Smart Energy Management System for ATM Using IOT

[1]Haripriya H, [2]Jaideep Joshua E and [3]Geetha A,
[1,2]UG students, [3]Assistant Professor,
[1,2,3]Department of Computer Science and Engineering, Easwari Engineering College, Chennai – 600089, India

Abstract: The shortage of resources in the present world is motivating many towards energy efficient technologies. . Electricity usage is soaring great heights and requires day to day monitoring to reduce the amount of power consumed. To sustain the living of human beings electricity is the most important inventions. So, proper utilization of this resource is of immense importance to us. Though many technological innovations are taking place in this world, existing electricity consumption is soaring great heights. Also with the advent of digital banking in India the number of ATMs is increasing rapidly. In this paper we present a newly designed smart energy management meter for ATMs based on cheap distributed components like microcontroller architecture and sensors working on the concept of Internet of Things. This system aims at monitoring the energy consumption within ATMs using web application and reduces the operational cost. It also monitors power tampering at ATMs by sending an alert message to the owner upon crossing the threshold.

Keywords: *Internet of things (IoT), Sensors, Smart energy meter, Microcontroller, GSM (Global system for Mobile Communication), GPRS (General Packet Radio Services)*

I. INTRODUCTION

Humans occupy the major part of the living system in the world, thus facing a major demand for all our basic needs. To save the resources from depleting soon electricity usage monitoring and reduction are essential. Gone are the days where maintenance staff had to go from one room to another switching off the appliances that are not needed. So the aim of this paper is to monitor the misuse of power as well as work on reducing the power consumption. Internet of things has helped many organizational systems to improve efficiency, increase the speed of processes, minimize error and prevent theft by coding and tracking the objects. Computing and communications has its future in the technological transformation brought by the Internet of Things. Power consumption can be reduced to a great extent if we can monitor our daily power usage and switch off appliances which are unnecessarily consuming electricity. This paper focuses on developing an energy management system that aims at reducing power consumption and also controls power tampering at ATMs using the concept of Internet of Things.

Gone are the days of the maintenance staff going from room to room and building to building to adjust the thermostat. It is now connected to sensors that can be controlled remotely. As small businesses continue to look for ways to reduce costs and gain agility, the Internet of Things can potentially level the playing field. IoT has been topping the list of revolutionary technologies for some years, and is definitely one of the most talked about tech innovations around. With sensors getting cheaper by the day, more and more physical objects are becoming part of a network of things, changing the way we live and work. The IoT today is like the Internet itself, as it was in its infancy about 2 decades ago, full of promise and potential but still a conceptual leap for many individuals. Nevertheless, it is becoming more and more practical by the day, keeping in mind the rise in demand and cost of electricity. When consumer products and services can engage meaningfully with broad socio-economic concerns, energy use can be lowered to a great extent and corporations and individuals will slowly and silently adopt IOT as they experience compounding benefits.

The smart energy meter that is used is an electronic device that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing. They enable two-way communication between the meter and the central system. Unlike home energy monitors, smart meters can gather data for remote reporting. Such an advanced metering infrastructure (AMI) differs from traditional automatic meter reading (AMR) in that it enables two-way communications with the meter. Communications from the meter to the network can be done via fixed wired connections (such as power line communications) or via wireless. In using wireless, one can opt for cellular communications (which can be expensive), Wi-Fi (readily available), wireless ad hoc networks over Wi-FI, wireless mesh networks, low power long range wireless (LORA), ZigBee (low power low data rate wireless), Wi-SUN (Smart Utility Networks), etc.

Thus this paper provides a system that uses smart energy meter and various other cheap sensors and GSM and GPRS modules connected to the microcontroller that can be scheduled and monitored through a web application enabling reduced power consumption and power tampering to be monitored efficiently within ATMs.

II. REVIEW OF LITERATURE

In paper "A Smart Power Meter to Monitor Energy Flow in Smart Grids", the authors De Capua C, Fulco G and R. Morello, proposed an outline of the potentialities of the sensing systems and IoT to monitor efficiently the energy flow among nodes of electric network. The proposed smart power meter intends to support the smart power grid to monitor electricity among different nodes in an efficient and effective way. Some challenges of this system include: the standardization of communication protocols, the improvement of the security standard, integration of the sensing systems into existing systems, to assure interoperability, harmonisation of equipment standards to allow plug-and play and interface, new power flow routing algorithms and innovative routing criteria, management of big data coming from thousands of sensing systems distributed through the grid, redefinition of the metrics used for billing consumptions and modernisation of current electric network architecture.

In paper "A smart home energy management system using IOT and big data analytics approach", the authors A.R. Al-Ali, M. Alikarar, R. Gupta, M. Rashid, I. A. Zualkernan, proposed an idea for implementing an Energy Management System (EMS) for smart homes. In this system, each home device is interfaced with a data acquisition module that is an IoT object with a unique IP address resulting in a large mesh wireless network of devices. The data acquisition System on Chip (SoC) module collects energy consumption data from each device of each smart home and transmits the data to a centralized server for further processing and analysis. This information from all residential areas accumulates in the utility's server as Big Data. The proposed EMS utilizes off-the-shelf Business Intelligence (BI) and Big Data analytics software packages to better manage energy consumption and to meet consumer demand. Some challenges of this system include: lifetime of a WSN network deteriorates with time due to the deployment of new sensors in the network, the data collected and aggregated solely by the home server ina system using zigbee as a communication protocol could lead to data loss in case of a system failure, the lack of standardized protocols and regulations were the main challenges in considering intelligent DC powered homes as suitable replacement to AC power systems and the device status and power consumption details transported to the web server through an extensible mark-up language (XML) interface would tend to be heavy weight for data delivery between browser and servers and the architecture will face significant bandwidth challenges in sending these large files across the network.

In paper "Syncretic Use of Smart Meters for Power Quality Monitoring in Emerging Networks" according to M. Albu, M. Sănduleac and C. Stănescu, a signal analysis framework for simplified PQ informative assessment method using the so-called instrumentation values available in most of today smart meters. Applications like smart grid synchro-SCADA observable and voltage control are also addressed in a novel design of Smart Meters, with negligible impact on cost. The main impediment in including calculation of PQ parameters among the functionalities of a SM appears to be their additional cost, mainly due to the fact that PQ is a well-regulated field, with detailed standards and norms in use, there have been only a few attempts to design low-cost PQ devices but these fail to comply with the minimal requirements imposed and developments in DSP components, like ARM Cortex with Digital Signal Processing (DSP), allowing complex computations for energy measurement with low uncertainties.

In paper "Sustainable Homecare Monitoring System by Sensing Electricity Data", D. Gualda, Á. Hernández, José M. Alcalá, J. Ureña, present a novel method for homecare monitoring systems based on the use of a sensor. The proposed event detector simplifies parameterization to increase its scalability while keeping similar performance. The classifier outperforms them due to its unique load signature (the PQD power trajectories) and the PCA reconstruction error method that successfully models and classifies general appliances. This study extends preliminary results in by including comparative results with other previous methods. However, physiological signals measured by direct monitoring methods often involve blood oxygen saturation, heart rate and breathing which are very accurate but non-scalable, since sensors need to be attached to the body.

In paper "Virtual Occupancy Sensing: Using Smart Meters to Indicate Your Presence", R. Jia, M. Jin, and C. J. Spanos, design a system which uses occupancy detection for residential and commercial buildings to improve energy efficiency, user comfort, and space utility. The pervasiveness of electricity meters eliminates the additional system cost and setup/maintenance efforts. Hence, electricity meters are viable candidates for presence sensing, with the added benefits of safeguarding privacy information (compared to cameras), and improving reliability (compared to environmental measurements). The capability of power for presence detection is first demonstrated in BL with methods like SVM and random forest. As a result, accuracy rates are 74 to 89% for residential buildings and about 90% for offices. TL approach tackles the case when data from other sources are used in the current learning task. Its results further confirm the appropriateness of using power to detect occupancy by producing superior performance as compared to standard SVM. Additionally, it will be promising to perform sensor fusion with other mobile nodes, such as smart phones, fitness trackers, and automobiles, for further improvement.

In paper "IoT-Based Sensor Data Fusion for Occupancy Sensing Using Dempster–Shafer Evidence Theory for Smart Buildings", the authors Indrajit Banerjee and Nashreen Nesa, proposed that detection of occupancy in a room from various ambient sources like temperature, humidity, light and CO2. In this system, remote monitoring of the building as well as leveraging control on the indoor parameters through HVAC control systems is possible at real-time. It also adopts Dempster-Shafer Evidence Theory for fusing sensory information collected from heterogeneous sensors, assigns probability mass assignments to the raw sensor readings, and finally performs mass combination to derive a conclusion about the occupancy status in a room. A probability mass assignment function has been proposed for this purpose. The results reveal a substantially high percentage of accuracy (up to 99.09%). estimate the number of occupants as well. household or office rooms in order to detect occupancy at real time. The model has to be first trained with some training samples after which it can run smoothly for any number of test cases. However, in case of change in location the model has to re-train to adapt to its changed environment which is a prerequisite for any classification model.

III. PROPOSED SYSTEM

A. Reduction of power consumption

The proposed system uses Internet of things and smart energy meter techniques to automate the power reduction process. The proposed system consists of the following sensors- personal intruder sensor, temperature sensor, current sensor and voltage sensor. In the proposed energy management system, the current, voltage and temperature sensors are attached to the energy meter. The current sensor calculates the current consumed and the voltage sensor calculates the voltage used. These two sensors calculate the power consumed by the electrical equipments such as AC, light and the ventilator fan within the ATM. A temperature sensor is used to measure the room temperature and this data is also collected continuously and stored in the database. The data from these sensors are collected using a micro-controller and it is sent to the database using wireless technology, and it is stored in the database. These data are used to analyze the power consumed by the electrical equipments within the ATMs. The temperature sensor upon sensing that the room temperature has exceeded 32 degree Celsius will turn on the air conditioning system. If the room temperature is below 32 degree Celsius then the air conditioner is switched off thereby saving energy. When the air conditioner is switched off the ventilator fan is switched on in order to control the humidity within the ATMs. The frequency of users to the ATM between 12:00A.M and 6:00A.M is very less therefore the operation of electrical equipments such as AC, light and ventilator fan is not required when there is no user within the ATMs so our system also makes use of the personal intruder sensor to increase the brightness of light upon the presence of humans into the ATMs. If no presence of human beings is detected then the light is made to glow dim by reducing the power supply to it. This way our system also controls the energy consumption of the lighting system in addition to the air-conditioning system. Constant monitoring of the power consumed by the air conditioner as well as the ventilator fan is monitored along with their running hours. Total power consumed is then computed by adding the power consumed by AC and ventilator fan.

B. Controlling Power Tampering:

ATMs provide ample scope for power tampering. With the advent of digital banking in India since the number of ATMs is increasing there is more scope for power tampering. Therefore it is crucial to monitor and control it. Our system provides a solution to monitor and control this issue. Since the usage of power consumed by both the air conditioner, light and the ventilator fan is monitored and stored in the database along with the total power consumed our system checks if the difference between the total power consumed and the average power consumed in a day exceeds 50Watts per hour, and if it does exceed an alert message using the GSM module is sent to the owner of the ATM stating over usage of power within the ATM so that he/she may check upon it. Thus our system prevents misuse of energy.

C. Scheduler Settings and Power Consumption Report Generation:

This system is also designed to suit the needs of the owner of the ATMs using a web application and/or android mobile application. The owner can change the schseduler settings by setting the temperature upon which the air conditioner should switch on or off and the light to glow dim or in an increased brightness state based on the ATMId and the SystemId. The owner can also set the maximum allowable power beyond which the power tampering alert would be sent. The owner can at any point of time also view the overall usage of power consumed as well as view the on/off status of the air conditioner, light and the ventilator fan within the ATMs in the form of power consumption report. The admin also has the privilege to add, delete or edit installation of this system in ATMs.

D. Live Status and Map Details:

The admin can view records with the details such as ATMId, SystemId, location, ATM temperature, status of AC and light, GPRS status, last sync date and time and power consumed in units based on the ATM branch, state, district entered by the admin. The map details such as ATMId and SystemId upon being entered by the admin will show the exact location of the ATM where the system is installed along with the status of the electrical equipments. It is also possible to view all the location of the ATMs where this system is installed on the map.

Architecture Diagram

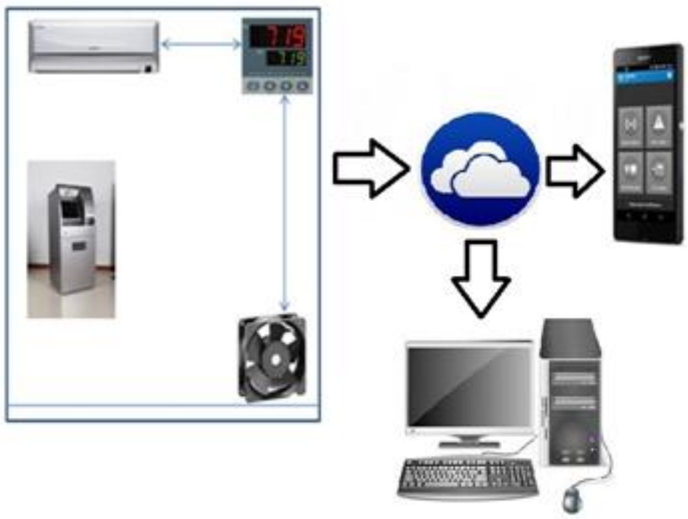

Fig 1: System Architecture

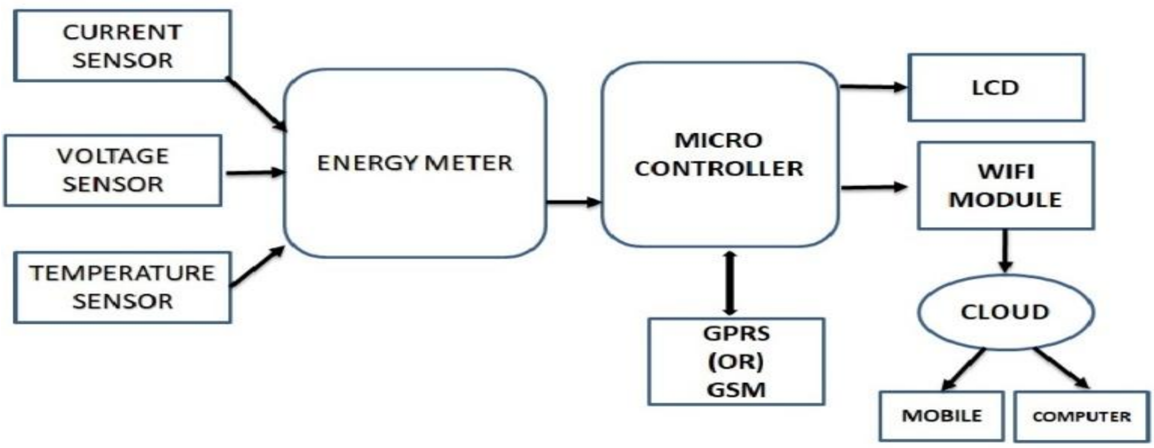

Fig 2: Functional Architecture

COMPONENTS

a. Current sensor:

This sensor is used to keep track of the current consumed by the ATM at regular intervals of time.

b. Voltage Sensor:

This sensor is used to measure the voltage consumed by the ATM and sends the data to the microcontroller.

c. Temperature Sensor:

This sensor keeps track of the temperature within the ATM and this data is used by the micro-controller to switch on or off the air conditioner based on a pre-condition specified.

d. Personal intruder Sensor:

The personal intruder sensor is used to detect the presence of the user within the ATM. This data is used by the microcontroller to make the light glow dim or bright based on the user presence in the ATM between 12:00 A.M and 5:00 A.M when the frequency of users to the ATM is less.

e. Global Systems for Mobile Communication:

This is used to send an alert message to the owner of the ATM incase of power tampering.

f. Micro-controller:

The micro-controllers are nothing but processors. These micro-controllers have the capability to process instructions. These micro-controllers are responsible for controlling the functions of the various sensors and integrating their functioning with the Central computing system.

g. Centralized computer system:

This is a computer which is located in a remote location and it is used to make decision. The computer learns from all the data which is in the database about energy consumption details. The computer performs data analytics and makes decision.

h. Zigbee:

In-order to send and receive values from various sensors in a wireless medium, the Zigbee technology is incorporated in the system. Once the sensors records values, they are transmitted to the database in the centralized system using this technology.

i. *Database:*

The database is used to store data about the power consumption details of the ATM. MySQL is used to manipulate the database.

IV. RESULT

S.NO	Module	Input	Output
1	Live status display details	Number of records to be displayed per page	Displays a list of records with their ATM ID, SEMS ID, Area, Last Sync date, Mode status, Temperature status, AC status, Fan status, Light status and GPRS status.
2	Master Details: 1) ATM Master	Enter the State, District, Bank, Area, ATM ID, SEMS ID, Latitude, Longitude, R Load, Y Load, B Load, Customer No, Location, Address	Adds the details of the ATM in which the system has been installed.
	2) Asset Master	Enter the ATM ID, Star rating, AC Ton, AC Status, No. of Units, Watts, Product, Phase and Remarks	Adds additional products that would be monitored by the system.
3	Energy Consumption Report	Enter the State, District, Bank, Area, ATM ID, From Date and To Date	Displays the energy consumed by each equipment, their running mode and the total power consumed.
4	Asset details	Enter the State, District, Bank, Area, ATM ID	Displays the asset details.
5	Tamper details	Enter From Date and To Date, Number of records to be displayed per page	Displays a list of records with their ATM ID, SEMS ID, Area, , R Phase Load, Y Phase Load, B Phase Load, , R Phase Actual Load, Y Phase Actual Load, B Phase Actual Load and the date and time
6	Instant details	Enter the State, District, Bank, Area, ATM ID	Displays the instant details about all the equipments in the ATM.
7	Scheduler details	Enter the number of records to be displayed per page	Allows to set the AC and light ON/OFF time and the temperature day and night mode(min and max time)
8	Map details	Enter the State, District, Bank, Area, ATM ID	Displays the latitude, longitude and the running mode of AC at the ATM in a particular location.

CONCLUSION AND FUTURE WORK

Energy consumption is crucial and requires proper usage especially in places such as ATMs where the electrical equipments are operated all day. The use of Internet of Things (IOT) in energy management takes it to a fully advanced level which is the need of the hour. By using cost effective sensors not only the power consumption can be reduced, the problem of power tampering in ATMs are also controlled by this system. Digital banking emergence in India has led to an increasing number of ATMs. Therefore, more energy is consumed since electrical equipments within ATMs need to operate all day. This has led to increased cost as well as increased changes of power tampering at ATMs.

It is concluded that, the usage of advanced technology improvises energy management and automation. However, there has not been a drastic change in the behaviour of these systems but many new ideas have been proposed. Before implementing any such technology a thorough knowledge about every component used has to be studied and analysed. As future work, we would like to implement this system on a large number of ATMs.

Table 1: Comparison With Atm Timer

Features	**ATM Timer**	**Smart Energy Management System**
Electrical Equipments On/Off	Yes (AC & Signage)	Yes (AC, Signage, UPS, Lights etc)
Working.	Manual	Automatic
Data Retrieval	No	Yes
Mobile App Support	No	Yes
Temperature Control	No	Yes
Internal Energy Meter	No	Yes
Phase-wise Reading/Watts	No	Yes
Web Dashboard	No	Yes
Cost	No	Yes
Live Status/Control	No	Yes
Just-in-time Reports	No	Yes
Energy Saving Status Report	No	Yes
Power Tampering Detection	No	Yes

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