iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** IV **Month of publication:** April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4021

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

Efficient Energy Management System Based on IoT

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Abstract: The Internet is one of the backbones of many emerging technology and trends. And it's also becoming a huge solution for controlling and directing things. The most common problem in today's electric grid is to meet the unconditionally rising energy demands. This paper proposes the concept to vandalize the unauthorized energy consumption by providing the accurate view of the consumption details by the great use of internet of things. This is done by defining the fundamental rules between the electric utility and the residents which govern the planning and distribution based on the rules and criteria. Consumers can use their home appliances by registering through a common portal. The Common portal deals between electric utility and consumers. Each consumer has a unique identity for their power plan which provides the secure access to the electricity.
Keywords: Internet of Things(IoT), Microcontroller, Electric theft, Smart Grids, Smart Meters.

I. INTRODUCTION

Our future is moving towards the smart energy management system which requires the changes from the basic energy usage and supply. Electric power distribution is the last stage in the delivery of electric power. It carries electricity from the transmission system to individual consumers. Distribution substations connect to the transmission system and lower the transmission voltage to medium voltage ranging between 2 kV and 35 kV with the use of transformers. Primary distribution lines carry this medium voltage power to distribution transformers located near the customer's premises. Distribution transformers again lower the voltage to the utilization voltage used by lighting, industrial equipment or household appliances. Often several customers are supplied from one transformer through secondary distribution lines. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the sub-transmission level. This conventional power distribution system to the consumers is not adequate to the changing and rising energy demand for the current century. Increase in the demand due to ever increasing population causes the burden on the power sector thus leading to the power outages and load shedding. And also Electric theft is mostly seen in the slum areas and in some villages. As a result, the substantial amount of power is wasted and there's is a mismatch between generation and monetary gains. Thus managing the power is an essential one. Smart grids are the new emerging concepts that combines the conventional electrical grid and makes as the two-way communication system between users and electric utility. This improves the efficiency of power generation, transmission, distribution, and consumption. Internet of Things provides the communication protocol for energy management. This work presents the effective and secured utilizing way of the generated electricity. It also detects the unauthorized access using IoT both in the transformer and at home. This enhances the traditional power management technique and also gives the clear view of the consumed power to the consumer.

II. PROPOSED SYSTEM

In this paper, we have proposed about the smart communication between the electric utility and the consumer network. Microcontroller plays an important role which acts as a smart meter in all the consumer entities. It acts as a gateway for the power usage. Each user has to register their identity in a specific web portal to get access to the electricity. All consumers have their unique identity on which they should specify the currently using home appliances detail. Consumers can use only the registered home appliances at their home. The web portal is a bridge between the consumers and the electric utility. They can also control their registered home appliances through the web portal by means of the Internet of things. The consumer can select their power usage level in advance and they can also demand power through the web portal. Information of all the consumers is stored on a separate server. The distribution transformer distributes the power to the consumers based on their Internet address with the help of the server. If the consumer using more power within the allotted days, Electric utility send a notification to the consumer to reduce any load at their home in order to use the power efficiently. The process such as planning in each substation, transmission via a specified route, distribution over the internet address will update the server.

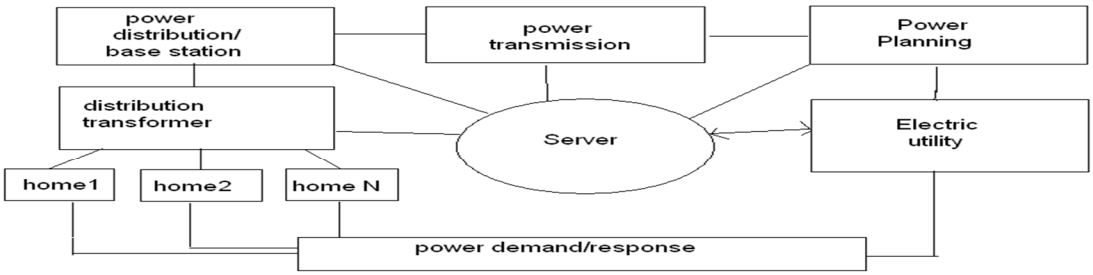

Figure 1 basic representation of the proposed system

The basic representation of this model is shown in figure 1. The Basic working block diagram of the proposed paper is shown in figure. Figure 2 shows the daily consumption details of the home appliances. The web portal also shows the used power level of each registered appliances in the consumer model.

III. WORKING MODEL

The working model includes the basic requirements to measure and sense the power. The top layer design is shown in figure 2. The System is monitoring on two sides that are in power transmission sector and also in the distribution sector. This is done by the electric utility.

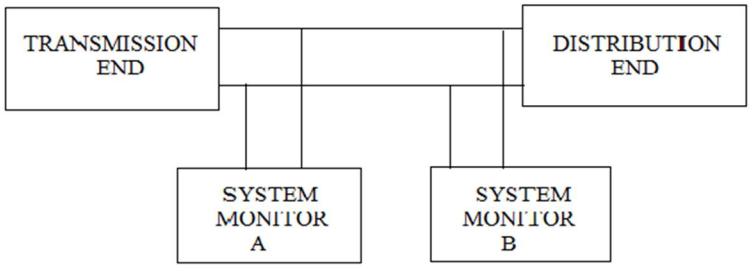

Figure 2. Top layer design

The working model is shown in figure 3.The Microcontroller acts as a gateway between the user and the distribution area. Each consumer has this model in their home. Since web portal is the key to transmit the power as they have a unique identity.If any anonymous consumption is made, that would indicate in the consumer web portal as well to the utility. IOT aids devices to communicate each other and to take the decision based on the defined rules.

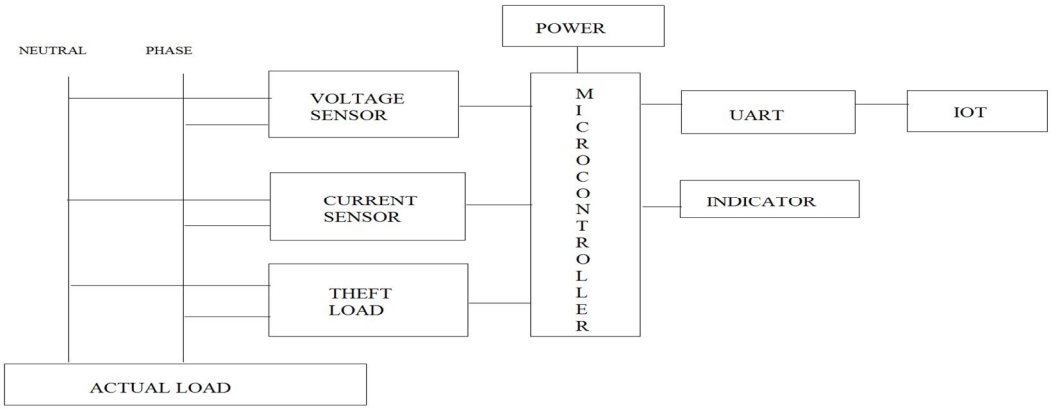

Figure 3.working model design

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IV. RELATED WORKS

A. Smart Home

A home is designed for power transfer between the electricity grid and energy consuming appliances. A smart residential building has two-way communication with the utility grid, enabled by a smart meter, so that it can interact dynamically with the grid system, receiving signals from the electric utility and responding with information on the usage of the consumer and diagnostics of the consumer. This bidirectional information exchange is done by Advanced Metering Infrastructure (AMI).

B. Internet of Things

The Internet is such an integral part of our daily lives that we struggle to imagine life without it. We are entering a new phase of growth where the everyday "things" around us will be connected to the web. This is the Internet of Things (IoT), and it will change the way we interact with our environment. Internet of Things (IoT) is a technology that connects things to networks and shares information. Not only does it transfer information but it analyzes the collected data and predicts accordingly. IOT consists of sensing, network infra, service interface, and security. Sensing acquires and transfers the real-time information by attaching electronic tags to the required objects or locations. It is being developed beyond the physical sensors for such data as temperature, humidity, heat, gas, and ultrasonic waves into smart sensors housing interfaces and data processing capabilities.

V. ENABLING TECHNOLOGIES

Enabling technologies for smart homes mostly fall into two broad categories: utility-side and customer-side, and may be further enhanced through policy and legislation. Psychological and behavioral could also greatly enhance the effectiveness of all the following enabling technologies.

A. Utility Side Enabling Technologies

One of the most pressing issues for a utility company is the management of high peak demand. From electricity generation to delivery, the electricity grid is designed to serve consumers during high demand conditions. Most of the time, the system is not used at full capacity, so a significant fraction of the system capacity idles. Smart homes are expected to help utility companies through the ability to dynamically modify their electric energy consumption level in response to grid conditions, allowing reductions in the output of peaking generation and transmission capacity. The savings introduced to electric utilities in the form of low capital investments as well as the reduced purchase of expensive electricity from peaking generators. There are two methods to modify the home energy consumption. One is to reduce the consumption level by demand basic response from consumers.In this method, demand is made by the consumer if they need more power to the electric utility. Another method is to notify the consumer about their regular consumption level.

1) *Demand Response:* Electric utilities may include strategies like demand response, to reduce high load conditions. It refers to a group of mechanisms that enable load curtailment in response to supply conditions. It is effective at reducing peak demand. It aims at temporarily reducing the load. Direct load control is generally used to mobilize capacity for load reduction.

B. Customer-Side Enabling Technologies

These technologies aid electric utility to communicate and to work with the electricity grids and to provide it more secure.

1) *Smart Meters:* The Smart Meter provides the information and communication infrastructure to communicate in real time the operational and pricing information bi-directionally between the end-user and the electric utility. It can record consumption data at intervals (as frequently as every minute) and automatically transfer the information to the utility over a secure network. Various communication architectures like point-to-multipoint have been implemented. The network also supports giving signals to the meter, which could be used for an "on demand" reading to confirm the power restoration after any time of the outage.
2) *Smart Loads:* A smart appliance is an end-user device that is connected to the internet and may be able to automatically or remotely respond to signals from the utility and other subsystems at home. The consumer can control their appliances through a web portal.if they are not responding properly when the high consumption time, the electric utility can also control the consumer appliances to reduce the consumption level.this in turn also helps monitors the transformer capacity by the utility.
3) *Customer Portal:* The information collected by the smart meter is viewed by the consumer in the web portal, as it can help increase awareness of energy consumption. To make this information accessible and understandable, electric utilities are introducing web portals that customers can use to access the detailed information on their consumption patterns and often know

the avenues of energy efficiency. Many web portals include analytics to increase energy efficiency based on consumption patterns, insights on why a bill increased and past bill information.

VI. RESULTS AND DISCUSSION

The following figure is the result obtained from the implementation of the system. Figure 5 shows the consumer side web portal.

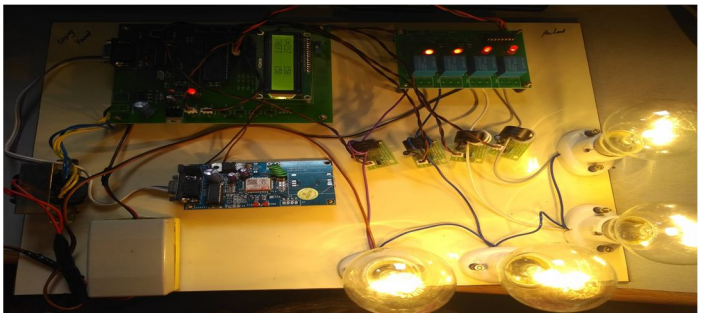

Figure 4 Result of the proposed system

It gives the consumption details of each home appliances and the basic details about each consumer. And figure 6 shows the electric Utility side web portal model. It shows all the consumer details. If any consumer reaching the near to the allotted power in short duration, it indicates as red in color which also shows in figure 6.

In this condition, utility alerts the consumer in order to reduce the load and power usage. If the consumer is not responding to the alert, the utility has the right to turn off the load via the web portal as the power distribution is made only by the internet address, no theft or anonymous power consumption can happen.

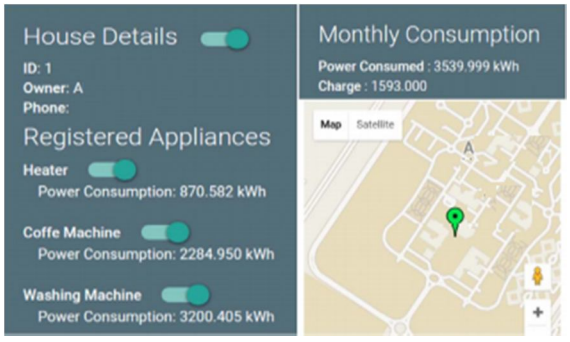

Figure 5 Consumer side model

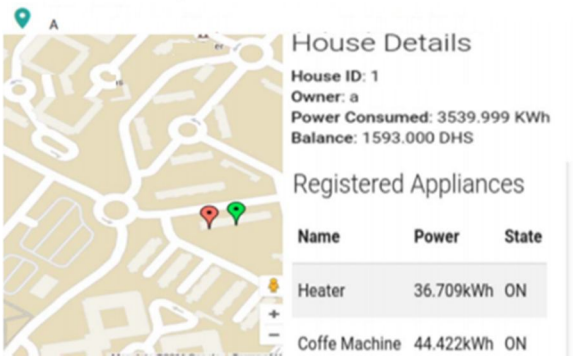

Figure 6 Utility side model

If any anonymous power consumption has happened, it can be easily determined with the help of Internet address.

VII. CONCLUSION AND FUTURE WORK

Home Energy Management is the current trend in the development of IOT. Many works have been reported in regards to controlling the home appliances and monitoring the electrical parameters towards the hazard. The conventional electric distribution system has no detection over the unauthorized access from the distributors. This system gives no idea about the energy utilization by the consumers which in turn makes the user blindly showing their overall consumption. Here, we have developed a better IoT system for Energy Management which takes the Humidity, Temperature and light intensity into consideration and interface with Microcontrollers for controlling the appliance like fan, light. Also, the system computes usage and send to the PIC. The information is computed all through the day and same uploaded to a cloud server. This ultimately achieves the energy consumption of household resulting in Energy Management. The system so developed is not fully complete as we have developed only for controlling two houses with the appliances i.e. fan and light. In future, we propose to extend the system for controlling appliances like Refrigerator, Air cooler, Television etc for many houses. The presence of human will only on the appliances. Much power can be saved based on the lesser usage of the appliances. There can be also a manual control over the appliances. We can implement many algorithms that learn the changes in the weather based on season and detect changes in the season based on the temperature and humidity etc.

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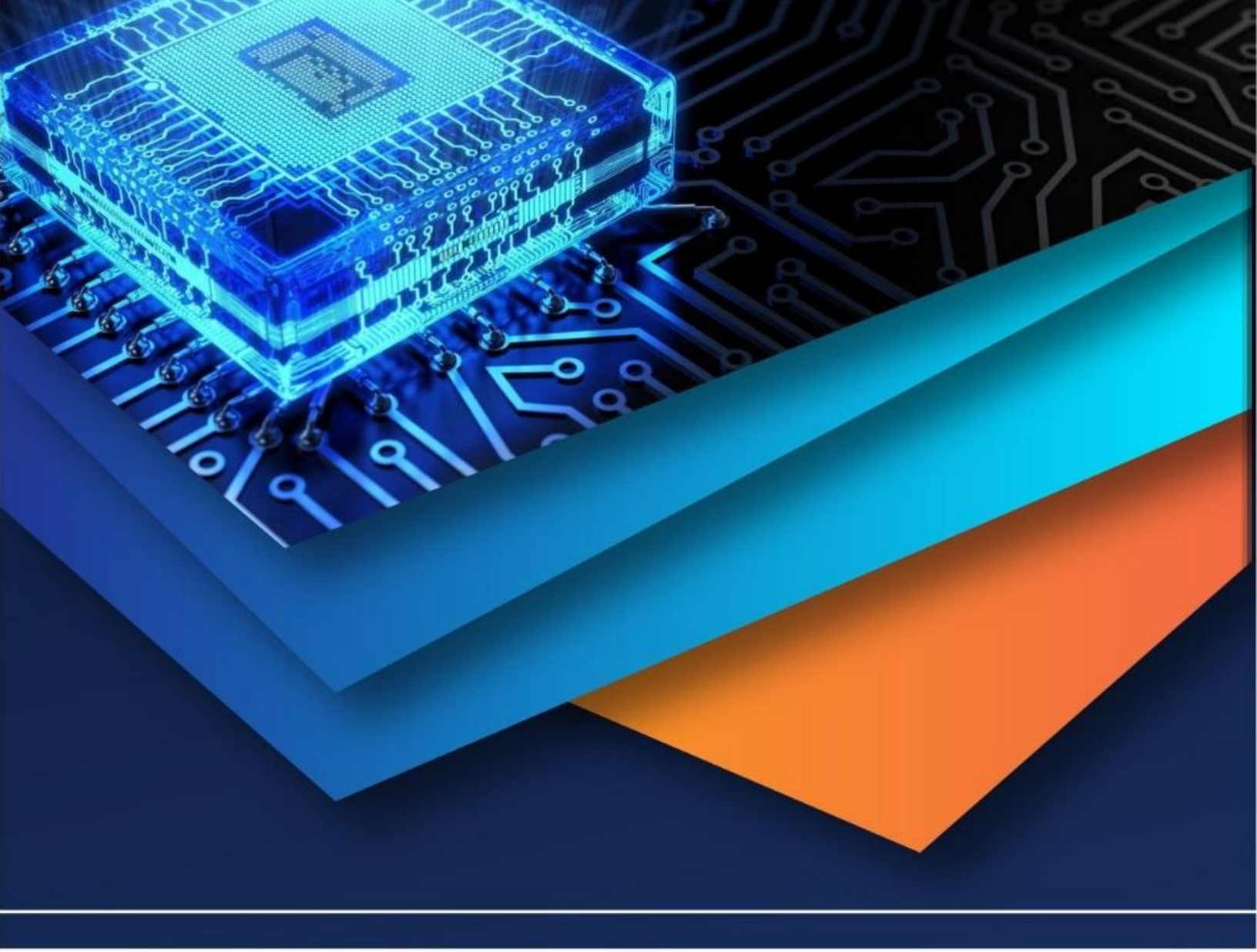

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