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Power Theft Location Identification at Distribution Level

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Abstract:- With the increasing technology there has a been a rapid increase in usage of power. Due to increasing cost of power charges resulted in power thefts in both rural and urban areas of India. In spite of several laws and strict penalties by the government, power theft is still among one of the most reported crimes worldwide. Due to this expensive loss there is an impact on Indian economy as well as energy consumption. Many technologies have been introduced from time to time but have been unable to make a big mark due to their complicated working and continuous interruption in supply. In this document a simple and economical solution to this problem has been presented. This scheme can be assembled and used at both pole site and service line where it provides appropriate location of power theft to the nearby substation and enables for manual checking and charge the person committing theft.

I. INTRODUCTION

Remarkable progress in technology has seen a rapid rise in power consumption across the world in the last two decades. In India, the gross electricity consumption per capita stands at around 210.61GW at present and is estimated to touch 400GW by the year 2023. In USA, which has the largest number of industries in the world, the power consumption per capita is less when compared to India.With a rapid increase in technology and power consumption, there has been an increase in power thefts. In the India's highly populated state Uttar Pradesh consumes around 19,970MW per capita at present**.**

Even with improved security system and awareness, power theft has not yet been suppressed. A simple tripping of supply is impossible to track the exact location of theft and person committing the theft, due to which only some thefts are successfully found. In this document, a simple and economical scheme has been outlined which can be used at both pole site and service line and provides reasonable protection against theft through tracking the theft location and sending to the nearby substation.

The technical background of this work lies in the works done on GSM and GPS based alert and tracking techniques. GSM based caution is used to send the appropriate location and GPS tracking by Mohammad Iqbal et.al and Mohammad Mufassirin et.al.

The basic idea behind this scheme is to keep on tracking the power supplied and consumed that will help the supplier to keep a track on power consumption at all times to avoid power thefts.

The main aspect is to provide a efficient tracking system where a simple text message is sent to nearby substation through GPS and GSM module. Whenever there is a difference in sending and receiving end currents, Arduino may activate GPS module and dump the appropriate location into a link. Here GSM module gets activated and sends the link through a SIM to the nearby substation. Here the link open up showing street location of power theft which is interfaced with google maps.

The second function lets the supplier manual check the location, whether there is a theft occurring or else there is any fault at the location. It enables the supplier to charge the only person committing theft in case of theft. It also helps in unwanted supply interruption to the consumers in case of any faults.

Here if any fault occurs then it can also be cleared easily without any interruption in supply. In case of theft once the theft is cleared, a message 'Energy Thefted?' is sent to Arduino. This is result sends a text message that consists of power consumed during the theft period. This helps the supplier to easily charge the penalty according to the power consumed in Watt-hour.

II. NEED OF THE STUDY

The establishment of largescale industries and improved technology, it has created a serious problems of power shortage. The seriousness of this shortage led to huge amount of power thefts. In India studies have been carried out at rural as well as urban levels, which resulted in about 5% of power produced is being thefted per day. Among all consumers across India developed areas and agricultural sector has recorded high rate of power thefts. The knowledge about the location of power theft and amount of power loss occurring is important to improve power supply efficiency. The power theft location identification helps in aquiring the required information in fast and efficient way.

III. LITERATURE SURVEY

Mufassirin et.al. [2] presented a paper describing a technique for detecting and monitoring electricity theft that enables violators to be identified from a far. Based on their half hourly power consumption data and location, Advanced Metering Infrastructure and Intelligent Algorithms profiles users. Recurrent Neural Networks are used to find irregularities in power usages. By means of an effective two way communication between sending end and receiving end, Pravin et.al. [9] used smart grid technology to identify power theft online. Both at the transmission side and load

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side smart power meters are fitted. Smart meters [10] can measure power sent and power consumed whenever a mismatch occurs above the tolerance level parameters. At that time, power theft is detected. The device will raise an alarm, alerting the appropriate authorities to take the required legal action and prevent power theft.

Qing-Hai et.al. [10] discussed recent advances in IoT technology and the architecture of the power IoT and proposed an IoT based status monitoring and early warning system for the power distribution network. The digital meter designed newly is based on relatively cheap distributed components such as microcontroller architecture and current sensors may assess energy consumption and make accurate decisions utilizing Internet of Things by using WIFI to interact with servers and consumers.

Sayyad et.al. [8] suggested a system that automates electricity meter reading by implementing IoT technology in electrical energy meters. This allows consumers to undertake power optimization by delivering electricity usage information on a regular basis via an Android app. A new GPRS based power cable grounding wire anti-theft monitoring device system efficiently solved the problem of power and cable grounding wire box theft. This provided prompt follow-up on grounded cable theft events and it prevented the occurrence of electric field of high voltage transmission line fault and improved the reliability of power grid safe operation.

Balakrishna et.al. [11] suggested a method for implementing a power theft detector kit using IoT and performing the same using GSM for back up protection.

IV. METHODOLOGY

Readings of the current and voltage drop at the transformer side and consumer end are necessary for this technique. The theft is detected if there is an extra current flow through the line. The control system takes the required steps to find and stop the theft if the excess current flows. The electricity theft can be located and tracked using a mathematical analysis and algorithm.

A. Mathematical analysis

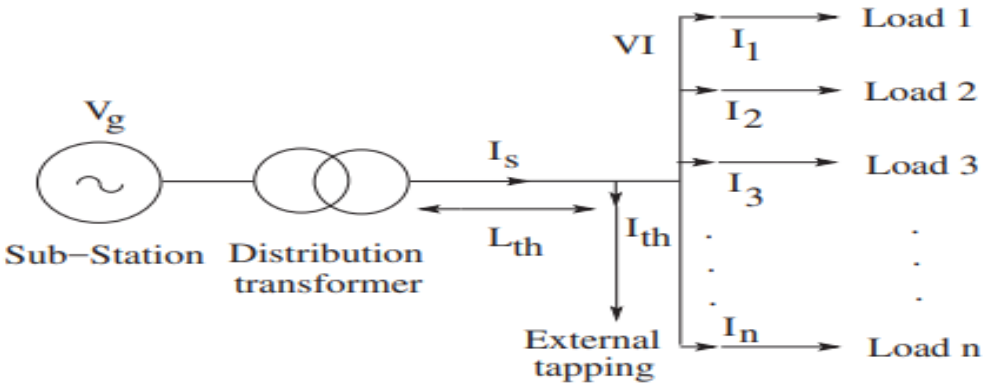

Fig. 1: Schematic diagram of Distribution line with External tapping.

Considers and depicts a distribution line. Transformer voltage is referred to as Vs. The current Is will flow through the circuit once the source and load are linked. An external tapping is contemplated from the distribution transformer at a distance of L meters. As more current passes through the tapping as a result, power stealing occurs.

Using Fig. 1, the transformer's source current is equivalent to the sum of all currents flowing through the various loads on the load side and current flowing through additional tapping.

$$I_S = [I_1 + I_2 + I_3 + \ldots\ldots\ldots\ldots + I_N] + I_{TH} \quad (1)$$

$$I_S = \Sigma I + Ith \quad (2)$$

Theft current Ith is derived as:

$$I_{TH} = I_S - \Sigma I \quad (3)$$

➢ *Under normal conditions:*

All extra loads have the same value as the source current.

$$I_S = \Sigma I \quad (4)$$

$$I_{TH} = 0 \quad (5)$$

➢ *Under theft condition:*

The sum of all load currents is less than the primary current.

$$I_S > \Sigma I \quad (6)$$

$$Ith \neq 0 \quad (7)$$

B. Flow chart of theft detection

The flow chart, which is depicted in Fig. 2, makes understanding the idea very simple. The readings of voltage and current levels at the consumer end and the distribution end are taken into consideration during the initial conditions. If the present flow remains unchanged then no theft is detected. Otherwise GPS and GSM modules gets activated by the Arduino Board and sends the tracked location to the nearby substation.

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After the alert is created respective officer reaches the tracked location to check whether there is theft or else any fault is occurring.If there is any theft, a message 'ENERGY' is sent to substation after clearing the theft. After receiving the text message amount of energy thefted is sent. By this supplier can easily charge the person committing theft.

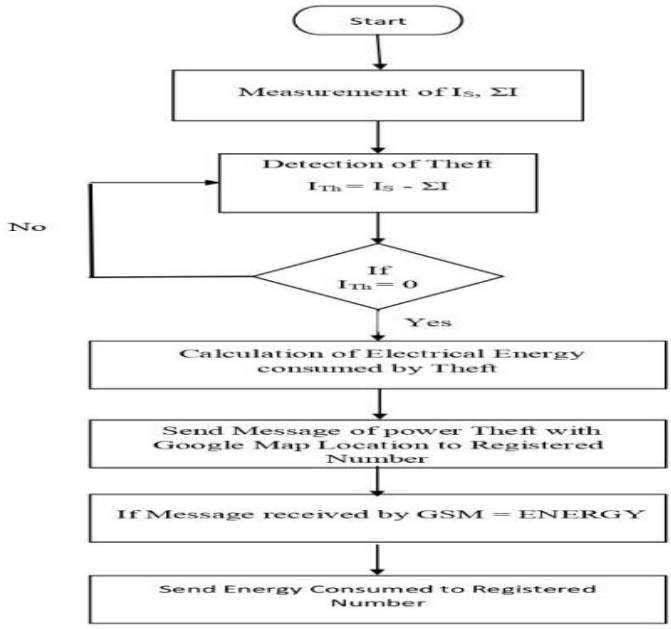

Fig. 2: Flow chart of Power Theft Detection

V. DESIGN AND IMPLEMENTATION

This part of report has been organized as

- Implementation of hardware
- B.Implementation of software
- C.Outcomes and Observation

A. *Implementation of hardware*

Here the system can be broadly divided into three parts:

- The Arduino board
- The GSM module
- The GPS module
- The Current sensors

➢ *The Arduino board*

The Arduino board is a programmable open source microcontroller board that can be used to integrate into a variety of electrical and electronics projects. With the advancement in technology this board is used to easily interface with other Arduino boards, Arduino shields and to control relays, LEDs and motors as an output.

There are many available options, among which , the Arduino UNO board has been used here. It supports voltage of 12V and provides fast and efficient performance.

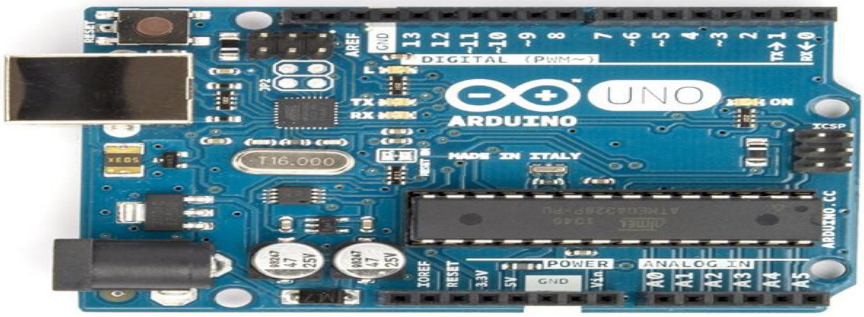

Fig. 3: Arduino Board

➢ *The GSM modem*

The GSM modem is generally used for communication purpose whenever required due to its unique nature of network. With the rapid increase in technology of GSM, there is always a new advancement in GSM network and it is available everywhere.

Due to this different working of GSM network, it has been picked for medium of communication. There are variable options are available, among which, GPRS GSM SIM800L modem has been used here. It supports voltage of 3V and gives fast response to the supplier.

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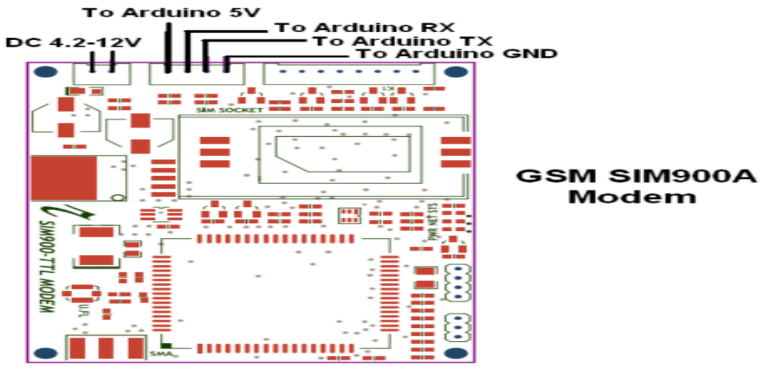

Fig. 4: Interfacing of the GSM SIM900A Modem

➢ *The GPS module*

The GPS module plays a vital role in power theft location tracking. Here the GPS module is interfaced with Arduino UNO board and provides the location whenever the current algorithm is not satisfied and Arduino asks for it.

There has been developed different types of GPS modules with respect to the technology advancement, among which, here we are using NEO 6M GPS module due its fast and accurate outcomes.

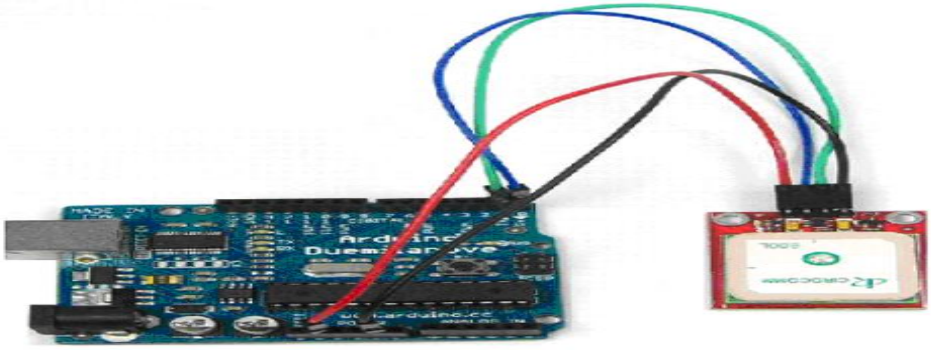

Fig. 5: Interfacing of the GPS Module

➢ *The Current Sensors*

The Current Sensors are used to detect and convert current to an easily measurable output voltage, which is proportional to the current through the measured path.

There are wide variety of sensors and each sensor is suitable for a specific current range and environmental condition. Among these multiple types, we are using hall effect current sensors to measure the current at both receiving and sending and use the values for comparison in algorithm.These support current range of 5A and provides easy measurable outcomes.

B. Implementation of software

The software part covers the code that has to be fed into the Arduino microcontroller. The code runs in an infinite loop and its outline is as follows:

- Measurement of Currents from Current Sensors for Identifying POWER THEFT.
- If $I_S > \Sigma I$
- ✓ Read Location from GPS module.
- ✓ Send Location to Assistant Engineer using GSM modem.
- ✓ Start calculation of amount of energy consumed by theft.
- Read MESSAGE from GSM MODEM.
- If message = “ENERGY”.
- ✓ Measurement of Currents from Current Sensors for Identifying POWER THEFT.
- If IS> Σ I
- ✓ Send “THEFT IS STILL ONLINE” MESSAGE to Assistant Engineer using GSM modem.
- If $I_S \leq \Sigma I$
- ✓ Send energy calculated to Assistant Engineer.
- END.

C. OUTCOMES AND OBSERVATION

The system has been tested on several loads and theft condition. It showed excellent performance, the GPS module took an average of 40-90 seconds for tracking the location under appropriate conditions of weather. From the time of tracking the appropriate location to sending the google map link, the tracking function took an average of 140 seconds.

The functions of sending location link and amount of energy theft worked without any glitches. On an average it took around 50 seconds for the functions completing and also around 90-140 seconds for the amount of energy thefted message to reach the nearby substation.

The time taken for functioning completely depended on the speed of GSM network and GPS connectivity. Even though the connectivity is universal, the strength of connectivity differs from one place to another. In case of problem in network connection it may take as long as 5 minutes.

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To make sure the security function, no tripping action is undertaken and the alert message is sent to the authorized nearby substation number. This action is to make sure to punish only the person committing theft. Here the continuous supply of 12V is provided to the Arduino, either it may be directly from supply by stepping down or a battery of 12V can also be used.To complement the tracking function a link is used that coordinates with modules and plot it on Google maps. This provides the suppliers amoreeasy way to understand the current location of the power theft.

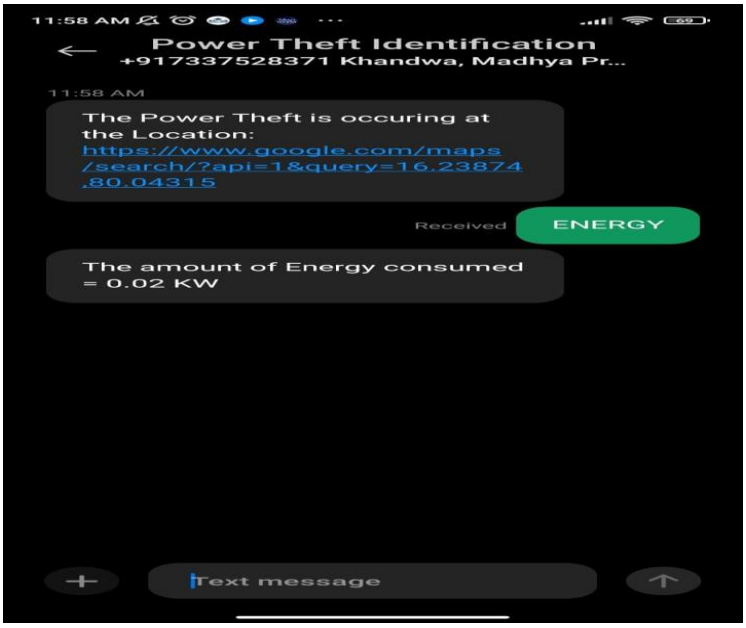

Fig. 6: Screenshot of Assistant Engineer ‘s mobile showing working.

VI. CONCLUSION

The system that has been developed provides adequate protection against theft. Here location tracking function is used for identification of appropriate location of theft, it basically simplifies the threat of theft by adding an extra level of security by sending immediate response in case of difference in current values. If used in collaboration with tracking function and quick sending link to nearby substation, the chances of theft clearing are immensely high.

The main attention has been to keep the system simple, affordable, without any adjustment on its authenticity. On an average it would cost around 1500INR to 2000INR to build this module. If implemented in bulk, this system may gradually reduce the threat of power thefts and may save power suppliers and consumers from energy losses.

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