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GSM Based Smart Energy Meter Monitoring With Theft Detection

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Abstract: *The smart grid is a digital communication system that facilitates monitoring, control, and analysis of energy delivery networks. This paper proposes a smart energy meter for a prepaid recharge system and theft detection. The meter reading network is enabled by the integration of a microcontroller and GSM technology. The proposed system can provide information such as the amount of energy consumed or produced, as well as security services. This information can be incorporated into the existing energy management system of power organizations or associations, allowing for remote metering and accurate billing. Furthermore, the system can automatically detect power theft in households or industries and send alerts to both the power company and the consumer. This paper aims to reduce the illegal use of power and decrease the incidence of theft, which remains a persistent issue in the country's power usage*

Keywords: Prepaid System, Energy Meter, GSM, Arduino UNO, Theft Detection, Electricity Theft

I. INTRODUCTION

Electric meter, Energy meter use for billing purpose and also interface between the Distribution Company and consumers for a long time. For a long time, we use the electromechanical energy meter so that meter reading is not accurate due to the class so that this time use digital meter or electronics meter for high accuracy. At present time using the digital meter because the analog meter is costly, slow, not accurate, bill process is flexibility as well as reliability. So that we attempt made to automate the billing systems.

At present demand for computing power at all levels of electronic systems is driving advance in semiconductor chip technology. Power theft is a global issue, but it has a particularly noteworthy impact on the Indian economy due to its high prevalence in the country. Electricity theft commonly occurs in India through methods such as bypassing energy meters or direct hooking from power lines. To tackle this problem and reduce revenue losses, wireless systems are being utilized by authorized agencies.

As there are many methods of stealing so to minimize that the method is also increasing. The thesis titled "Electricity Theft Identification in Distribution Side Using GSM-Based System" aims to introduce a solution to prevent the unlawful consumption of electrical power.

II. LITERATURE SURVEY

The Automatic Meter Reading (AMR) system was first introduced by Mr. Paraskevakos, who utilized advanced technologies such as wired or wireless systems including power lines, cable networks, RF modules, GSM modules, and LCD displays for viewing purposes. Building on this foundation, Mr. Jain Abhinandan et al. developed an Automated Energy Meter that offers remote monitoring and control features. The AMR system continuously observes and monitors the energy meter and sends meter readings to the service provider via SMS. Online payment options are also available, including credit card, debit card, or net banking. To eliminate errors caused by manual reading, the AMR system uses a GSM network for automatic electric meter reading. In the past, government employees would take approximately 150 meter photos each day, and data from these photos would be checked and stored on a server. However, there were issues with closed houses and inaccessible meters, which required repeated visits. To overcome these issues, the AMR system was introduced. For future improvements, a program can be written to update the tariff within the energy meter, making the billing process flexible for both users and companies.

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III. METHODOLOGY

3.1 Description

The implementation of the Prepaid Energy Meter involves the Hardware and software stages. The 230V AC power supply is given to operate the loads .A 12V Adapter is used to provide 5V supply to Arduino Uno board and from there it is further interfaced with the relay, GSM and LCD. The transmitter and receiver pins of GSM are connected to the receiver (Rx 0) and transmitter (Tx 1) pins of Arduino board. The optocoupler is given to the 8 pin of Arduino Uno and the other end is given to the energy meter. The relay is connected to the 12 pin of the Arduino board and to the energy meter as well as the load. The load in turn is connected to the energy meter. The LCD 6 pins i.e. RS, RW, E, D0-D2 are given to the 2, 3,4,5,6,7 pins and the switch is connected to the 13 pin of the ARDUINO UNO board. The pins connected to AO and GROUND from the Energy Meter are used for the purpose detecting the theft in electricity if done.

3.2 Blog Diagram of Proposed System

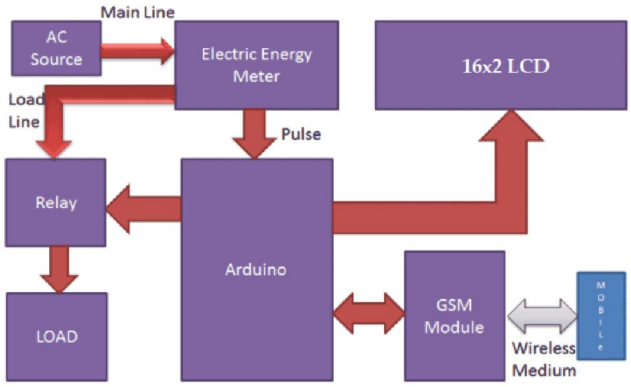

Fig. 1. Proposed System

3.3 Hardware Description

Different components are used to monitor the Energy meter. The following are the components:

3.3.1 Arduino

The ATmega328-based Arduino Uno is a microcontroller board with up to 14 digital I/O pins and six PWM pins for output, as well as six analog inputs. Featuring a 16 MHz quartz oscillator, USB connection, ICSP header, and a push button, the Arduino has everything necessary to support the microcontroller and can connect to a personal computer via USB. The Arduino is an open-source platform commonly used for electronics projects, consisting of a programmable circuit board and integrated development environment software for uploading code. Its simplicity and ease of use make it popular for beginners in electronics. Unlike other microcontroller boards, the Arduino can be loaded with new code through its USB port, without the need for separate hardware. Additionally, the Arduino IDE uses the C++ platform for increased efficiency. The newest board in the Arduino line-up is the Uno, which is ideal for monitoring the energy usage of analog devices.

Fig. 2 Arduino Uno

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3.3.2 GSM Shield (SIM 800L)

The SIM800L module from SIMCOM is a trusted GPRS (General Packet Radio Service) Shield that is compatible with Arduino. The shield features a special 3V3/5V TTL (Transistor Transistor Logic) interfacing circuitry that allows direct interfacing with both 5V and 3V3 microcontrollers such as ARM and ARM Cortex XX. The modem begins in Autobaud mode during the initial stage. This GSM/GPRS TTL modem has an internal TCP/IP stack that enables internet connectivity through GPRS. It is suitable for short message service (SMS), as well as data transfer applications in machine-to-machine (M2M) interfaces. With the GPRS Shield, you can communicate using the GSM telephone network, including SMS, MMS, GPRS, and audio via UART by sending AT commands. Additionally, the shield has 12 GPIOs, 2 PWMs (Pulse Width Modulator), and an ADC (Analog to Digital Converter) of the SIM900 module, all with 2V8 logic, present onboard. By connecting this shield to the Arduino circuit board and inserting a SIM card from an operator with GPRS coverage, you can easily control devices over the internet by following some simple instructions.

Fig. 3 GSM SIM800L

3.3.3 Optocoupler

An optocoupler is a device that is commonly used to electrically isolate microcontroller electronics from any potentially dangerous current or voltage in its surroundings in power systems. It serves as a circuit breaker. The optocoupler contains a gallium arsenide infrared LED and a silicon NPN phototransistor. It is typically a 6-pin device, with pins 1 and 2 connected to the meter where pin 1 is connected to the anode and pin 2 is not connected, pin 4 is the emitter, pin 5 is the collector, and pin 6 is the base. The optocoupler usually has one, two, or four LED diodes on its input and an equivalent number of light-sensitive elements, such as phototransistors, photo-thyristors, or phototriacs, on its output. The isolation test voltage of an optocoupler is typically 5000 VRMS.

Fig.4 Optocoupler

3.3.4 Relay

The relay is a type of switch that is activated by electricity. While most relay circuits use an electromagnet to activate a mechanical switch, there are other types, such as solid-state relays. This type of circuit is used when it is necessary to switch on or off a circuit using a voltage or current that exceeds the capacity of a microcontroller. The relay's purpose is to protect each circuit from the other. Each channel in the module has three connections: Normally Open (NO), Common (COM), and Normally Closed (NC).

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Fig. 5 Relay

3.4 Software Description

All the data coming from the sensors is fetched and processed using Arduino IDE. Depending on the condition GSM is commanded to send signal to the customer.

IV. RESULTS AND DISCUSSIONS

The GSM BasedSmart Energy Meter provides an effective solution for the accurate monitoring of energy consumption. By utilizing GSM technology, the system enables continuous and remote monitoring of energy usage, thus reducing the need for manual meter readings and minimizing the potential for human error. The system also provides a means of detecting energy theft and ensuring that customers are accurately billed for their energy usage. Overall, the implementation of the proposed system has the potential to benefit both consumers and energy providers by providing a reliable and efficient means of monitoring energy consumption. With the increasing demand for energy-efficient systems, the proposed GSM Based Smart Energy Meter is a step towards achieving a sustainable future.

V. BENEFITS AND APPLICATIONS

5.1 Benefits

- Prevent any external energy theft
- SMS notification
- Does not affect the power transfer capability of the line.

5.2 Applications

- House, Offices.
- Industry.

VI. FUTURE SCOPE

- We can use GPS system to track exact location of power theft.
- We can save continuous data reading when we use the data base.
- We can use multiple secondary modules at every customer for better accuracy.

VII. CONCLUSION

In conclusion, the prepaid energy meter with power theft detection offers numerous benefits for both energy providers and consumers. The system greatly reduces manual efforts and human errors, while effectively monitoring all the parameters and functioning of connections. With this technology, we can better control electricity usage and avoid wastage of power, ultimately contributing to a more sustainable and efficient energy system. By interfacing with static electronic energy meters, the complexity and cost of the circuit are reduced, making it more accessible and affordable for wider implementation. Moreover, the system is highly effective in detecting electricity theft, making the energy

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meter tamper-proof and increasing revenue for the government. Overall, the prepaid energy meter with power theft detection is a highly valuable solution for the modern energy landscape.

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