IMPLEMENTATION OF SMART POWER CONSUMPTION MONITORING SYSTEM USING IOT

A MINI PROJECT REPORT

Submitted by

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in partial fulfillment of the requirement for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRICAL AND ELECTRONICS ENGINEERING

K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY

(An Autonomous Institution, affiliated to Anna University Chennai and Approved by AICTE, New Delhi)

SAMAYAPURAM – 621 112

MARCH 2021

K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY

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BONAFIDE CERTIFICATE

Certified that this project report titled **"IMPLEMENTATION OF SMART POWER CONSUMPTION MONITORING SYSTEM USING IOT"** is the bonafide work of **JENNIFER SUNITHA J. (811718105023), KEERTHANA K. (811718105025), RATCHAMBIKA C. (811718105036)** and **SHARAN JOHN J. (811718105040)** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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We jointly declare that the project report on **"IMPLEMENTATION OF SMART POWER CONSUMPTION MONITORING SYSTEM USING IOT"** is the result of original work done by us and best of our knowledge, similar work has not been submitted to **"ANNA UNIVERSITY CHENNAI"** for the requirement of Degree of EEE. This project report is submitted on the partial fulfilment of the requirement of the award of Degree of EEE.

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ACKNOWLEDGEMENT

It is with great pride that we express our gratitude and in-debt to our institution "**K.Ramakrishnan College of Technology**", for providing us with the opportunity to do this project.

We are glad to credit honorable chairman **Dr. K.RAMAKRISHNAN**, **B.E.,** for having provided for the facilities during the course of our study in college.

We would like to express our sincere thanks to our beloved Executive Director **Dr. S. KUPPUSAMY, MBA, Ph.D.,** for forwarding to our project and offering adequate duration in completing our project.

We would like to thank **Dr.K.V.SHRIRAM, M.E., Ph.D.,** Dean, who gave opportunity to frame the project the full satisfaction.

We whole heartily thanks to **Dr.A.Rajkumar M.E, Ph.D.,** Professor and Head of the department, **Electrical and Electronics Engineering** for providing his encourage pursuing this project.

I express my deep and sincere gratitude to my project guide **Mr. P.Sabarish, M.E,(Ph.D).,** Assistant Professor, Department of Electrical and Electronics Engineering**,** for his incalculable suggestions, creativity, assistance and patience which motivated me to carry out this project.

I render my sincere thanks to Course Coordinator and other staff members for providing valuable information during the course.

I wish to express my special thanks to the officials and Lab Technicians of our departments who rendered their help during the period of the work progress.

ABSTRACT

The use of power is very essential in our life and proper utilization of this is a challenging task. In order to consume minimum electricity, the calculation parameter is arrived by using Power Consumption Controller. For the monitoring home appliances purpose, we will use IOT. In order to accomplish this goal, a complete front-end to back-end system that includes a smart device application (Android platform), a cloud-based database, an Application Programming Interface (API), and a hardware development are designed and proposed. In addition to this, we are also using A small programmable computing device.

This Microprocessor is identified due to familiarity, and its capabilities, such as general purpose pins(GPIO pins) and built-in Wi-Fi chip module. In this process we are placing the current sensor and voltage sensor at electrical load to measure the current and voltage. After this, power consumption of electrical appliances is generated. This data will be transmitted wirelessly using Wi-Fi access protocol to the Ethernet shield. The transmitted data is monitored and analyzed remotely using IOT. This enables user to have flexible control mechanism remotely through a secured internet web connection. Our projects aim and implementing a new method of measurement of Tariff Cost according to the tariff rates of the Tamil Nadu Electricity Board especially industrial consumers, how edge signed the circuit is employed simply and easy to implement under various environmental condition.

This circuit includes the Measuring the power by using sensors in circuit's measures the digital meter's signals. These signals are converted to digital pulse, which is obtained to use for recording the consumed tariff and calculates corresponding to the tariff consumed through the rate meter attached to the tariff meter block.

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INTRODUCTION

CHAPTER 1

1.1 . INTRODUCTION:

Though electricity is essential for our life cycle, the proper utilization of this must be done to utilize maximum availability in the minimum efforts and cost. We can consume the electricity and calculate corresponding consumption by using the electric meter. This supply and consumption will direct impact of economy of an individual family or an agency or a company especially in impacting of financial results. In our working environment, it is necessary to manage consumption of electricity due to limited availability of resources. The Tariff of a house consumptions are detected with the help of current transformer. This will give the units which are consumed by the house mates. The derived Digital value is send to the micro controller through which converted into serial data and send to IOT.

The system is designed on an Arduino micro controller .It can be differentiated into three parts viz., controller, theft detection circuit and a WiFi unit. The controller performs the basic calculations and processes the information transmitting and the most important role is transmitted by the Wi-Fi unit and sends information from the controller over the Internet. The Arduino controller is programmed on the Arduino software IDE (Integrated Development Environment) which is a pre-requisite to operate on the Arduino board. It is code derivative of the C language programming. The idea involves providing multiple stations placed in several areas of cities.

These stations periodically upload and send data to IOT cloud. For the proof of the concept and exploding ideas, the author used developed boards, such as Nitrogen iMX 6 or Raspberry Pi, but for the final IOT solution, properly studied and calibrated high-quality sensors where industrial IOT gateway devices, such as HMS Netbiter or equivalent equipment, are targeted. The key differentiator between this solution and other solutions are the design of security for the IOT gateway and communications to the IOT Clouds. The artificial intelligence (AI) and ontology's and other technologies may be used for better prediction and data analysis.

OVERVIEW:

The aim of this paper is to recognize proper usage of electricity without any loss on the tariff part. 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. According to researchers, "The IOT is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers and the ability to transfer data over a network without requiring people from one to another and also human to computer interaction.

Computing and communications have their own future in technological transformation brought by IOT. Many researchers have been studying the concept of IOT, the applications and security of these parameters using IOT [2, 3]. Power consumption can be reduced to a great extent if we monitor our daily power consumption and switch off appliances which are not required for necessary usage which consuming electricity more and more (like Heater, Electrical Stove /etc). This paper focuses on developing a monitoring system using the concept of Internet of Things (IOT).

Internet of Things (IOT) is a recent revolutionary in technology which consists of integration of sensors and communication capabilities to common things. This will gather useful data also. Such IOT enabled devices can be used to monitor various important physical, electrical or environmental devices and their parameters.

The generated information is used to analyze, identify and solve different problems related to everyday life setup. Electrical power management which we are using at our home environment is an important aspect on usage. IOT enabled power monitoring devices can help to solve this problem by providing information about electricity consumption. In the present Indian scenario, conventional electric meters supplied by electricity supplier's measure power consumption of the whole building not like individual. These devices are not used to calculate the individual power utilization of electrical and electronic appliances.

These meters also lack of storage feature as well as not having to analyze data. Due to absence of communication facility in these meters, power consumption has to be noted down manually by human intervention at each meter level in each location for billing purpose. This process may lead to human error and making improper calculations while billing and other capacity monitoring

It is becoming more complicated to handle electricity maintenance and requirements in this process. Therefore there is an immediate requirement to save as much electricity at the maximum possible level. As the demand from the newer generations of people, the electricity need on increasing figures which require a technology improvement to do all this. The proposed system provides a technical twist to the normal energy meters using the IOT technology. Also there are other issues that we have to address such as power theft which in turn generate economic loss to the nation. Monitoring, Optimized power usage and reduction of power wastage are the major objectives that lie ahead for a better system.

Smart energy meter using Wi-Fi system is designed based on three major objectives. Those are:-

1. To provide automated load energy reading over an immediate basis.
2. To use the electricity in an optimized manner.
3. Reduce the power wastage.

The system basically can be classified on the basis of service ends in two ways:-

1. Consumer end
2. Service end.

The data from the system is displayed on a web page which can be accessed by the consumer.

1.2 . PROBLEM STATEMENT:

The Tariff for the house consumptions detected with the help of current transformer. This will give the units which are consumed by the user end. Digital value is send to the micro controller through which it is converted into serial data and then sends to RF TRANSMITTER and at the other end it is received by RF RECEIVER. This received value is send to the micro controller.

The software consists of set point values in the other end. The software will compare the set point value with the actual value of unit in the micro controller, Then the corresponding output values are displayed in **LCD DISPLAY** device, when it exceeds a control mechanism of switch must be pressed. Individual usage on house consumption is connected with the Electricity office and while pressing the switch the EB billing will displayed in the LCD display.

OBJECTIVE OF THE PROJECT

This paper describes Arduino Micro controller based design and implementation of energy meter using IOT concept. The proposed system design eliminates the manual involvement from human being in Electricity maintenance. The Buyer needs to pay for the usage of electricity on schedule. In case if he could not pay bills, the electricity transmission can be turned off autonomously from the distant server. The user can monitor the energy consumption in units from a web page by providing device IP address. Theft detection unit connected to energy meter will notify company side when meter tampering occurs in energy meter and it will send theft detect information through PLC modem and theft detected will be displayed on the terminal window of the company side. Wi-Fi unit performs the IOT operation by sending energy meter data to web page which can be accessed through IP address.

New data sets were generated through a process of data acquisition and quality assessment, the establishing of data handling and management and assessment processes, and then these were used in several environmental modeling approaches to study both present and future expected impacts. The specific objectives of the program were to:

1. Develop a scientific framework for a regional, integrated assessment of air quality and its environmental impacts.

2. Review sample methods and data handling techniques, data acquisition and assessment methods where needed developed tools for greater automation and improved access.

3. Establish a distributed, interoperable database for data assimilation and quality assurance and a set of flexible, efficient user interfaces for data access and information sharing.

4. Formulate and apply models for the assessment of regional air quality and associated environmental impacts, including the use of data mining techniques as well as load and concentrations estimates from an emissions database.

5. Establish an urban air quality and meteorological reference station at Sohar University.

LITERATURE REVIEW

CHAPTER-2

2.1 LITERATURE REVIEW:

[1] "Landi, C.; Dipt. di Ing. dell"Inf., Seconda Univ. di Napoli, Aversa, Italy ; Merola, P. ; Ianniello, G", "ARM-based management system using smart meter and Web server",2011.

In this paper they described such as a low cost real-time ARM-based energy management system is proposed. It is conceived as part of a distributed system that measures the main power system quantities and give the possibility to manage the whole power plant. An integrated Web Server allow collecting the statistics of power consumptions, power quality and is able to interface devices for load displacement. The device is characterized by easy access to the information and the combination of a smart meter and data communication capability allow local and remote access. In this way it is possible to manage the power consumption of the power system leading to an overall reduction in consumption and costs.

[2] "Garrab, A.; Bouallegue, A.; Ben Abdallah" , "A new AMR approach for energy saving in Smart Grids using Smart Meter and partial Power Line Communication" , 2012.

In this paper they described such as the growing demand of energy, the capacity limitations of energy management, one-way communication, the need of an interoperability of the different standards, the security of the communication and the greenhouse gas emissions, leads to emerge a new infrastructure grid: Smart Grid. Smart Meters are one of the proposed solutions for the Smart Grid. In this paper, an AMR solution which provides enhanced end-to-end application. It is based on an energy meter with low-power microcontroller MSP430FE423A and the Power Line Communication standards. The microcontroller includes an energy metering module ESP430CEl. The aim of this work is to realize a real time pricing thanks to the proposed communication infrastructure. This solution is with great interest in economical and low carbon society point of view.

[3] "B. S. Koay, S. S. Cheah, Y. H. Sng, P. H. Chong, P. Shum, Y. C. Tong, X. Y. Wang, Y. X. Zuo and H. W. Kuek" , "Design and implementation of Bluetooth energy meter", 2012.
In this paper they described such as Presently electronics energy measurement is continuously replacing existing technology of electro-mechanical meters especially in China and India. By the year 2004, digital meter has start replacing electromechanical meters in Singapore. A wireless digital energy meter would definitely offer greater convenience to the meter reading task. Bluetooth technology is chosen as a possible wireless solution to this issue. In this paper, we present the design and implementation issues of a Bluetooth-enabled energy meter. The energy reader can collect the energy consumption reading from the energy meter wirelessly based on Bluetooth.

[4]“Darshan Iyer N, Dr. KA Radhakrishna Rao M Tech. student, Dept. of ECE ,PES College of Engineering, Mandya, Karnataka, India” , “ IoT Based Energy Meter Reading, Theft Detection and Disconnection using PLC modem and Power optimization” , Vol. 4, Issue 7, July 2015.
Francesco Benzi and Lucia Frosini reported electricity Smart Meters Interfacing the Households. They addresses this topic by proposing the definition of a local interface for smart meters, by looking at the actual European Union and international regulations, at the technological solutions available on the market, and at those implemented in different countries, and, finally, by proposing specific architectures for a proper consumer-oriented implementation of a smart meter network. Pedro Cheong and Ka-Fai Chang describes a ZigBee-based wireless sensor network node for the ultraviolet (UV) detection of flame.

SMART ENERGY MONITORING SYSTEM

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3.1 POWER CONSUPTION SYSTEM

3.1.1 INTRODUCTION:

The specific feature of Arduino smart energy meter is their ability to communicate the meter data to the supplier and consumer. Due to large network coverage, low cost and with negligible maintenance, availability, sending the data through SMS (GSM) is a useful and handy tool. Arduino based Smart energy meter also records data locally, prevent tempering and overloading.

An Arduino based smart metering system comprising of a smart energy meter and a mobile phone acting as a central server receiving all the data sent by the energy meter. Other features of smart energy meter using Arduino are:

- Meter measures, record and integrate the energy consumption of the load connected
- It transmits the reading of voltage, current, power factor and kiloWatts to utility and customer through GSM Sim900D module and Arduino.
- if customer is using the load above maximum demand limit, It turns the load off.
- It turns the load off, if customer tries to tamper the meter or tries to illegal activities with meter.
- It saves all the values in an SD card, related to energy, power factor and load.

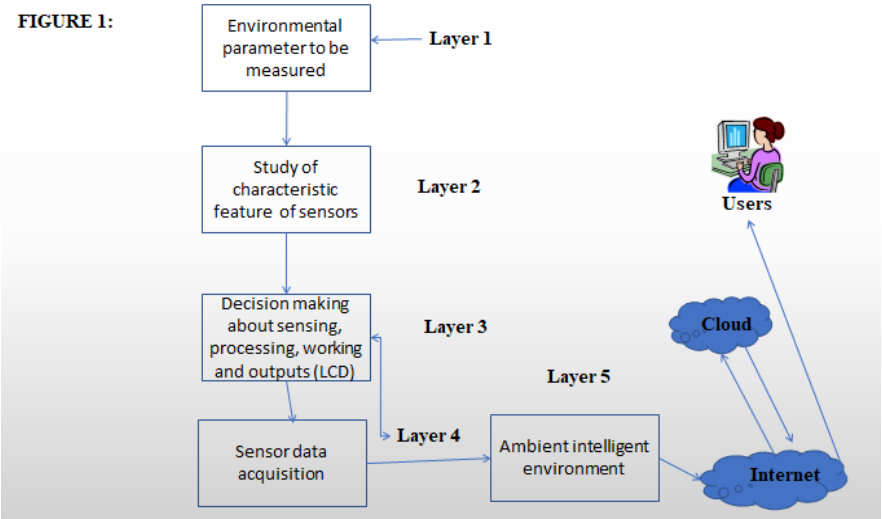
In voltage measurement, main power supply is connected to the primary of a 230-4.5 V step down transformer. while secondary of the transformer is connected to a voltage divider circuit which consists of a two resistors of values 100k and 10k which divides the secondary voltage of the transformer into a ratio of 10:1.

GSM sends the energy and billing information after fixed interval. We have set the time interval of 3 minutes. During normal operating condition information about total energy and billing is send to mobile phone via SMS. So, When consumer load exceeds the maximum demand an alert message is send to mobile phone to limit their load. When someone tries to pull the meter casing, meter turns the load OFF and alert message is send to consumer. GSM messages received on mobile are:

3.1.2. METHODOLOGY

The model was designed using an Arduino Uno micro controller, Wi-Fi module 8266, MQ135current and voltage measurement sensor and a 16 by 2 liquid crystal display (LCD) Screen. Figure 1 shows the proposed system overview and the functional block diagram is depicted in figure 2. The proposed flowchart is presented in figure 3.

FIGURE 1:



The system overview procedure was classified into Five (5) layers as shown in figure 1.The first layer was the environmental parameters which are obtained by measurement. The second layer was the study of the characteristics and features of the sensors. The third layerwas the decision making, sensing, measuring, fixing of the threshold valve, periodicity of sensitivity, timing and space. The fourth layer was the sensor data acquisition. The fifth layer was the ambient intelligence environment. The sensor collected data when operated by the micro controller and forwarded it over the internet for analysis via the Wi-Fi module. Users were able to monitor measured parameters on their smart phones.

PROPOSED SYSTEM

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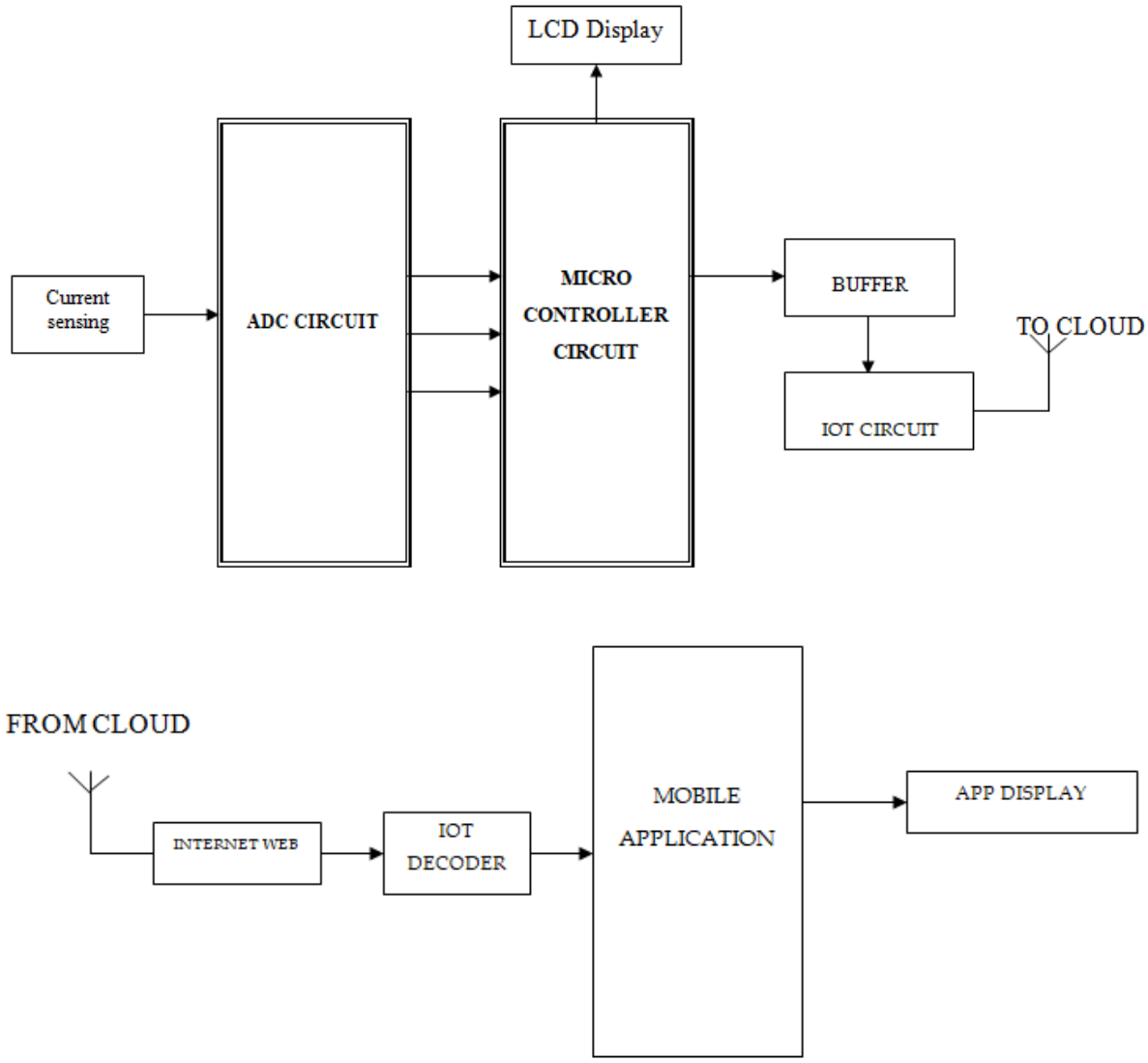
4.1. LAYOUT OF THE PROPOSAL

BLOCK DIAGRAM:



4.2.METHODOLGY

DESIGN PROCEDURE:

The Arduino was loaded and a message was sent to the LCD. Power consumption data was collected using the MQ135 sensor. The calibrated sensor made the analog output voltage proportional to the concentration of polluting gases in Parts per Million (ppm). The data is first displayed on the LCD screen and then sent to the Wi-Fi module. The Wi-Fi module transfers the measured data valve to the server via internet. The Wi-Fi module is configured to transfer measured data an application on a remote server called “Thing speak”. The online application provides global access to measured data via any device.

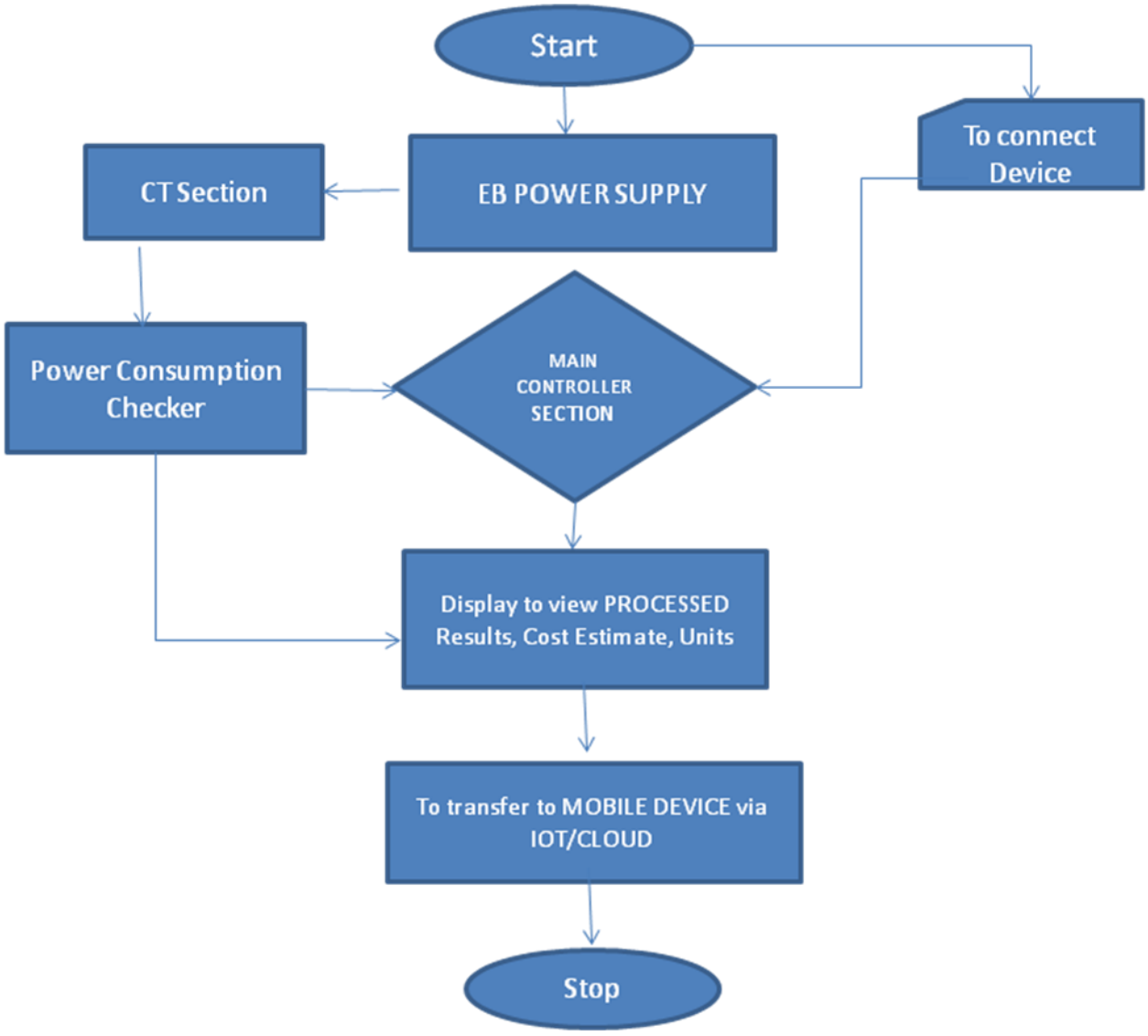
WORKING PRINCIPLE

Micro controller is a general-purpose device and is used for control purpose using a fixed program that is stored in EPROM. The micro controller design uses a much more limited set of single byte and double byte instructions that are used to move data and code from internal memory to ALU. All sensing of current will be first converted into voltage level by using proper transducers.

Then these voltages are given to the comparator circuits. The output of the comparator circuit is connected to the micro controller circuit through switching circuits. Here we are using ATMEGA micro controller. The atmega is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory (PEROM). The switching circuit is used to give input signal to the micro controller from the comparator circuits. The port lines are connected to the IOT code generator circuit, which will produce coded serial data. This coded serial data are transmitted using the IOT transmitter. In the receiver side to receive the operation code ISM based receiver is used.

In this arrangement the energy and cost will be indicated immediately with display at the far end using wireless. So, whenever electricity board wants to check our bill it is very easy to monitor. It is easily identified and to bills to be cleared by the consumer.

FLOW CHART


Start
To connect Device
CT Section
EB POWER SUPPLY
Power Consumption Checker
MAIN CONTROLLER SECTION
Display to view PROCESSED Results, Cost Estimate, Units
To transfer to MOBILE DEVICE via IOT/CLOUD
Stop

DESCRIPTION OF COMPONENTS

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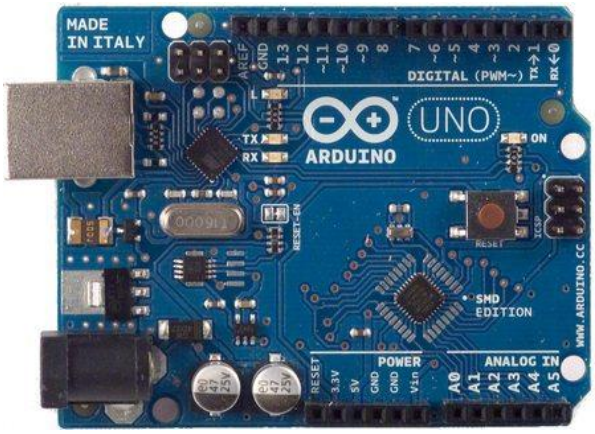
DESCRIPTION OF COMPONENTS

5.1. ARDUINO CONTROLLER:

Arduino Uno is a micro controller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the micro controller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.



IOT section

The Internet of Things (IOT) refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention.

Today, businesses are motivated by IoT and the prospects of increasing revenue, reducing operating costs, and improving efficiencies. Businesses also are driven by a need for regulatory compliance. Regardless of the reasons, IoT device deployments provide the data and insights necessary to streamline workflows, visualize usage patterns, automate processes, meet compliance requirements, and compete more effectively in a changing business environment.

IOT module

Operation IOT

The most important hardware in IOT might be its sensors. These devices consist of energy modules, power management modules, RF modules, and sensing modules. RF modules manage communications through their signal processing, WiFi, ZigBee, Bluetooth, radio transceiver, duplexer, and BAW.

Data Collection

This software manages sensing, measurements, light data filtering, light data security, and aggregation of data. It uses certain protocols to aid sensors in connecting with real-time, machine-to-machine networks. Then it collects data from multiple devices and distributes it in accordance with settings. It also works in reverse by distributing data over devices. The system eventually transmits all collected data to a central server.

Device Integration

Software supporting integration binds (dependent relationships) all system devices to create the body of the IOT system. It ensures the necessary cooperation and stable networking between devices. These applications are the defining software technology of the IOT network because without them, it is not an IOT system. They manage the various applications, protocols, and limitations of each device to allow communication.

Real-Time Analytics

These applications take data or input from various devices and convert it into viable actions or clear patterns for human analysis. They analyze information based on various settings

and designs in order to perform automation-related tasks or provide the data required by industry.

Application and Process Extension

These applications extend the reach of existing systems and software to allow a wider, more effective system. They integrate predefined devices for specific purposes such as allowing certain mobile devices or engineering instruments access. It supports improved productivity and more accurate data collection.

IOT Operation

3.1.1 Security in IOT

Every connected device creates opportunities for attackers. These vulnerabilities are broad, even for a single small device. The risks posed include data transfer, device access, malfunctioning devices, and always-on/always-connected devices.

Security Spectrum

The definition of a secured device spans from the most simple measures to sophisticated designs. Security should be thought of as a spectrum of vulnerability which changes over time as threats evolve.

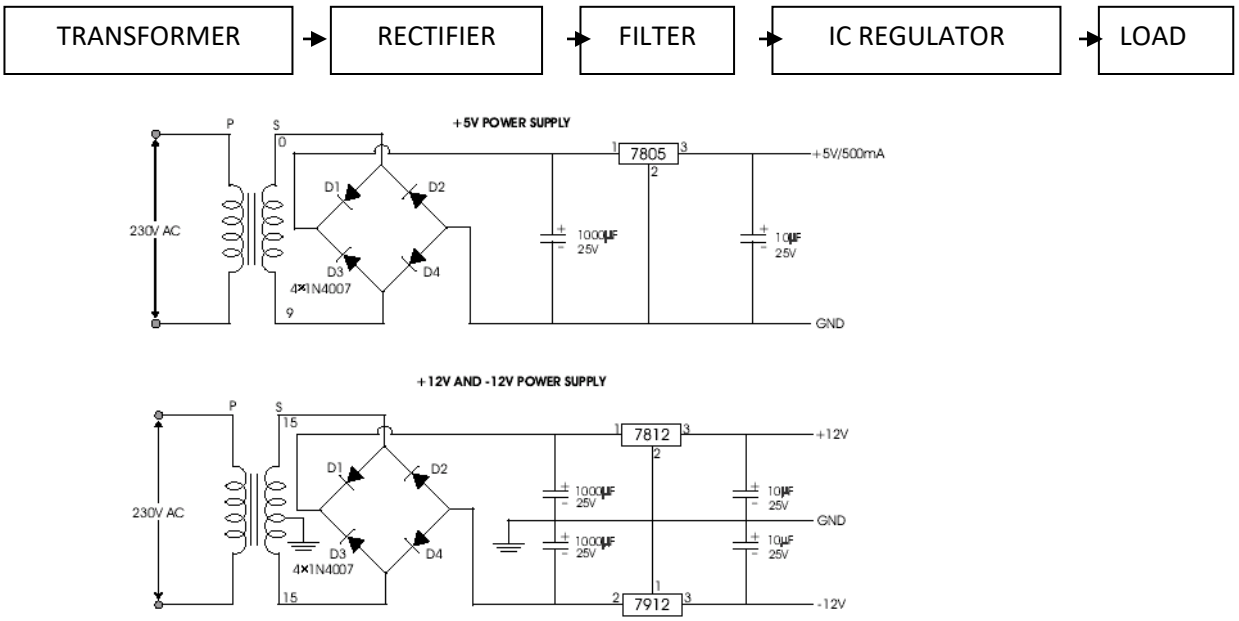
Security must be assessed based on user needs and implementation. Users must recognize the impact of security measures because poorly designed security creates more problems than it solves.

- Out any consideration for the potential consequences.

Power supply Section

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.



BUZZER:

A buzzer or electronic device may be a device which used in cars, manages appliances like a microwave, or game shows. It comprises of variety of switches or sensors connects to a sway unit that determines and if that button was pushed or a planned time has non church going, and typically illuminates a light-weight on the specified button or instrument panel, and sounds a warning within the style of endless or intermittent noisy or beeping sound.

APPLICATIONS AND ADVANTAGES

CHAPTER - 6

APPLICATIONS

1. Simplicity of Design and Control.
2. This type of machine are easy to operate and less time consuming.Advancements in wireless communication and sensor technology are rapidly changing air pollution monitoring paradigm.
3. Design and implementation of the proof of concept (PoC) of an IoT architecture to collect metrics within a smart city using the best practices in software development technologies.
4. Analysis of the technologies and platforms that may be used within a energy consumption monitoring solution.

ADVANTAGES

1. Simple in construction
2. Efficiency of the unit cannot be affected.
3. Security of the Message Queuing Telemetry Transport (MQTT) communication protocol implementation for the collected data, in order to avoid indirect attacks on the data collection process.
4. The system also needs to be resilient to malicious threats (e.g., cyber terrorism) that could represent high risks once the integration with any traffic control system is made.

SCOPE FOR FURTHER WORK

The online application used to analyze consumption data got from current transformer in this proposed system was “Thing-speak”. Thing-speak is an open source internet of things application programming interface used to store and retrieve data from interconnected things using the hypertext protocol over the internet or via a local area network. It also provides access to a broad range of embedded devices and web services. This enables the creation of sensor logging applications that can be updated regularly. We can add power theft consept and an IVR section to develop our project in future.

RESULTS AND DISCUSSION

RESULT:

The android mobile application is the primary graphical user interface (GUI) for the product. This interface allowed users to manipulate the power status of electronic devices. The application provided the component status and check-backs on whether or not the component was successfully able to respond to the requested change in power status. The android application is written in English. The data can be viewed per unit and in an increase of hours for the duration of one day, week, or month.

DISCUSSION

The proposed system can be used to display load energy usage reading in terms of Watts. Every user would be able to access the information from anywhere on the earth. Thingspeak.com is one such web-page which takes the help of the PHP programming. Power Consumption Controller using IOT is an innovative application of internet of things, developed to control home appliances remotely over the cloud from anywhere in the world. In the proposed project current sensor (CS) is used to sense the current and display it on web page or the android application using IoT. The system updates the information in every 1 to 2 seconds on the internet using public cloud.

CONCLUSION

CHAPTER - 7

CONCLUSION

By doing a design and fabrication project we learnt many more about the design of parts, Purchasing of parts PCB's and parts, assembling of parts, Testing of parts, rectifications of technical problems and completion of the project successfully. The system is working efficiently in both modes internal warning and IOT based sms alert to eb control department. When the sensor senses any current level and the status of unit and their levels, it sends signals to the control unit which allows the public's to know their consumption status anywhere in the world. Thus, we have an "intelligent model to warn the industry and officials" which helps in understanding how to achieve low-cost automation.

We have full confidence that this system will be more useful for the household implementation and industrialists of such scope for further work.

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[6] Pallavi Ravindra Joshi1, Prof. M S khan2 1M. E Student, Department of ECE, G S Mandal's MIT COE, Aurangabad, Maharastra, India 2Associate Professor, Department of ECE, G S Mandal's MIT COE, Aurangabad, Maharastra, India "IOT Based Smart Power Management System Using WSN" Volume: 04 Issue: 06 | June - 2017,https://www.irjet.net/archives/V4/i6/IRJET-V4I6133.pdf.