

Theft Control Based Master Meter Using Different Network Technologies

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Abstract

The power theft is one of the main problems facing the electric energy sector in Iraq, where a large amount of electrical energy is lost due to theft. It is required to design a system capable of detecting and locating energy theft without any human interaction. This paper presents an effective solution with low cost to solve power theft issue in distribution lines. Master meter is designed to measure the power of all meters of the homes connected to it. All the measured values are transmitted to the server via GPRS. The values of power for all energy meters within the grid are also transmitted. The comparison between the power of the master meter and all the other meters are transmitted to the server. If there is a difference between the energy meters, then a theft is happened and the server will send a signal via GSM to the overrun meter to switch off the power supply. Raspberry pi is used as a server and equipped and programmed to detect the power theft.

KEYWORDS: Power theft, Raspberry pi, GSM, GPRS.

I. INTRODUCTION

The main objective of installing an energy meter in consumer buildings is to allow the consumer to access the meter to know its consumption. Besides on this, utilities do not hide the energy meter or place it in closed place, but put it within reach of the consumer. The easy accessibility of these meters made it easy for the consumer to tamper with them. This is done to reduce or eliminate the cost of energy consumption. This is called theft and is considered a criminal act. Losses from energy theft have been identified as the largest contributor to revenue losses in the distribution companies in the developing countries [1]. One of the major reasons to design smart meter is to reduce the power theft [2]. There are two types of losses in the electric sector, technical losses in power systems are naturally occurring losses, which result from the internal actions of a power system, and consist mainly of power dissipation in electrical system components such as transmission lines, transducers, and metering systems [3] [4]. Non-technical losses (NTLs) refer to losses that occur independently of technical losses in power systems. NTLs occur due to actions outside the power system, and also due to loads and conditions that technical loss calculations do not take into account. More specifically, NTLs are primarily associated with energy theft, and can also be thought of as undetected consumer loads that local utilities and electricity distribution companies don't even know exist. NTLs are difficult to measure because they are

often not countable by system operators and therefore have no recorded information [5]

The power theft is occurred in two places [6]

1. In the distribution lines.
2. In the house hold energy meters.

There are many types of power theft in the distribution lines [7]:

1. Illegal eavesdropping on the distribution lines.
2. Bypass the energy meter.
3. Damage or removal of power meter wires.
4. Tamper the energy meter.
5. Incorrect billing by meter readers.

The above method should be considered when designing proposed system. These criminal activities are allayed when appropriate power theft detection mechanisms are incorporated into the system that will be designed. There are various ways that proposed to detect power theft. Theft detection smart power [8] proposed design distributor box that is put after the distributor lines measures the current for each house and sends the values to server. Each house is sent the current to the same server through GSM, if there is any difference between two values, the theft is happened. Location tracking to detect electric theft [9] proposed multiple current transformers in the phase line and neutral line to determine the electric theft if there any difference between two readings. But this method is not effective and required high cost. The theft of power detection and location



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[10] is determined in this paper. This paper uses IR sensor and camera to detect the power theft. IR sensor is tripped when any person approach to the meter and camera takes picture for this person. But this method is not effective because IR sensor causes improper detection due to the sensitivity of this sensor to any heat signal. Power theft detection [11] designed a controller to compare between the current readings from the distribution transformer and that of home energy meter. Based on the current reading differences, the power theft detected.

This paper focuses on an efficient and economical approach to solve the problem of electricity theft in distribution lines. The proposed system detects energy theft and energy theft location of distribution transformer precisely to control of the electrical supply during theft conditions. The proposed system will process all parameters and take effectiveness of the decision without any human interaction. The proposed system uses Arduino as microcontroller, PZEM to measure power, GSM to transmit data to the server, and raspberry pi as server because its low cost and its low power consumption [12, 13]. There many objectives of this work such as :-

1. This system provides a simple way to detect power theft without any human interface.
2. The proposed system can specify the location of the theft precisely in real time.
3. It will be saved the time and the cost for the utility because the readings of all meters can be taken by wireless technique.
4. Maximizing the profit margin of the power utility by providing large amount of wasted energy.

II. PROPOSED SYSTEM

The proposed system is consisting of three parts:

1- Master meter

Master meter is the first part of this system; the main function of this meter is detecting energy theft by sending consumed power to the server periodically through hypertext transfer protocol (HTTP) via GSM as shown Fig. 1.

These values are compared with the amount of consumed power by each smart meter according to a specific programming that designed in high level languages (PHP, MySQL database, python). If the values sent by the master meter are greater than the values received from the smart meter, the power theft is happened. The server will send signal to the smart meter informing him of existence of theft. It's sending a message to the consumer's mobile informing him of the presence of an overrun on the meter.

2- Smart meter

The smart meter is the second part of the proposed system. Smart meter calculates the quantity of electricity consumption. These values transmits periodically to the work-station via HTTP protocol through GSM as shown in Fig. 2.

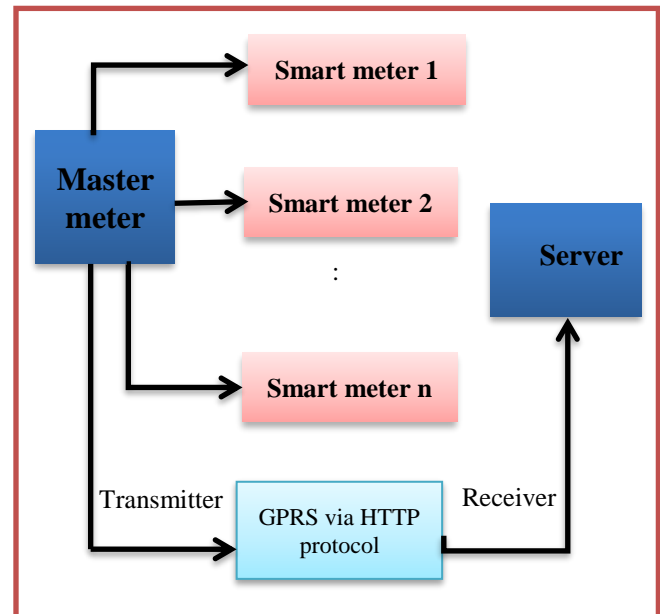


Fig. 1 The master meter connecting to server.

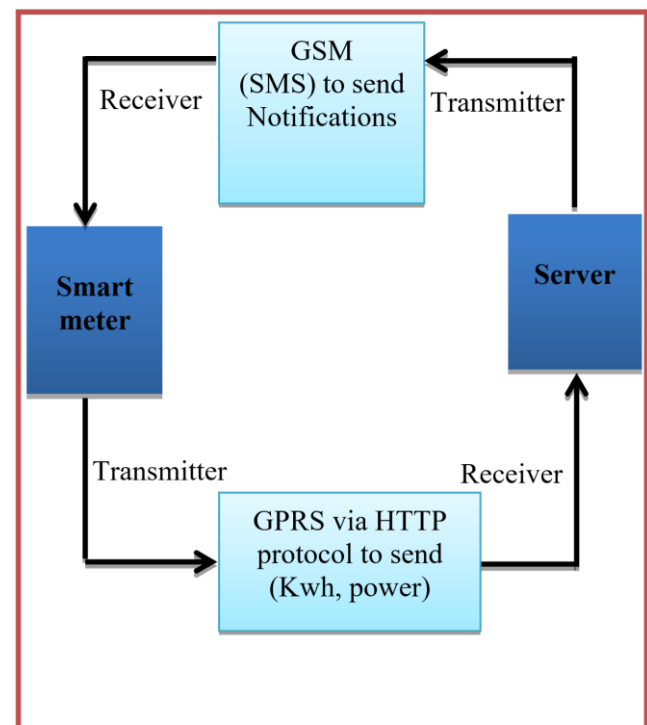


Fig. 2 The smart meter connects to server.

3- Server

The server is the third part of the proposed system and is considered the main part as shown in Fig. 3. It receives data from all smart meters connected to the grid and also from the main meter through HTTP protocol via GSM. This data is saving in data-base, processed for the purpose of billing depending on the tariff issued by ministry of electricity. Sent the billing amount to the phone of each consumer via SMS and e-mail.

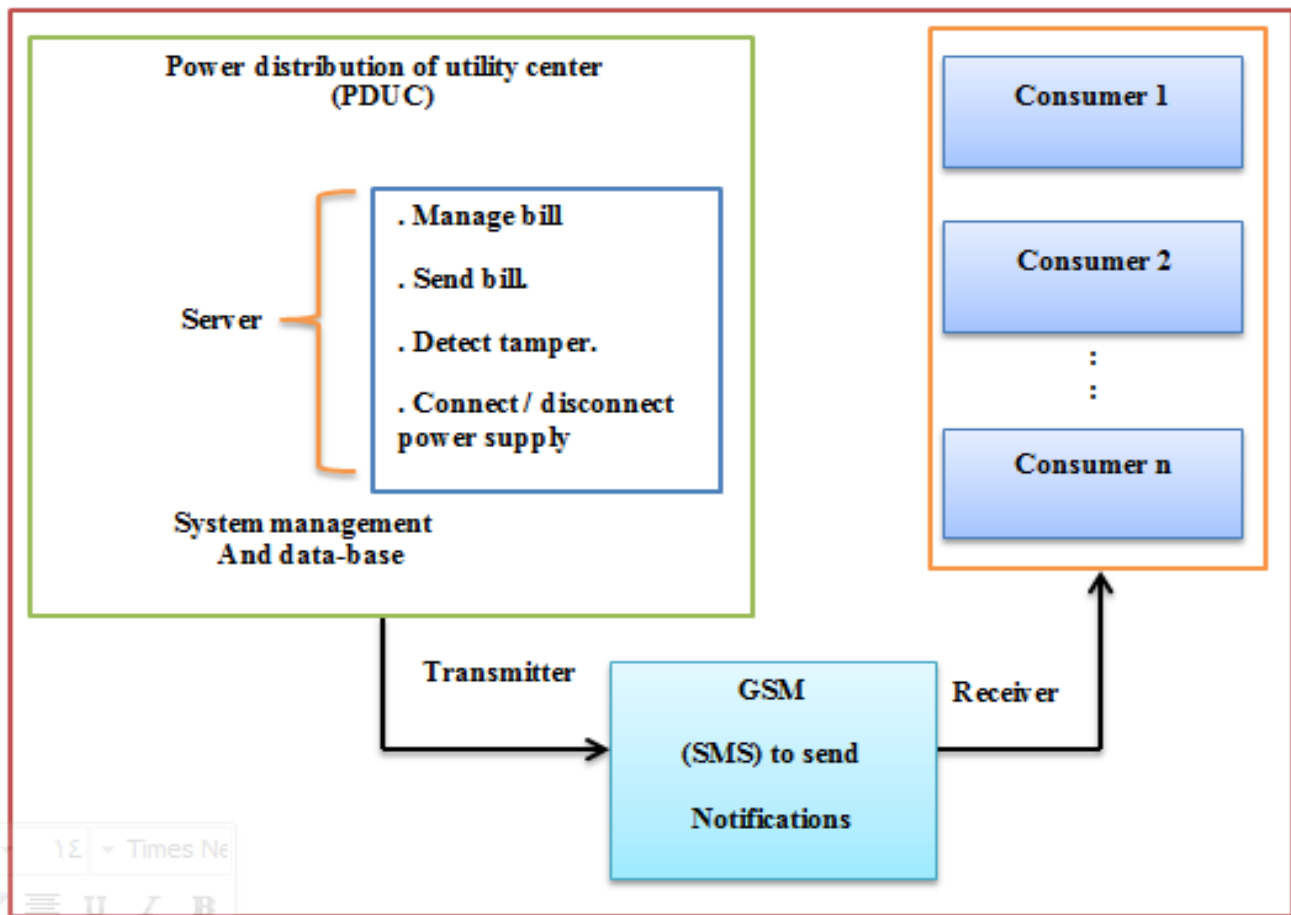


Fig. 3 The server connection

III. HARDWARE COMPONENT FOR THE SYSTEM

The smart meter and master meter consist of

- Arduino mega 2560

It is a microcontroller board used to control all the components of the proposed system.

- PZEM 004T

PZEM-004T module effectively can determine the voltage on the load terminal, the current which been consumed, the active power and therefore the consumption in Kwh besides measuring the reactive power, and the power factor.

- GSM (SIM 900)

A key function of smart meter is the transmission of meter data and the reception of control information from its designed utility. In this proposed system GSM is used to transfer data to the server via HTTP protocol.

- LCD display

This component is liable for displaying consumption data in Kwh and utility transmitted notification.

There are additional elements that have been used in the design of the smart meter to give it additional properties such as

- Real Time Clock (RTC)

The Real clock module DS3231 is used in the proposed smart meter to provide real time for the consumption data.

- SD RAM

Micro SD card module is used to store values so meter readings will not be lost when the meter is turned off. Also, the SD card serves the purpose of checking the meter reading is sent to the utility through GSM.

- Relay

Relay is an electrically switch for turning on or off electrical grids by gives low voltage signal from microcontroller. In this proposed smart meter, it's used to control the smart meter from the server.

The overall block daigram of prposed system is shown in Fig. 4

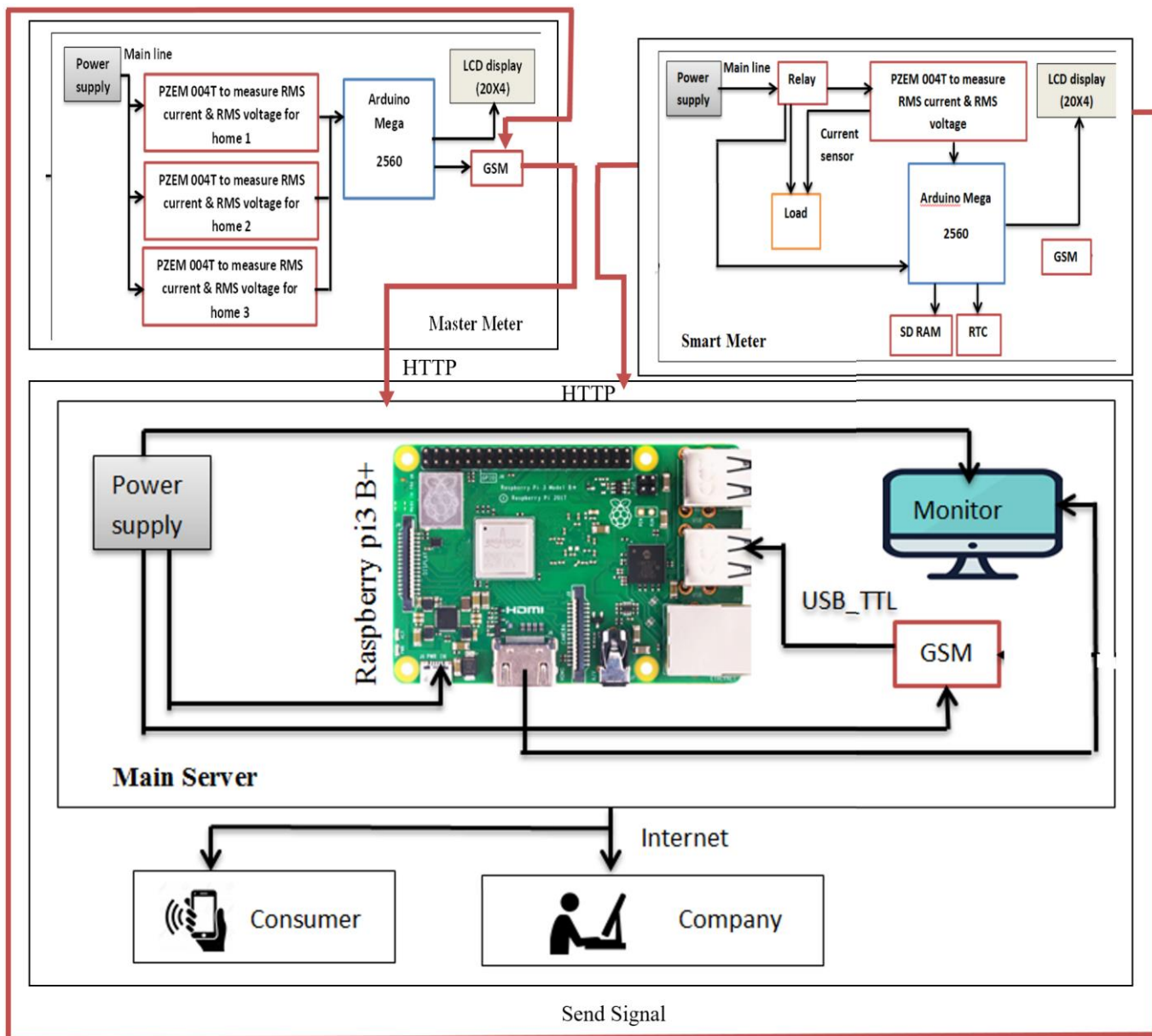


Fig. 4 The block diagram of proposed system.

The master can measure the consumed power of each house, which is recorded by the Master Meter and sent it to the server. The consumed power that recorded by Smart Meter in each home is sent via the http protocol to the server through GSM periodically. The two values (master meter and the smart meters) are compared. If there is any difference between the two values, the power theft is detected. A signal is sent by the GSM connected to the server automatically to the GSM in the smart meter in which electricity is restored through the server by reactivating the relay of smart meter. The flowchart of proposed system is shown in Fig. 5.

The experiment was carried out laboratory for three smart meters, as shown in the Fig. 7. The data of the Smart Meter was accessed to the data-base in a Table named "po" as shown in Fig. 8. The data of the Master Meter was accessed to the data-base in Table named "trans" as shown in Fig. 9. The power consumed by the three smart meters was

compared with the amount of power consumed by the Master Meter in the server. If there is difference between the values of consumed power for the smart meter and the consumed power that recorded by master meter that have the same identification number (id), the theft is happen. Signal is sent to the overcome smart meter to cut off power supply. It could be note that from Fig. 8 and Fig. 9 the theft has happened in home 2 that has (id=2). The simple difference in the reading of the master meter and the smart meter about (0.5 watt) is the amount of electricity consumed by the equipment (GSM, PZEM and other components) of the smart meter. Message to the consumer as presented in Fig. 10, and notification in LCD of the smart meter as shown in Fig. 11 and about the existence of a case of theft.

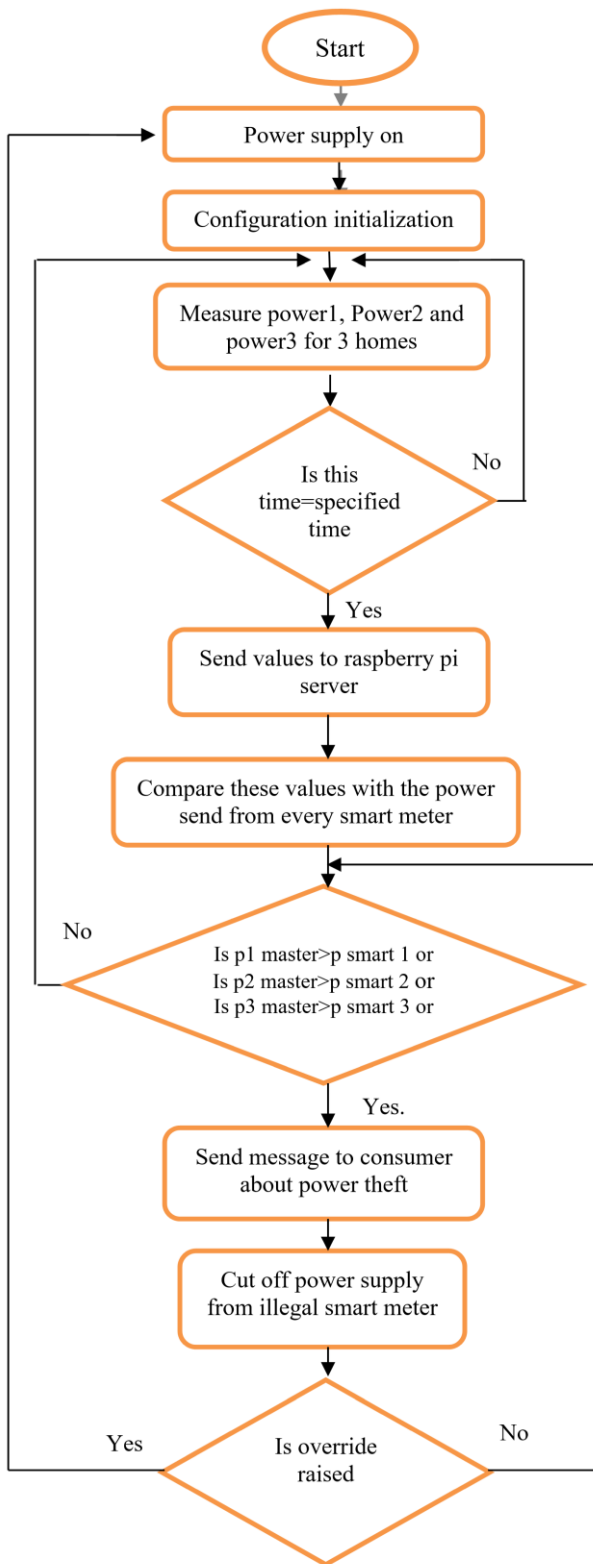


Fig. 5 The flowchart of the proposed system

IV. PRACTICAL IMPLEMENTED

The prototype design is shown in Fig. 6

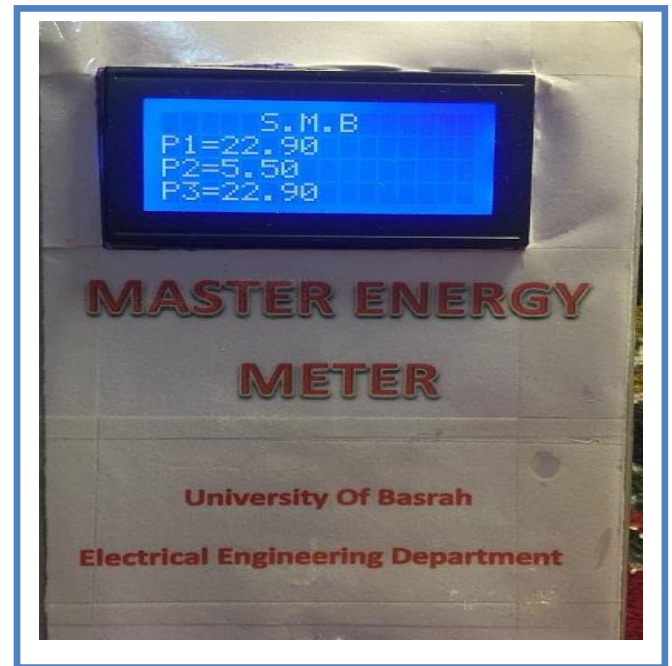


Fig. 6 The prototype design of master meter.

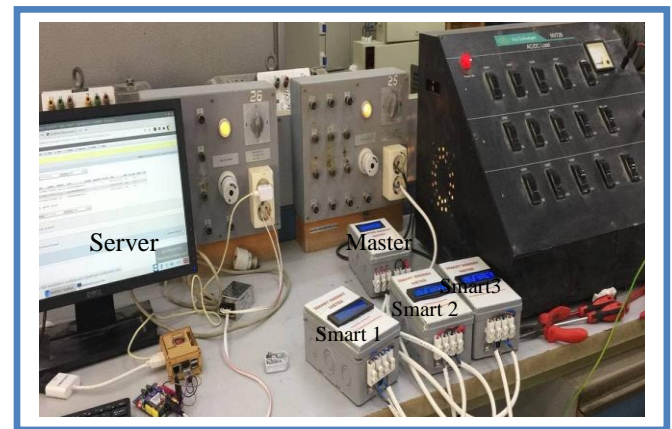
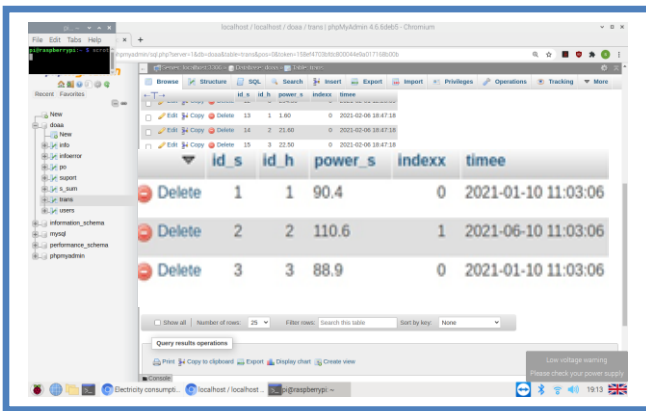


Fig. 7 Theft test in laboratory.

	id_po	id_m	power_m	indexxx	time
Delete	1	1	89.9	0	2021-01-10 11:03:10
Delete	2	2	90.7	1	2021-01-10 11:03:07
Delete	3	3	88.4	0	2021-01-10 11:02:14

Fig. 8 Table of consumed power of three smart meters in MYSQL database.



	id_s	id_h	power_s	Indexx	timee
Delete	1	1	90.4	0	2021-01-10 11:03:06
Delete	2	2	110.6	1	2021-06-10 11:03:06
Delete	3	3	88.9	0	2021-01-10 11:03:06

Fig. 9 Table of consumed power of master meter in MYSQL database.

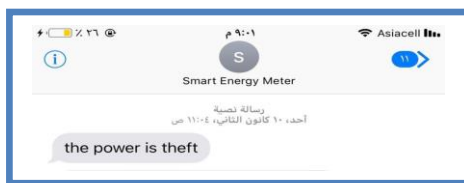


Fig. 10 The message receives by the consumer.



Fig. 11 The notification on LCD smart meter

V. CONCLUSION

The main goal of this work is to introduce a method to prevent the loss of electrical energy due to energy theft. The proposed system has the ability to solve the most prevalent issue of energy theft. Use GSM as wireless data communication network that increase the effectiveness and the reliability. The proposed system based on location and real time theft detection, it can be easily identified with the help of received data, the consumed power of master meter and energy meter at each house. Where the electricity cannot be returned to the consumer until the theft is raised. Otherwise, the interruption will continue, and with this result, the effort and time spent in tracking the thefts that occur on the electrical network by employees of electricity companies will be decreased. The experimental test approved the efficient of the proposed system.

CONFLICT OF INTEREST

The authors have no conflict of relevant interest to this article.

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