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Integrating GPS Geotagging with Energy Meter for Enhanced Security and Accountability

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ABSTRACT: The integration of GPS Module into energy meter enables geo-tagging, allowing for the precise tracking of meter locations. This geospatial data empowers utility companies to verify the accurate installation of meters and monitor their usage patterns remotely. The integration of GPS geo-tagging with energy meters offers a promising avenue for reducing theft, improving in finding the Energy Services. Moreover, the fusion of geo-tagged data with energy consumption information provides utility companies with a comprehensive view of their energy distribution network. Advanced analytics can be leveraged to detect irregularities, potential theft patterns. In this project we are using Node MCU as microcontroller, GPS module and GSM module. Here we are using MEMS sensor to detect theft and a push button for geo-tagging.

KEYWORDS: MEMS, Node MCU, GPS, GSM, Signals

I.INTRODUCTION

The Security of Energy Meter is also important role because through the data from meter, the energy providers can collect the money as revenue. The Energy Meters which are provided to the Panchayath and Municipality, are as low maintenance and secure. It is an advanced metering technology involving placing intelligent meters to read, process and feedback the data to customers. It measures energy consumption, remotely switches the supply to customers and remotely controls the maximum electricity consumption. Smart metering system uses the advanced metering infrastructure (AMI) system technology for better performance. They can transmit the data to the utilities like energy consumption, parameter values, alarms, etc. and also can receive information from utilities such as automatic meter reading system, reconnect/disconnect instructions, upgrading of meter software's and other important messages.

These meters reduce the need to visit while taking or reading monthly bill. Modems are used in these smart meters to facilitate communication systems such as telephone, wireless, fiber cable, power line communications. Another advantage of smart metering is complete avoidance of tampering of energy meter where there is scope of using power in an illegal way. They can not only measure energy units but also send those units to the utility company through some communication medium like GSM/GPRS, Radio Frequency, PLC (Power Line Communication). Through these mediums company can control the load of consumer as well. While doing these basic responsibilities, these meters can also be used for load management and load forecasting purposes. To enhance the security and tracking the meter when billing is happens by Node MCU, GPS module.

II.PROPOSED SYSTEM

The system aims to enhance security and accountability by utilizing real-time location tracking. The key components of the system include a node MCU, GPS module, GSM module, and MEMS sensor. The node MCU serves as the central processing unit, managing data acquisition, communication, and control functions. The GPS module acquires the meter's location coordinates, while the GSM module enables cellular network connectivity for data transmission. The MEMS accelerometer sensor continuously monitors the meter's position and triggers alerts detected when movement is detected. The objective of this project is to integrate GPS geo-tagging capabilities into energy meters to strengthen security and accountability.

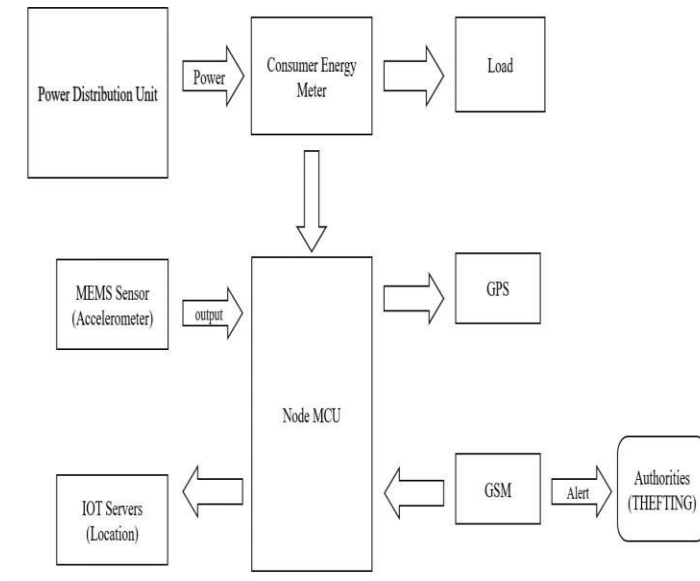


Figure.1. Block Diagram of Proposed System

Node MCU

The Node MCU is an open-source firmware and development kit that helps you to Prototype your IOT product within a few Lua script lines. It includes firmware which runs on the ESP8266 Wi-Fi SOC from Espressif Systems, and hardware which is based on the ESP-12 module.



Figure.2. NODE MCU

ESP-12E Wi-Fi module is developed by Ai-thinker Team. core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultralow power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller [2]. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement. ESP8266EX offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor.

MEMS SENSOR

The term MEMS stands for micro-electro- mechanical systems. These are a set of devices, and the characterization of these devices can be done by their tiny size & the designing mode. The designing of these sensors can be done with the 1-100-micrometer components. These devices can differ from small structures to very difficult electromechanical systems with numerous moving elements beneath the control of incorporated micro-electronics. Usually, these sensors include mechanical micro-actuators, micro-structures, micro-electronics, and micro-sensors in one package.

MEMS are low-cost, and high accuracy inertial sensors and these are used to serve an extensive range of industrial applications. This sensor uses a chip-based technology namely micro-electro-mechanical-system. These sensors are used to detect as well as measure the external stimulus like pressure, after that it responds to the pressure which is measured pressure with the help of some mechanical actions. The best examples of this mainly include revolving of a motor for compensating the pressure change.



Figure.3. MEMS Sensor

GSM Module – SIM900

This is a GSM/GPRS-compatible Quad-band cell phone, which works on a frequency of 850/900/1800/1900MHz and which can be used not only to access the Internet, but also for oral communication (provided that it is connected to a microphone and a small loud speaker) and for SMSs. Externally, it looks like a big package (0.94 inches x 0.94 inches x 0.12 inches) with L-shaped contacts on four sides so that they can be soldered both on the side and at the bottom. Internally, the module is managed by an AMR926EJ-S processor, which controls phone communication, data communication (through an integrated TCP/IP stack), and (through an UART and a TTL serial interface) the communication with the circuit interfaced with the cell phone itself. The processor is also in charge of a SIM card (3 or 1,8 V) which needs to be attached to the outer wall of the module. In addition, the GSM900 device integrates an analog interface, an A/D converter, an RTC, an SPI bus, an I²C, and a PWM module.



Figure.4. GSM Module SIM-900

GPS Receiver

GPS receiver module gives output in standard (National Marine Electronics Association) NMEA string format. It provides output serially on Tx pin with default 9600 Baud rate. This NMEA string output from GPS receiver contains different parameters separated by commas like longitude, latitude, altitude, time etc.



Figure.5. GPS Receiver

GPS receivers are generally used in smartphones, fleet management system, military etc. for tracking or finding location. GPS is also known as Navigation System with Time and Ranging (NAVSTAR) GPS. GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites.

III.HARDWARE RESULTS

The MEMS Sensor is kind of gyroscope sensor which align with earth magnetic field. The MEMS Sensor can be used for the Movement, Temperature, Position, Pressure sensing purposes. The energy meter is fixed to a point like a pole or a wall. When someone try to steal or tamper the energy meter, the movement in meter is detected it triggers and Node MCU, sends the location to the authorities by GSM module and location taken by GPS module. During, billing of the energy meters finding the location of the energy meter is not so easy. This could help the authorities while billing and stealing the energy meter.



Figure.6. Hardware Results

IV.CONCLUSION

In conclusion, the project aims to seamlessly integrate GPS geo-tagging with an energy meter to enhance security and accountability in a novel and efficient manner. The utilization of MEMS sensors for motion sensing, the Node MCU as the central controller, and the integration of a GPS module and GSM module form a comprehensive system capable of providing real-time data on both the location and energy consumption of monitored assets. The amalgamation of these technologies not only facilitates accurate positioning but also allows for a deeper understanding of the dynamic motion

and orientation of the object. This is particularly relevant in scenarios where precise location data and energy consumption patterns are crucial for security and accountability purposes. The hardware implementation, discussed in detail in the project report, involves careful wiring and configuration of the MEMS sensor, Node MCU, GPS module, and GSM module. Challenges encountered during the integration phase were addressed systematically, ensuring the robustness and reliability of the overall system. In essence, this project contributes to the advancement of technology by showcasing a holistic approach to combining MEMS sensor data and GPS coordinates. The resultant system not only provides enhanced security measures but also offers a valuable tool for monitoring and optimizing energy consumption.

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