Both the components are used to alert the surrounding people about the opening of the energy meter box. The LCD is to warn and alert the person right beside the energy meter box. Whereas the buzzer is to alert and warn the people around surrounding for a certain distance of radius. When the IR sensor is high input, the buzzer is set not to produce any alert sound. Once the IR sensor is set to low input the buzzer is programmed to produce a loud sound where the buzzer tone is set to 500. As for the LCD, text has been programmed to display during the IR sensor is low and high, The LCD prints 'Warning!!! Close The Box' and 'Box is Closed' respectively.

```
Serial.println("IR : Box Open");
lcd.clear();
lcd.setCursor(1, 0);
lcd.print("IR : Box Open");


while (irVar != LOW)
{
irVar = digitalRead(irPin);
tone(buzzerPin, 532, 500);
```

```
Serial.println("IR : Box Close");

lcd.clear();
lcd.setCursor(1, 0);
lcd.print("IR : Box Close");

digitalWrite(buzzerPin, HIGH);
delay(1);
}
```

Figure 4.6 Buzzer and LCD Coding

4.3.4 Declaration of Arduino Pins

After all the libraries have been integrated into the code, a process of identifying all of the analogue and digital pins used in the Arduino UNO board should be carried out. The goal of this identification is to identify each component port pinned into the Arduino board by noting each component name, pin that has been pinned, and a description of the component pins and their functions. The integrals and pins that were declared in this project are listed in Table 4.1.

Table 4.1 Declarations of Pin

Component	Pin	I/0	Description
Infrared Sensor (IR Sensor)	7	Input	The IR sensor consists of 3 pins on which the VCC is connected to the 5V pin on the arduino, the GND is connected to the ground pin of the Arduino and the I/O pin the connected to digital pin 7 of the Arduino
GSM Module	10,11	Output	The GSM sim consists of 4 pins which is the Vcc, GND, Rx and Tx. The Vcc and the GND are respectively connected to 5V and the GND pin of the Arduino. As for the Rx is connected to digital pin 10 and the Tx is connected to pin 11
Buzzer	6	Output	The buzzer consists of 3 pins on which the VCC is connected to the 5V pin on the arduino, the GND is connected to the ground pin of the Arduino and the I/O pin the connected to digital pin 6 of the Arduino
Liquid Crystal Display (LCD)	2,3,4,5, 12,13	Output	The LCD consists of 6 pins in which the d4 to d7 are connected from digital pin 2 to pin 5 respectively and the Rs and En of the LCD are connected to digital pin 12 and 13.

4.4 Software Design

The circuit is designed using the Proteus software by creating a simple circuit diagram of the proposed project. This circuit diagram consists of infrared sensor, Arduino Uno, buzzer, LED, and LCD. Proteus software is not included with the GSM Module library. Therefore, as an alternative, LCD is used to represent the GSM modem which will be used in the actual hardware. The input for the IR sensor is given by using the logic toggle switch. The high input states the energy meter cover is closed; therefore, the IR sensor detects the obstacle in front. When the toggle is reduced to low input which means the energy meter cover is opened and no obstacle is detected. The buzzer will quickly produce an alert sound together with the LED light which lights up. Whereas the LCD screen will print out a message saying, "Represent GSM". In the actual hardware, the LCD will be replaced by the GSM Module and an alert message will be sent to the dedicated mobile numbers which is registered in the Arduino.

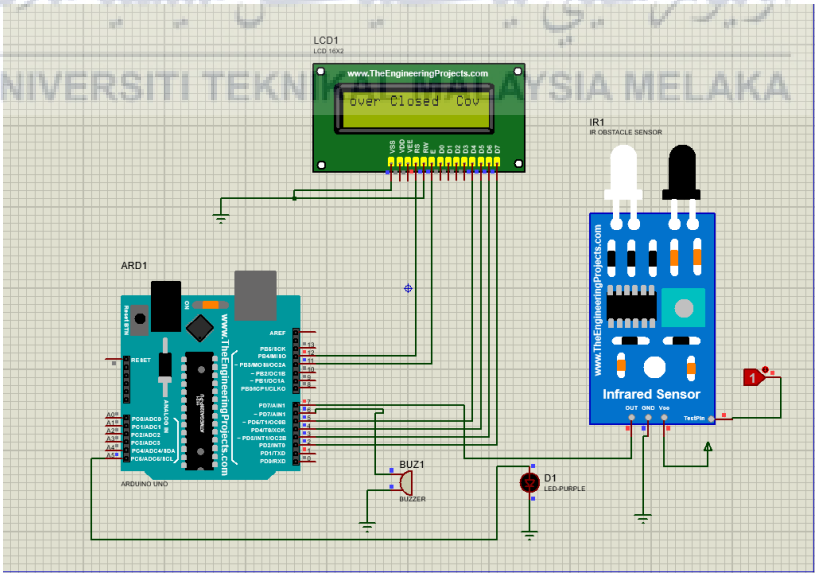

Figure 4.7 Circuit Simulation

4.5 Field Test Results

The result the that the project has produce upon completion is, the IR sensor is able to detect any obstacle difference in the energy meter cover. The IR sensor is triggered and sends logical signals to the Arduino UNO when the meter cover is removed. This shows that the IR sensor is programmed in a reverse operation where the input of the IR sensor turns low the rest of the circuit will function. As the IR sensor is triggered the Arduino UNO received the signals. The Arduino then process the signals and produced and output of triggering the GSM modem connected to the Arduino UNO and the buzzer simultaneously. The GSM modem then sent an alert message to two different mobile numbers which is programmed in the Arduino.

The message content sent by the GSM module is 'Energy Meter Box is opened at No.10 Jalan Merak 9, Tmn Desa'. The numbers that will be programmed are the owner of the energy meter and an authorized person by the energy meter supplier such as TNB. The numbers programmed and the location of this program installed can be manipulated. As for the buzzer, it created a loud alarm kind sound to alert the surrounding of the tampering which will occur. The results have achieved the objectives of the project by improving the security system of the project. This will avoid tampering from being happening and thus will secure proper billing system

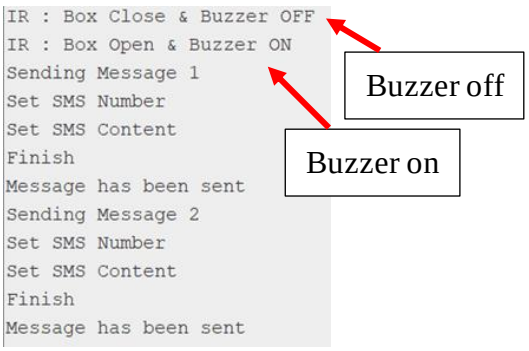

Figure 4.8 Buzzer On Indicator

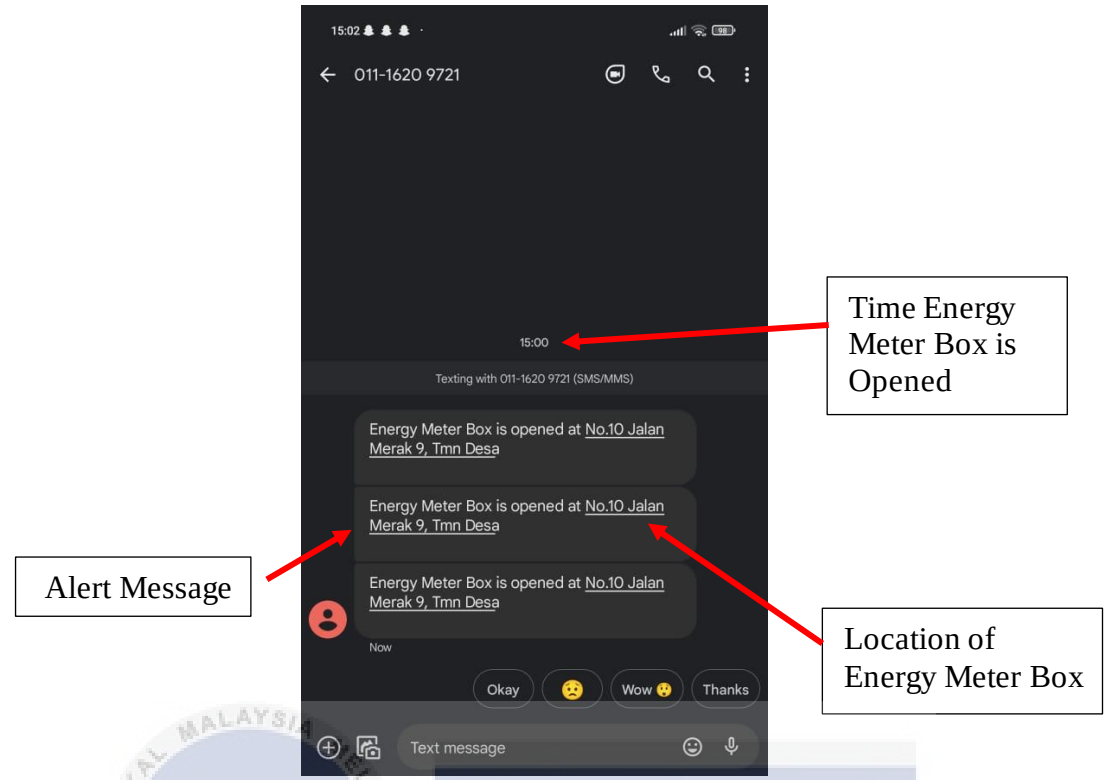

Figure 4.9 Alert Message Recived from GSM Module

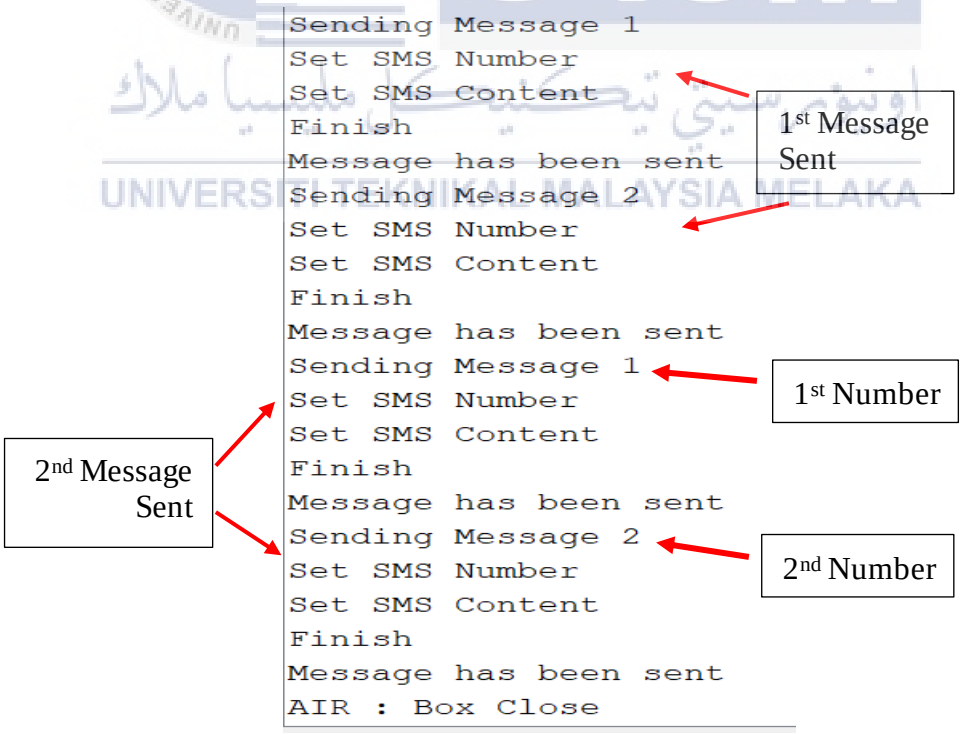

Figure 4.10 Serial Monitor Results

To ensure the continuation of the message is present several tests have been carried out. The experiments carried out in different time intervals to ensure the GSM module is generating the alert messages and sending to the assigned numbers. The experiment conducted with a time interval of 30 secs. This allows the consumers to get information on the duration the energy meter box is opened by noticing the number of messages is recieved from the GSM module in the certain time interval.

Figure 4.10 shows the number of messages recieved when the energy meter box is opened for 30 seconds. The total number of messages recieved is 4. Both numbers assigned in the Arduino recieved the same number of alert messages at the similar time.

Figure 4.11 Alert Messages Recieved in 30 seconds

```
IR : Box Open
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
```

```
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
AIR : Box Close
TIR : Box Close
+IR : Box Close
CIR : Box Close
MIR : Box Close
GIR : Box Close
FIR : Box Close
=IR : Box Close
1IR : Box Close
IR : Box Close
```

Figure 4.12 Serial Monitor Results for 30 seconds

Figure 4.12 shows the number of messages recieved when the energy meter box is opened for 60 seconds. The total number of messages recieved is 6. Both numbers assigned in the Arduino recieved the same number of alert messages at the similar time.

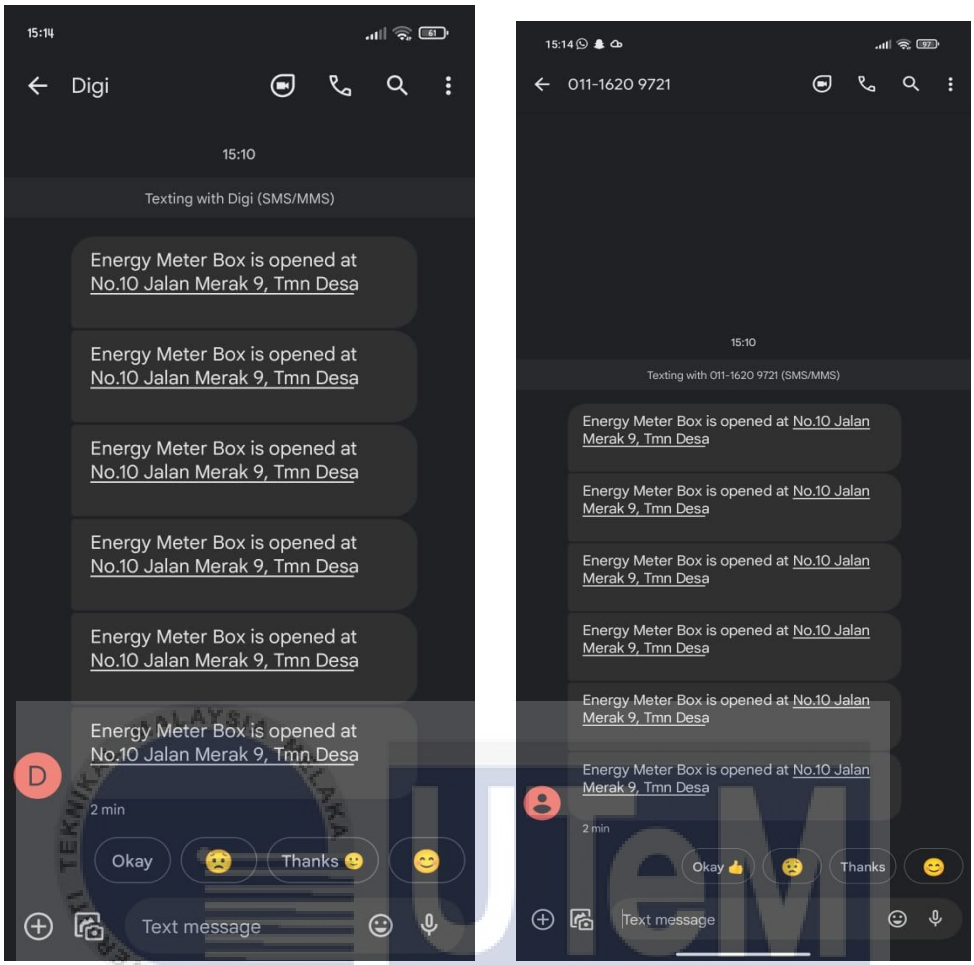

Figure 4.13 Alert Messages Recieved in 60 seconds

```
IR : Box Open
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
AIR : Box Close
```

Figure 4.14 Serial Monitor Results for 60 seconds

Figure 4.14 shows the number of messages recieved when the energy meter box is opened for 90 seconds. The total number of messages recieved is 9. Both numbers assigned in the Arduino recieved the same number of alert messages at the similar time.

Figure 4.15 Alert Messages Recieved in 90 seconds

```
IR : Box Open
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
```

```
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
```

```
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
```


Figure 4.16 Serial Monitor Results for 90 seconds

Figure 4.16 shows the number of messages recieved when the energy meter box is opened for 120 seconds. The total number of messages recieved is 11. Both numbers assigned in the Arduino recieved the same number of alert messages at the similar time.

Figure 4.17 Alert Messages Recieved in 120 seconds

```
IR : Box Open
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
```

```
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
```

```
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
```

```
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 1
Set SMS Number
Set SMS Content
Finish
Message has been sent
Sending Message 2
Set SMS Number
Set SMS Content
Finish
Message has been sent
AIR : Box Close
TIR : Box Close
+IR : Box Close
CIR : Box Close
MIR : Box Close
GIR : Box Close
```


Figure 4.18 Serial Monitor Results for 120 seconds

Graph Figure 4.18 shows that the number of messages received increases as the duration of box opened increases. From this result we can see that the numbers assigned are receiving the alert messages in the correct order.

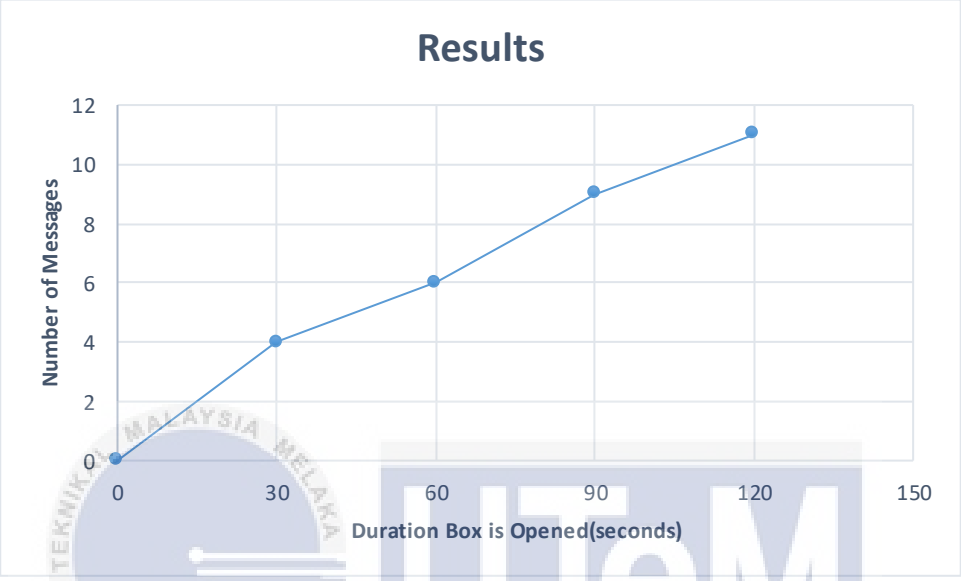

Figure 4.19 Graph of Number of Messages vs Duration

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, it will discuss about the conclusion made from implementing this project. This chapter will conclude the overall scope of the project report which was made from the first chapter to the previous chapter. It will ensure that the objectives of the project which is stated is achieved and the problems are solved by implementing this project.

5.2 Conclusion

The report chiefly comprises of five section which is presentation, writing audit, investigation, framework configuration, results and examination and decision about the altering recognition of energy meter by GSM Modem. I have accomplished my objectives by doing this proposed plan which to prevent the altering of energy meter, guarantee appropriate charging and to empower security in electric meters. The project implemented will also ensure a proper billing for the consumers and will secure the revenue of the government and helps the energy supplier to get back the return of investment. Besides, security of the energy meter will also be improved and no illegal replacements or any sort of security-based activities will be done to the energy meter. Finally, by implementing this project we can reduce the demand and supply gap slowly between the suppliers and the consumers of electricity globally. This ensures that the project have served the purpose and is being affordable for are type of users.

5.3 Future Works

Several upgrades can be done to improve the security system of this project with the help of advance technology and bigger budget. Such as:

i) Buzzer can be replaced with an alarm system which will be able to alert the surrounding with a bigger radius and higher volume.

ii) An automatic circuit breaker can be installed to cut-off the power supply using the help of GSM Module once the IR sensor senses an environmental change.

iii) GSM module can be replaced to IOT based system once rural areas gets stable access to internet facilities.

iv) Automatic billing system can be also added to the system to reduce time consumption of current billing system.

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APPENDICES

Appendix A : Coding

```
#include <SoftwareSerial.h>

#include <LiquidCrystal.h>

#define irPin 7

#define buzzerPin 6

int irVar = HIGH;

String msgContent = "Energy Meter Box is opened at No.10 Jalan Merak 9, Tmn Desa";

const int rs = 13, en = 12, d4 = 5, d5 = 4, d6 = 3, d7 = 2; // LCD TERMINAL CONNECTION


SoftwareSerial SIM900A(10,11);

LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

void setup()

{

lcd.begin(16, 2);

lcd.setCursor(4, 0);

lcd.print("PROJECT");

lcd.setCursor(1,1);
```

```
lcd.print("TNB Meter Box");

delay(2000);


SIM900A.begin(9600); // Setting the baud rate of GSM Module

Serial.begin(9600);  // Setting the baud rate of Serial Monitor (Arduino)

Serial.println ("SIM900A Ready");

delay(100);

pinMode(irPin, INPUT);

pinMode(buzzerPin, OUTPUT);

digitalWrite(buzzerPin, HIGH);

lcd.clear();

}

void loop()

{

if (SIM900A.available()>0)

{

  Serial.write(SIM900A.read());

}
```

```
irVar = digitalRead(irPin);

if (irVar == LOW)

{

Serial.println("IR : Box Close");

lcd.clear();

lcd.setCursor(1, 0);

lcd.print("Box Is Closed");

digitalWrite(buzzerPin, HIGH);

delay(100);

}

else

{

Serial.println("IR : Box Open");

lcd.clear();

lcd.setCursor(1, 0);

lcd.print("Warning!!! ");

lcd.setCursor(1, 1);
```

```
lcd.print ("Close The Box");

delay(500);

while (irVar == HIGH)

{

irVar = digitalRead(irPin);

tone(buzzerPin, 532, 500);


SendMessage();

delay(4000);

SendMessage2();

delay(2500);

}

}

}

void SendMessage()

{

Serial.println ("Sending Message 1");

SIM900A.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
```

```
delay(1000);

Serial.println ("Set SMS Number");

SIM900A.println("AT+CMGS=\"+60189604094\"\r"); //Mobile phone number to send message

delay(1000);

Serial.println ("Set SMS Content");

SIM900A.println(msgContent);// Messsage content     NUMBER 1

delay(100);

Serial.println ("Finish");

SIM900A.println((char)26);// ASCII code of CTRL+Z

delay(1000);

Serial.println (("Message has been sent"));

}

void SendMessage2()

{

Serial.println ("Sending Message 2");

SIM900A.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode

delay(1000);
```

```
Serial.println ("Set SMS Number");

SIM900A.println("AT+CMGS=\"+601133071570\"\r"); //Mobile phone number to send message

delay(1000);

Serial.println ("Set SMS Content");

SIM900A.println(msgContent);// Messsage content     NUMBER 2

delay(100);

Serial.println ("Finish");

SIM900A.println((char)26);// ASCII code of CTRL+Z

delay(1000);

Serial.println (("Message has been sent"));

}
```