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ECS IoT An Automatic Energy Meter Reading System

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ABSTRACT

Energy Control System based on Internet of Things (ECS_IoT) is an automatic meter reading system. This paper contains implementation aspects of ECS_IoT including hardware and software methodology adopted. Power distribution and revenue generation from power consumption. The paper is focused on internet based AMR system to provide global access to energy meters. ECS_IoT is built around ESP8266 Wi-Fi enabled microcontroller which is configured to work as a client node in power distribution chain this led our solution a more reliable and low cost AMR system.

Keywords: Internet, Internet of Things (IoT), Automatic Meter Reading System (AMR), Embedded System, Power Sector in India, Network Topologies.

I. INTRODUCTION

India is place where power distribution and revenue collection is very low as compare with power generation capability. After the month of March 2017 Indian power generation capacity has raised to a milestone achievement of 319.60 GW including conventional and non-conventional power generation sources. The report is published by Central Electricity Authority of India [1]. Indian government is facing the distribution problems due to the less distribution network infrastructural development. Even India having the power transmission line network of over 2.2 lakh circuit kilometers (1 circuit kilometer = 2 x Rout km)[2] is still facing a high percentage of distribution losses (Also known as aggregate technical and commercial losses - AT&C losses) approximately 30 % of distribution losses occur while distribution. Indian government is trying to electrify the un-electrified villages so each and every citizen of India can become an active part of the development chain of India. Government of India had launched various schemes and programs including "Rajiv Gandhi Grameen Vidhyurtikarn Yojna", "Ujwal Bharat Yojna" etc. these policies are aimed to provide electricity to each and every citizen of India [3] [4].

To reduce AT&C losses various steps has taken one of the major step taken by Indian government is "Accelerated Power Development Reform Programme" which is aimed to reduce financial losses and re-aimed to reduce AT&C losses[3][4]. Soham Ghosh presented an analytical report for reducing the AT&C losses. According to him IT can play a vital role to reduce the AT&C with the help IT the distribution system can be automated up to curtain level to make the system more reliable and effective to fight against reduction of losses.

A paper has been presented by Ashan K and Sudhish N George on Automatic Meter Reading (AMR) System. They have designed a Metering Module which connects to remote station using short message service (SMS). They have used PIC16F887 microcontroller for metering unit, web application is developed is developed using dot.net frame work and database using Microsoft SQL [6]. A similar approach has been adopted by Mr. Sarwade Narasing J. and his team, but they have used Zigbee for communicate between meter unit and control unit [8]. Sreelakshmi and his team clubbed these solutions together Zigbee is used to communicate meter unit to central office section unit and SMS based information feedback system is provided in the system. They have not provided any web application to view the status [9]. Another system has been generated by Kun-Lin Tsai and his team published a paper that contains information about their solution for Smart Socket automation. In this system Zigbee and Internet is used as communication medium. Zigbee is used to communicate between home gateway

and smart socket. Internet is used to store/read information to/from server. They have developed a web application through which one can set a limit for any smart socket after which the socket can be turn off or on the device connected to the specific socket [10].

II. METHODS AND MATERIAL

The proposed architectural block diagram is shown in fig 1. In our system the Meter Unit (MU) are directly connected to power house server using internet and observer/operator can also view the status of MUs. We have used a Wi-Fi enabled microcontroller to build the MU. ESP8266 System on Chip (SoC) is packaged with Tensilica L106 32-bit microcontroller, Wi-Fi 2.4GHz (802.11 b/g/n), one 10-Bit ADC, 17-General purpose input/output (GPIO's) multiplexed with I2C, I2S, USART PWM etc. Two USART, Integrated TCP/IP protocol stack and more peripherals are integrated in a tiny package.

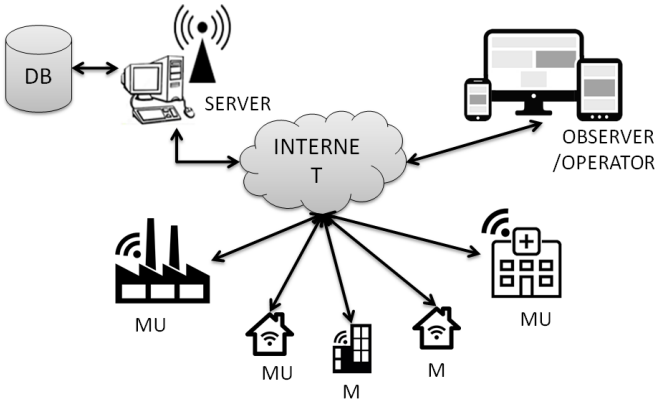

Figure 1. System Architecture

For the sack of control and observe the activity of MU a web based solution has been developed. Whit the help of web application one can generate and pay bills, create a new MU, and view the month wise consumption details of MUs. Web application is also divided into two parts first is accessible to power house and second is hardware accessible WebPages that are accessible only by MU to view and communicate with server. This web application is stored on a dedicated server provided to power house. My SQL DBMS is used to create Database which stores billing information of MU, MU details, Billing month details, admin login list that are accessed in web application using PHP server side language tool.

The block diagram of MU is shown in fig 2. Each part of the system has a dedicated functioning in the application. Energy Meter is a device that is capable of measuring the kWh consumption of consumer. It generates a pulse output that can be used to calculate power consumption. Opto-couplers are used to isolate two electrical appliances that are working in different voltage range. Operational Amplifier (Op-Amp) LM358 is used to function as electrical voltage comparator that compares two input voltages give a high pulse if the non-inverting input terminal is high. This pulse is then can be use by microcontroller for counting purpose. LCD16x2 is used for the display information and Power switch is used to control energy meter and is build using electrostatic relay. This is used to power ON and OFF for consumption.

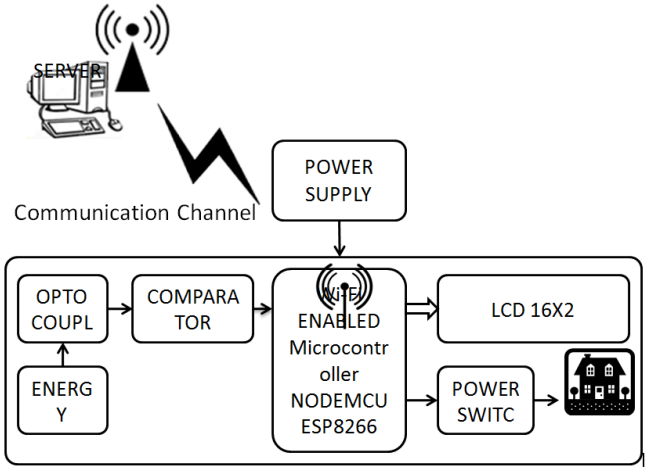

Figure 2. Block Diagram of MU

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III. IMPLIMENTATION AND RESULTS AND

A. Circuit diagram and working

The circuit diagram of MU is divided into parts for ease of understanding. First is power supply fig.3(A) followed by rest pulse sensing circuit fig.3(B), power switching circuit fig.3(C), controller circuit fig.3(D) and the PCB layout of MU is shown in fig. 7.

- **Power Supply:** 5V supply is required for controller and other electronics devices connected in MU. To maintain constant 5V DC voltage for MU voltage regulator IC LM7805 is used output of the IC is followed by a capacitor for filtering purpose. Resistor R2 in series with LED D2 is used to indicate power status and Diode D1 is used to protect voltage regulator.

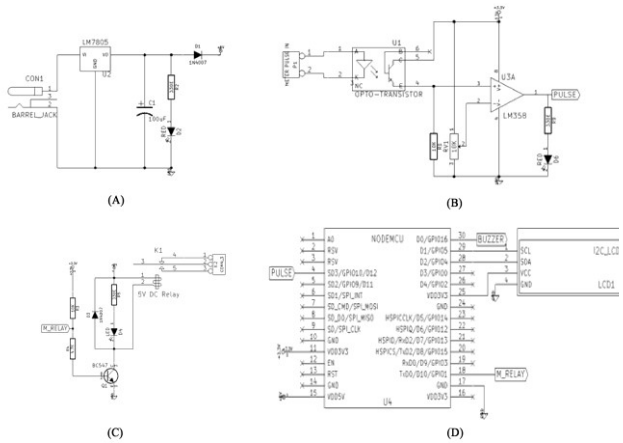

Figure 3. Circuit Diagram

- **Pulse Sensing Circuit:** This circuit is build around Op-Amp IC LM358 which is a dual Op-Amp IC out of which one is configured as comparator that compares input pulse of energy meter. The pulses generated by energy meter may be of higher voltage and to isolate the two circuits Opto-isolators (Opto -Transistor) is used which electrically isolate energy meter and controller circuit. The Op-Amp IC gives a high / low output as per input from energy meter.
- **Power Switching Circuit:** Energy meter power consumption is controlled by an electrostatic relay the circuit diagram of power switching circuit is shown in fig.3(C). Relay is controlled by transistor BC547 which is an NPN transistor functioning as a switch to control supply to the coil of relay. Controller sends a high pulse to activate relay and so the power output.
- **Controller Circuit:** The circuit is shown in fig.3 (D) which shows the connection of peripheral devices connected to controller pins. LCD16x2 is connected to the I2C pins of ESP8266 microcontroller.

B. PCB Layout

The layout of MU is shown in fig.4

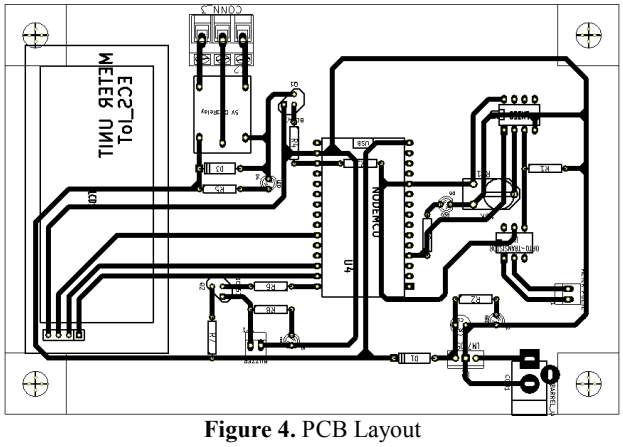

Figure 4. PCB Layout

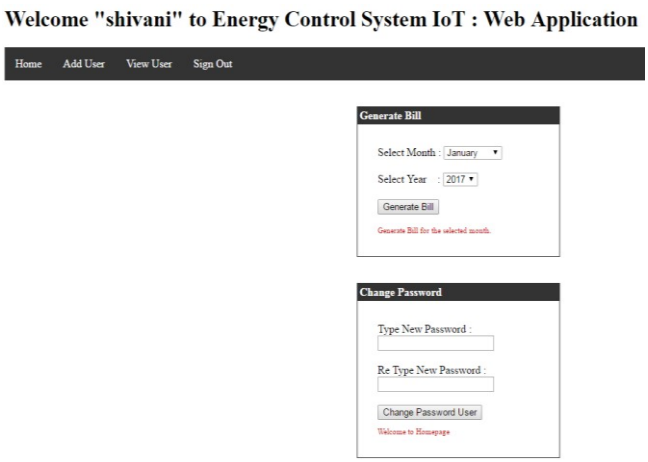

Figure 5. Homepage of Web application

C. Web application

The homepage of web application is shown in fig.5 and flow chart of energy control system is shown in fig.6, after the starts and initialization is done user or observer or operator can login into his account. As observer login into his account he can select any action. An operator can create new meter ID for registering new meters on web. He can also generate bill for specified month, and can also make payment of bill by using web application.

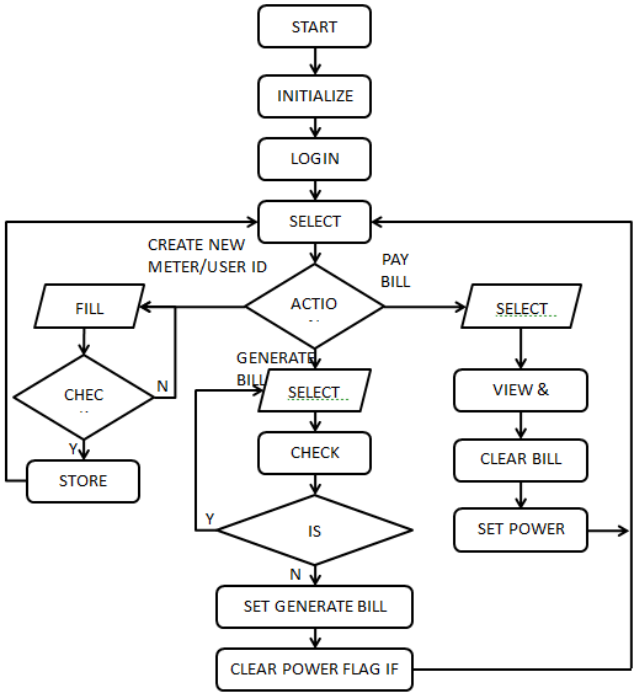

Figure 6. Flow Chart

D. Result and Analysis

List of registered users (MU) and billing detail MU is shown in fig.7 and fig.8. Table 1 shows a comparative view of previous researches and our implementation.

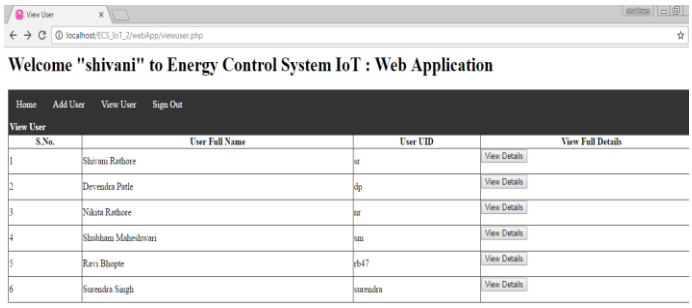

Figure 7. User View

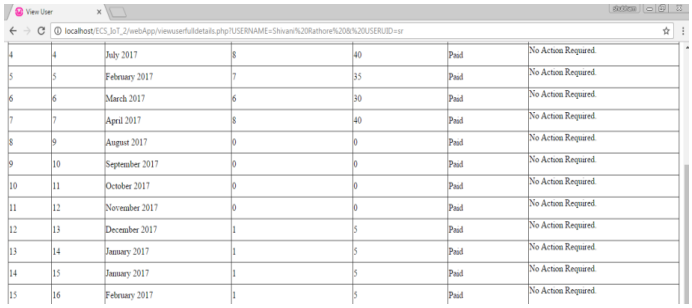

Figure 8. Billing information list

TABLE I
ANALYTICAL REVIEW OF RESULT

SN	Feature	Our System	Ref [8]	Ref [7]	Ref [9]	Ref [10]
1	Communication Technology	Wi-Fi - Internet	Zigbee	GSM	Zigbee	Zigbee and GSM
2	Range	Global Access	Low Area	Global Access	Low Area	Global Access
3	Controlling System	Web Application	GUI Application	Web Application	GUI Application	Web Application
4	Feedback System	No	No	SMS		SMS
5	Operating System	Independent of OS	Windows	Independent of OS	Windows	Independent of OS

IV.CONCLUSION

Live energy meter billing system is successfully implemented using IoT technology and internet as communication medium. The earlier versions of the same had used SMS based communication medium which much as compared with Internet some of earlier researchers had used Zigbee as communication medium which a low range solution while internet given a long/global range to MUs and so Controller authority.

The system designed have various advantages over previously existing systems but it can still be enhanced by providing consumer login system with the help of which consumer can view previous history of bills. A feedback system can also be incorporated with the existing system with the help of which payment and billing generation intimation can be sent to the consumer.

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