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MACHINE LEARNING APPROACH BASED HOME ENERGY MANAGEMENT PREDICTION SYSTEM

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Abstract - *Energy crisis is one among the prime challenges being faced by many of the countries within the world today. For an enormous extent of the demand of energy in industrial development has increased tremendously. A lot of techniques are suggested like an Energy monitoring and prediction system which is an efficient technique to watch the devices present inside a house or industries and provide notification about their abnormal behavior. In this paper, we have focused on predicting electric energy use of home appliances in a low energy consumption house. Electric energy demands are changed in weekdays and weekend days due to the staying time of home residents. In this project the implementation of an advanced Internet of Things (IoT) based system for intelligent energy management in Industries and the home usage. The users can view their status threw the IOT based android application and the webserver.*

Key Words: Energy Meter, Intelligent Prediction Model, Internet of Things. Energy Management

1. INTRODUCTION

Internet of Things and Everything (IoT/E) is a relatively new concept that explains the aggregation of objects, systems, processes etc, via an IPv6 backbone into the web environment. In the existing power utility setup, an IoT framework is often to improve the issues faced by energy consumers on day to day. For instance, consumers are presented with consumed energy details just one occasion a month with zero control on the deployed smart meter (if in existence). The way that is too long for the consumer to watch the instantaneous changes within the power usage. So the length of the time is also getting increase. In addition, utility bills can be convoluted on how they present usage information, but a consumer may not be able to decipher changes in their power usage from the last bill. In most cases, if any consumer fails to pay the bill, the utility field marketers go to their houses to disconnect the facility supply. To display the total real time usage of power and amount of electricity, the conventional energy meters are presently installed in households.

1.1 Need for Demand

There is no thanks to access the small print on what the day's, week's or month's consumption was on these meters. Often, these meters are placed in an inconvenient location which makes regular viewing somewhat difficult. Sadly, ubiquitous access to consumption rate and energy profile by consumers is impracticable. By deploying a sensing/monitoring mechanism in real time (using IoT), the precise power consumed are often ascertained while deriving informed decisions on the way to manage the connected loads. A system which will give users an estimate of what proportion energy is getting used, that has been used, or which may be consumed will allow them to regulate their habits and lower the costs [4]. This is a sort of Demand Side Management during a previous study, i.e., R-SGEMS.

1.2 Meter Reading Techniques

In the conventional electro-mechanical and computerized metering framework, electric vitality is reviewed by individual and regularly they arranged the bill through suspicion dependent on his history of power utilization. Possibly the buyer has not used the comparable measure of power in the present month as in the earlier months for reasons, for example, holidaying somewhere else or being in the office for long time, and so on. This strategy for charging is additionally not appropriate for the power supply organization since it gives a wrong record of the general power utilization in the buyer's region and may at last outcome in blunders in future arranging by the organization.

Over the previous years, metering gadgets have experienced numerous enhancements and clothed to be more convoluted with more highlights and capacities. Electro mechanical Meter has next to no exactness and absence of configurability. There are such a significant number of issues require service organizations to

conquer, for example, power burglary, meter adjustments and the sky is the limit from there. Moreover, meters are restricted to offer the measure of vitality utilization on shopper's premises. In spite of the very fact that there have been presented paid before time metering framework during a few regions in India, the observing framework isn't accessible and because the unit needs to purchase before the utilization, the customers may not settle the measure of unit which they need to purchase and that is the reason continuous power isn't discovered. Today an outsized portion of the utilities organizations are checking out answers to beat these detriments.

1.3 Controller Processing Method

Using PIC micro controller module to achieving real time high performance computing (RTHPC) for smart metering application is novel concept. It has a benefits for transaction processing and data processing in cloud computing environment. Arduino based wireless meter gives more control to both utilities and consumers by providing them detailed information about power consumption on real time basis. The meter send readings like power (kWh), voltage (v), current (I), cost billing (Naira/USD), etc. to a central cloud server. This then stores the knowledge in its database for predictive analysis while allowing both power consumed and bill generated to be viewed by consumers remotely using any internet-ready device. Data are often collected at any desired interval like hourly, daily, weekly, or monthly basis. Since, there's no human intervention within the entire process, to eliminate human error and corruption. This type of remote meter is often utilized in residential apartments, especially for industrial consumers where bulk energy is consumed. The novelty of this work is predicated on belief and integration of a Composite Design methodology for smart metering and cloud interfacing.

This paper focused on smart system that wirelessly profiles energy consumption by calculating the facility consumed by the individual consumers, transmits the calculated rate to a cloud web server so that any valid consumer can view individual consumption rate remotely and enforce demand side management. This system is often adapted in on-grid or off-grid utilities. A simple solar off-grid pure wave Inverter or utility are often used as Alternating Current (AC) source. The materials used include: Arduino Uno microcontroller for saving metering data and transmitting to the online server; a liquid crystal display (LCD), a matrix keypad, a GSM module, a current sensor and a designed website application with database. The integration concepts involve electronics, control, communication, computer and mechanical engineering. These are the basic concepts of mechatronics engineering scientific research.

2. PROBLEM IDENTIFICATION CONVENTIONAL METHOD

2.1 Automated Meter Reading Introduction

Here three different forms of AMR devices. These are:
Advanced meters - a remote reading device, which is connected to the meter
Data loggers – remote reading equipment provided by transporters on larger sites
Gas embedded meters - where the remote reading device is integral to the meter
All of those different AMR devices create a remote communication channel between a business and its energy supplier.

2.2 Block Diagram

Consumption (usage) information is often transmitted from an AMR device on to the energy supplier, meaning manual meter readings are generally not required. To analyse the energy usage data it ensures that the more accurate bills and provide to the customers for their choice. In most cases, this data is available from the energy supplier like daily, weekly or monthly basis, giving customers the choice to monitor their consumption and develop new ways to operate more efficiently. Businesses will, therefore, only pay for the energy they use each month because AMR devices provide an accurate meter reading; estimated bills become a thing of the past and it's much easier to forecast usage.

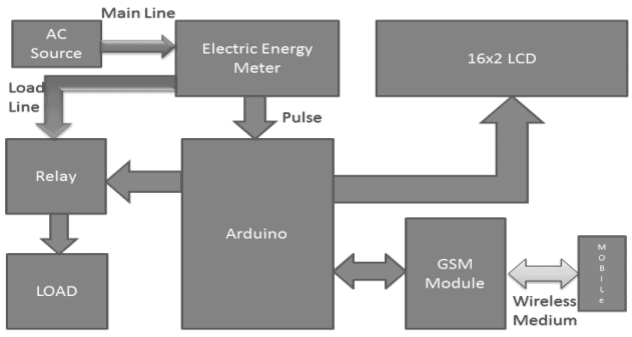

Fig – 1: Conventional Block diagram

2.3 Conventional System Working

The energy meter stores the quantity of energy consumed by the load. In the olden days, electromechanical type of energy meters was available and nowadays digital energy meters are available. The energy meter mainly works on the current increment in amount of current flow through circuit causes the disc to

rotate, means that the rotational speed of disc is directly proportional to the quantity of current flowing through circuit. Old type rotation effect of disc type meter causes the gear to work accordingly and in similar way power consumption by the load is recorded by the micro controller the blinking rate of LED integrated within the meter. Present kind of energy meter also had a blinking led for the counting the pulses from this LED are fed to microcontroller for count operation i.e. these pulses are sent to the microcontroller and these readings are stored into external memory of the micro controller. External memory is an EEPROM.

This memory is able to store previous Energy consumed as well in case one needs to check present Energy consumed status. LCD is connected with microcontroller; microcontroller sends a message to LCD display unit in order that we will view the status of GSM Modem. Whenever a message is sent to the GSM modem, it communicates the message to the micro controller and micro controller is responded back as the preset mobile number through the program. If the customer fails to pay the bills the due bill is shipped by SMS to the customer after updating the readings within the electricity board and supply will be cut by the electricity department.

2.4 Disadvantages

- Still there is no way to maintain Meter Records or Huge Database.
- The system needs Bulk SMS Server.
- The system has one-sided benefits.
- There are two parameters in SVM namely that penalty parameter C defines the trade-off between minimizing the training error and model complexity.

3. PROPOSED METHOD

In the Energy Management system, the most constraints are accurate metering, energy monitoring and implementation of visual data for consumer load profile. This can be achieved by using Smart Meters. This Project is meant in designing a system at home which monitors the energy consumption of each device, and displaying the usage during a graphical way. The aspects of the proposed design will cover three categories where utility which represents a computational system installed where the data acquisition from consumers smart meters can be processed and analyzed. Network which is a bidirectional link to transmit and receive data of consumers through the internet enabled devices.

Based on the data analytics the load profile is created and it will required actions for the consumer active where they will online monitor. The main improvement in this system as compared is to complete the loop and making the consumer as an active part of the system to take decision depending on the notifications/messages provided after data analytics.

Live energy consumption reading from the Smart energy meter is shipped back to the online server periodically and details are updated during a central database. The web server is made and an interface is created for the users to trace the consumption of every appliance within the home continuously from anywhere and anytime.

3.1 Hardware Architecture Detailing

This system is implemented to measure the power, thus the energy in terms of Kilowatt-hour so we need to measure the current and voltage from the mains supply. The voltage is measured from the lines passing through the step down transformer and a voltage regulator so that it's give the regulated dc output that is in the acceptable range of the microcontroller i.e. PIC micro controller.

PIC micro controller platform easy-to-use hardware and software. It senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators. The power calculation is done using the current and voltage values obtained from the supply and also the energy consumption for each of the devices is done in Kilowatt-hour. To interface with microcontroller these data are going to be sent wirelessly via the Wi-Fi module. The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (microcontroller unit) capability supporting IEEE 802.11 b/g/n Wi-Fi standards.

3.2 Proposed Block Diagram Model

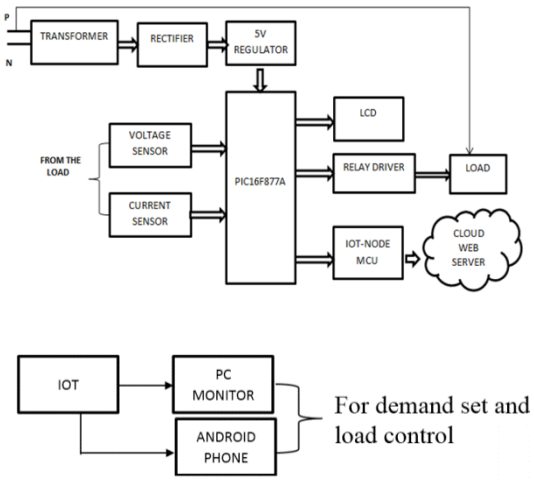

Fig – 2: Proposed System Block Diagram

3.2 Working Methodology of Prototype Model

The predictive analysis based home energy management is proposed in this project. The pic microcontroller based control and monitoring system is used. To calculate the energy consumption by load is calculated through current sensor and voltage sensor. The different load voltage is calculated and read by the microcontroller. The IoT module is interfaced with the Controller which is used to update the home energy consumption reading to the web server. Here we used esp8266 is for the IOT module. The IoT server is linked with our controller kit through this module by setting user name and password by the user.

The second thing is to estimate the cost analysis of the consumed power. Whenever the load consumption is exceeds the limits the GSM send the message to the user. And after the node mcu is used to control to cut the particular load. Total progress of our project is displayed in LCD display.

3.3 Flow of Work Progress

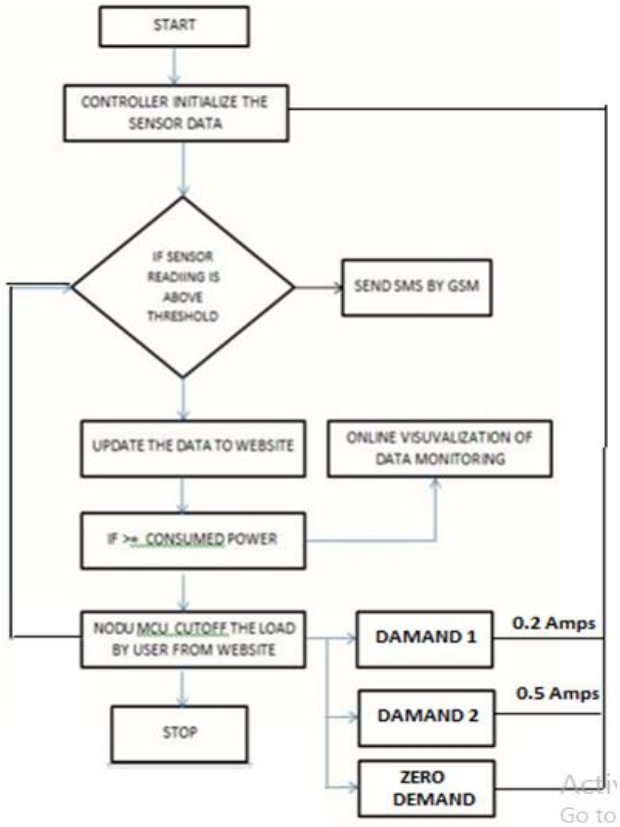

Fig – 3: Proposed System Work Flow Diagram

There is an excellent necessity for the optimization of energy consumption, especially for the case of electrical energy, in altogether economic sectors. The aim is typically to enforce the utilization of renewable energy from the standpoint of electricity source. While from an economic point of view, since energy costs represent a large percentage of the total costs of industrial processes, the aim is set at reducing the associated outlay. This work presents an IOT based Machine learning providing support to a new intelligent system for energy management within a given range of time to optimize costs. Its operation is predicated on analysis and decision-making for real-time energy generation and consumption data, consistent some conditions.

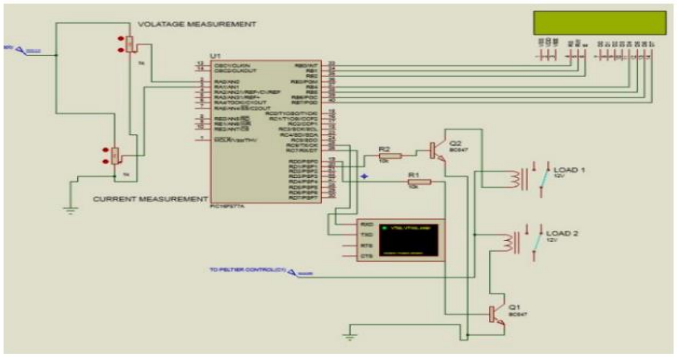

Fig – 4: Proteus Simulation Model of Proposed System

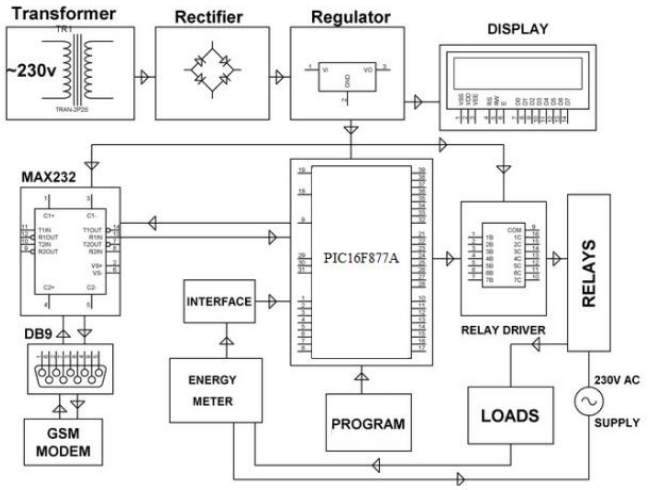

Fig – 5: Circuit Diagram Hardware prototype Model

3.4 Advantages For Consumer

- Far greater and more detailed feedback regarding energy use.
- Ability to adjust habits in order to lower electricity bills.
- Reduces the number of blackouts and system-wide electricity failures.

3.5 ADVANTAGES FOR INDUSTRIES

- Eliminates manual monthly meter readings.
- Monitors the electric system in real time.
- Encourages more efficient use of power resources.
- Provides responsive data for balancing electric loads while reducing blackouts.
- Enables dynamic pricing.
- Avoids the capital expense of building new power plants.
- Helps to optimize the profit with Existing resources.

4. RESULT AND DISCUSSION

The hardware prototype of this project is shown in figure 6. Here the components are step down transformer, current transformer, LCD display, GSM and node mcu. Step down transformer is used for power supply to the whole circuit and also it used to measure the voltage reading. AC to DC conversion is done by full wave rectifier circuit. The regulator IC 7805 converts the 16v DC into 5v DC constant power supply. PIC micro controller is master of this hardware prototype. It consists of 8 analog to digital conversion channel which is very necessary in this project. According to this project the micro controller have to read current and voltage measurement like an energy meter. And also it must know individual load current status. Then only it can predict how to reduce the billing to next month usage. So the reason behind high billing we can predict in early stages.

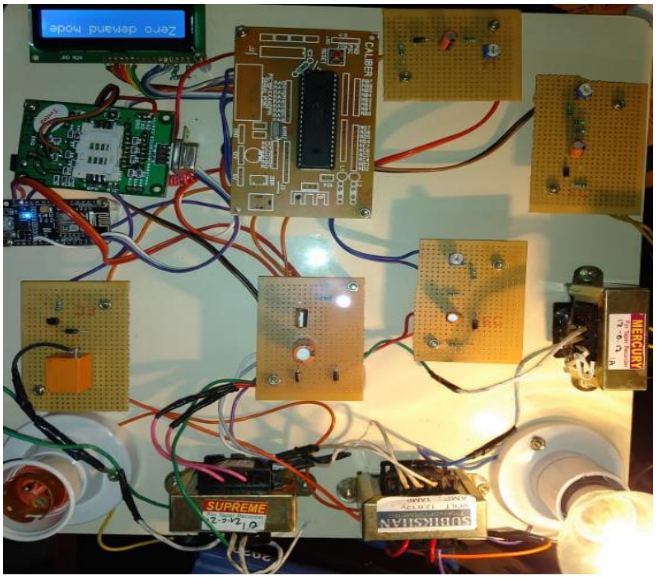

Fig – 6: Hardware Setup Arrangement of Demo Model

Maximum load capacity of current transformer is 200 watts. Load 1 and load 2 connected to analog pin of A0 and A1 respectively. GSM communication established here for user friendly. Every end of the month it will send a SMS to users authorized mobile number details like total power consumption, unit and billing info and also predictive analysis information. The micro controller activates GSM modem through AT commands. To help the electricity department Node Mcu was developed in this project. It can send the data to particular web server through internet connectivity. Cayenne android mobile application is used to set the demand mode in these meters.

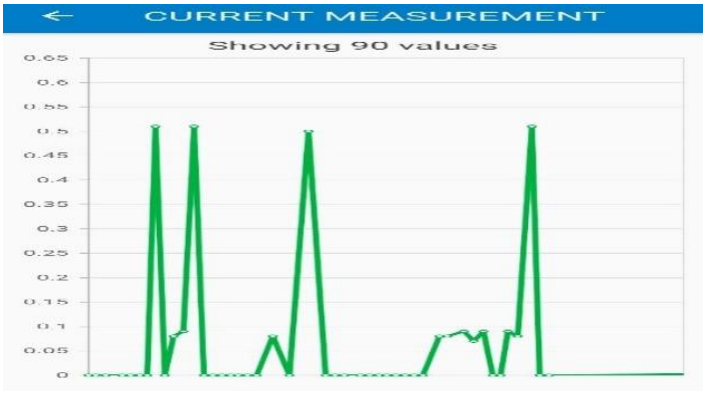

Chart – 1: Current value (DAQ) through thing view

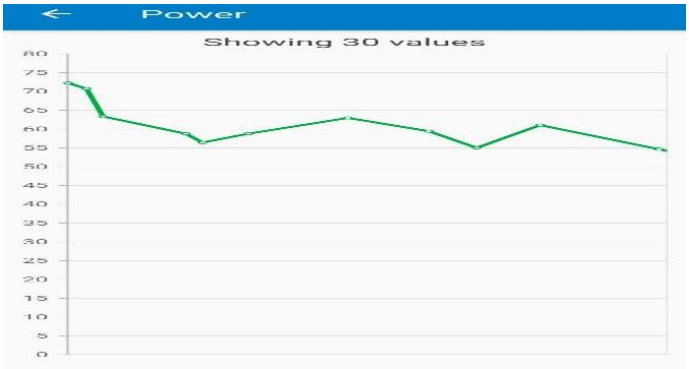

Chart – 2: Power value (DAQ) through thing view

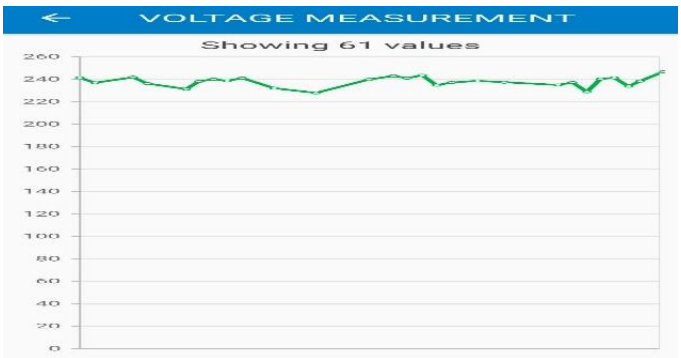

Chart – 3: Shows the screen shot of voltage value (DAQ) through thing view

Fig - 7: Normal / Demand Mode Selection

5. CONCLUSION

The proposed Smart Metering System is capable of monitoring various parameters of electricity like Voltage, Power Factor, Current, energy consumption in kWh etc., and therefore the consumer can take suitable precautions to safe guard the electrical appliances. This makes the buyer a lively a part of Energy Management. The consumer also can monitor the load during peak hours. If the quantity of load shifted to normal hours there by the peak demand will go down and hence power generation during peak hour are often reduced, this brings the production cost down. Since, the consumers get benefited for limiting the consumption during peak hours, they become vigilant in managing electricity consumption. Hence, the designed Smart metering system is beneficial to both utility Provider and consumers. An intelligent circuit which detects theft and generate a switching pulse on detection of theft can be designed and integrated with the system. An apt tariff system and theft detection circuitry can be integrated with the proposed smart meter design.

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