

IoT Based Smart Home with Real Time E-Metering using E-controller

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Abstract—Technology stemming from web of things is home automation. World's main focus is to make a smart home to take advantage in providing comfort for human life. Web technology is a thing which is growing all the time. Embedded systems with Internet on Things (IoT) is becoming important and necessary part in the current IT industry and exhibiting potential market. Power consumption and efficiency with a user's comfort level is most important issue during this stage while performing various operations. Controller is suitable for power consumption in system and efficiency experiments with size factor. E-controller is represented by combining embedded technology with IoT. Real time information data monitoring of energy consumption is main objective of system. The paper introduces smart home system based on IoT with the help of Web application.
keywords—E-Controller, Asp.Net, E-metering, Web application, MySQL.

I. INTRODUCTION

Technology is developing all the time and that time system should be upgraded according to the technology. Now a days the technologies are made for ease of everyone's life. The technology which provides automatic system best suited for us. Now a days all the data, system is available on internet and web technology is growing very fast. Embedded system with web technology provides remote management and controlling of embedded device via network interface

Internet on Things devices are control by web controller or E-controller which is a bundle of embedded system and software stack, which is the most popular procedure for Web development using in the world . Remote login and monitoring by building a distributed Web control system with the help of web pages build in web application. Instead of using big servers systems for managing and handling data. This kind of Web control system with IoT has characteristics of (1) Energy Saving, (2) Comfort, and (3) Efficiency. Our objective is to apply the web control system to the web of things, so that people can access the application from anywhere in the world with the help of internet facility.

The problem facing by common consumer is to pay continuously increasing bills for electricity without knowing the consumption again the problem of faulty meters and frequently cut off of energy. In such a situation, a question that arises

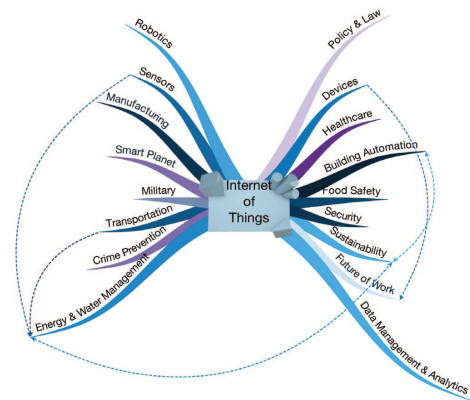


Fig. 1. Internet of Things[11]

constantly in the minds of consumers is that why the service provides are not providing any real time systems. This common consumers issue is solved in this paper. He will get to know what is happening with his bill and meter readings. The system contains a smart home technology with smart grid facility to overcome the issues facing by every consumer. System interfaced with cloud application is used for controlling or monitoring home appliances. Also all billing facility including all other features is available on web application.

A. Internet of Things (IoT)

Home automation is a forward step is "Internet of Things," in which everything has configured with an Internet Protocol (IP) addresses , and can be monitor, control and access remotely with the help of web technology. The most obvious advantage of this technique is "smart" devices like sensors and other transducers can be connected to a local area network (LAN), via Ethernet connectivity or Wi-Fi. However, electrical systems like light switches and electrical AC/DC systems, were also connected for automation of home, IP based inventory tracking is also done in IoT just like shown in figure 1[11].

II. LITERATURE SURVEY

Remote laboratories can provide significant benefits over some proximal laboratories. For these benefits to be realized,

consideration must be given to the complex interplay between desired educational outcomes, pedagogical design, and the nature of the technology supporting the laboratory.[1]

Remote power management using GPRS technology with long distance communication is possible in China with the help of Arm and uC/OS operating system with forming link between energy meter and GPRS Module. Net electric energy meter is used in real time measurement situations according to the principle of Peak Electricity or Valley Electricity.[2] Energy has become a major problem for large data centers and server farms. Low power consumption Microcontroller can also be used as an embedded web server [3]. Embedded systems is becoming the center of interest in the current IT industry and exhibiting broad potential market. Designed an embedded web server with S3C2410 as a platform to embedded Linux operating system [4].

Smart home system with various communication technologies are developed in [5] [8] [9] [10]. Home automation with intelligent system is designed [8] with cortex A8 processor. System is stable, reliable and very practical. ZigBee which has significances of low power consumption and self-organize network is more suitable for smart home and GPRS/CDMA/GSM technologies are more suitable for mobile application development [9].

To reduce E-experiment system's power consumption, cost and size, this paper presents a kind of Web controller by combining embedded technology with LAMP (Linux + Apache + MySQL + PHP), which is the most popular solution stack for Web development all over the word. Web controller reduced the remote control system's dependence on servers [6]. There is increased demand for a reliable and efficient Automatic Meter Reading (AMR) system. The developed system is highly effective in the sense it is able to eliminate the drawback of serial communication [7]. Web of Things comprise of a set of Web services provided on top of a number of Internet enabled Embedded devices. Smart grid architecture is implemented with two kind of energy sources renewable and nonrenewable. In case of emergency power cut of user can change source of energy. System is very effective method for implementing green energy concept on a larger scale.

Based off of the technology that already exists in the market of home automation and the up-and-coming technological advances that will work to make it more accessible in the future (like IPv6 and cloud computing), it seems that a fully functional smart home is to be expected in the very near future [11]. IMS using the tri-level context making model was designed with open source hardware and software in order to expand into future IoT. Two different scenarios were tested disaster management service and smart home health care service. Simple monitoring service, an automatic control service, and a user-centric service are the tri level context model for future smart home services [12].

III. PROBLEM STATEMENT

Power consumption of server farms is becoming a huge issue in the server operation community. Server required more

cost for running it as well for cooling them (to operate servers and to cool temperature them). However, recently energy consumption and cost offered has become a major problem for large data centers and server farms. The main issue is size of data centers and big servers. Low power consumption controller can solve the issues and increases the speed of performance.

Electrical energy or power is an important factor for human being survival now a days. Apart from this efforts automation in the energy distribution is necessary for enhancing people's needs. Now a day's human meter reading is providing insufficient to cope up with future residential need. So demand is going to increase in rapid manner for Automatic Meter Reading (AMR) systems which measures power consumption readings electronically, and it is expanding at industrial, commercial with utility environment.

A. Project Objective

- To reduce power consumption in the web applications
- To make energy metering easy by creating web application
- To make home automated and intelligent and provide comfort to every consumer
- Also the application is real time means the user can monitor real-time data and takes a particular action

IV. PROPOSED SYSTEM

The system contains home automation as a smart home with intelligence and provides e-metering system as a smart grid to overcome the issues. The system along with web application is controlling smart devices in home and also all billing features from web application working as a cloud application. The main objective of this project is to design energy consumption meter and control, monitor system for all service providers.. According to this technology a user can login and check usage of electricity real time as well as control the devices (home appliances). There are various energy provides like BEST, TATA Power, MSEB, Reliance etc. All this

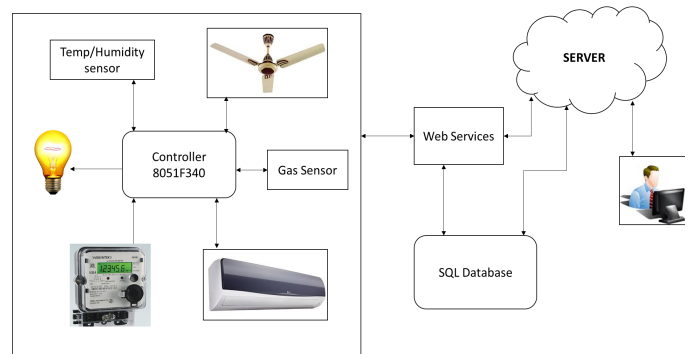


Fig. 2. Basic Block Diagram

provider can use same application for service management or controlling. Not need to use separate application. The proposed system shows a block diagram of the project. Heart of the project is Microcontroller C8051F340 which is high speed

microcontroller SMD device. Which is controlling the entire device as shown in a Figure 2. It contains a server which is having a web application working as a cloud application where we can monitor or control the devices which are connected to the microcontroller. Temperature and humidity is measure by the sensor and displayed on web app also gas sensor is used to detection of leakage of gas. Figure contains SQL database which contains all the data and values and these values are provided to application by web services.

V. SYSTEM IMPLEMENTATION

Sensors, Microcontroller Board, Wi-Fi modem and Current sensor as an Energy meter this all is hardware part where as all the data is sent to the server which operated as a cloud to store a data and we can access this data from anywhere and anytime. MySQL database software basically used for controlling and maintaining data which are used in application. Web application working as a cloud is designed to access or manage all this data with the help of .Net framework in C# programming language

A. Hardware Design Details

An Embedded technology is combination of some form of hardware with a software stack, it can be as a fix capability that is designed for a given function. System hardware having a chip of C8051F340 with 8 k ISP Flash with MCU Family core having high speed 8051uc. The core provides up to 50 MIPS throughput and it provides inbuilt memory of 768 Bytes (256 + 512) contains on-Chip RAM and 8kilo Bytes Flash memory. 512 byte Sectors is provided for make system working as programmable. Operating voltage is 2.7V and supply current is minimum up to 5.8 mA at 25 MHz and 11mA at 32 kHz having 32-PIN LQFP type Package. Energy

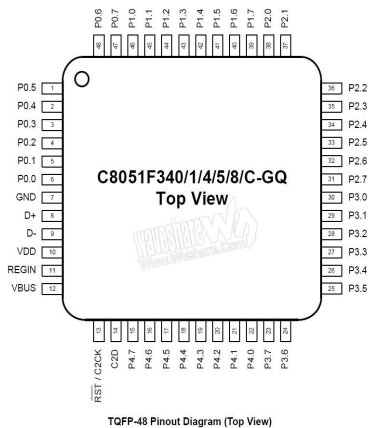


Fig. 3. Pin Configuration of C8051f340 [13]

consumption measurement is necessary for generation of bill. But now a days digital meters are preferred hence in this paper we are using current sensor IC to measure current consumption Home automation or intelligence system having various sensors for measuring various parameters and this parameters are send to the Web services. Sensors such as

such as temperature, Light Dependent resister, LPG gas leakage sensor etc. ACS712 is a sensor module used for calculating current consumption [14]. It simply operates on 5V and provides analog outputs from current sensing at 2 terminal proportional to current measured. Sensing terminal can measure current up to 5A or 15A for loads at high voltages upto 230V AC mains based on different module. Output sensitivity is about 185 mV/A.

DHT 11 temperature and humidity sensor is used for controlling fan speed and the data in form of degree centigrade and percent is send toward the application [15]. It provides best accuracy for the Temperature and humidity measurement as compared with other sensors.

MQ6 gas sensor sensed a leakage of gas, if found system sends an email to consumer or alert on web application. MQ6 is a 6 pin sensor module operate on 5v supply voltage and MQ6 contains heating element inside the sensor which becomes hot at 5 volt and remains stand by [16]. When the gas sensor sensed a leakage of gas molecules in the range of 100 ppm to 1000 ppm, its output switches high from low and triggers transistor causes activation of buzzer.

B. Software Design

Embedded C is a language used for programming the controller which is the part of hardware. Visual Studio 2012 as a .NET Framework with C# language is used for designing a website or web application. Web Application is acting as a Web Server and Internet on Things are control by this and embedded system behaving as an E-Controller. All the usable data is stored on server, software used for maintaining cloud database (server) is SQL server 2008 r2.

1) *Cloud Application Overview:* Cloud application (or cloud app) is an application program that functions in the cloud, with some characteristics of a pure desktop app and some characteristics of a pure Web application. A desktop application operates entirely on a single device at the consumer's location it could be a mobile, laptop or tablet. A cloud application is stored on a server which is managed remotely and is accessed from the Internet through a browser interface. Application having security and every consumer having its own meter number and password which is randomly generated through code and send to registered email id from web portal id "smarthomeportal@gmail.com". By using Meter number with Password user can login and manage his smart home.

C. System Flow

The system actually works on the principal of "Tri-Level Context making Model"[12]. Role of this model is to generate context after data acquisition. To maintain a Quality of service in different service domain model consist of three levels of working. Simple monitoring, Automatic controlling and user centric services.

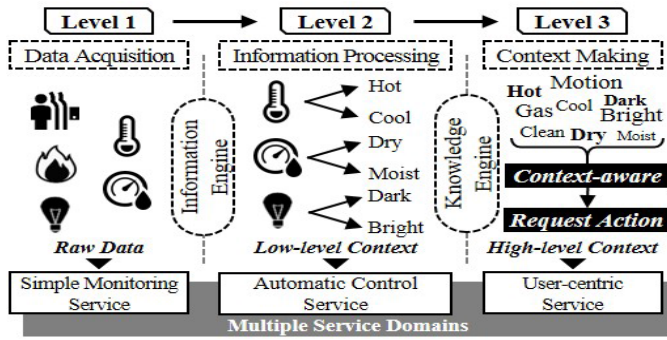


Fig. 4. Tri-Level Context making Model [12]

Data acquisition and signal processing are the low level context and high level context is used to generate situation awareness. The Figure 4 shows concept of Tri Level Context Model. The system works on the basis of this model. Sensors are the transducers which have functions of sensing the characteristics of environment. Hardware contains main controller board with various sensors attached with these. Firstly all the sensors detect their current status and this status is sent towards the main controller.

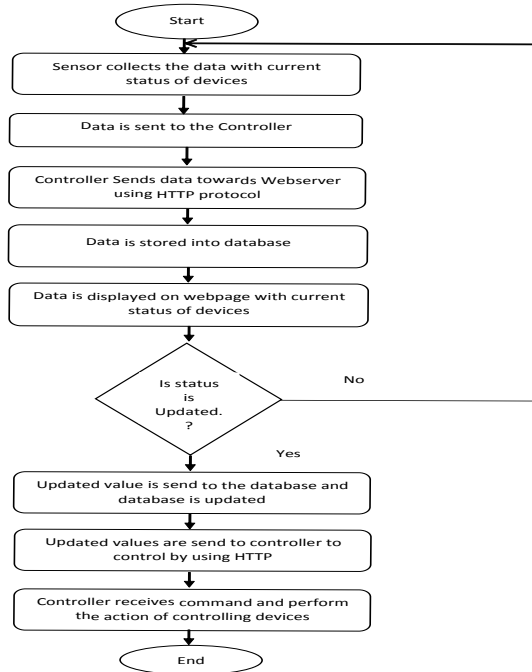


Fig. 5. System Flow

Controller is connected with WI-FI module with internet connectivity status is sent to web application by http request. Current status values are stored into the database and these values are fetched and displayed on application.

If status is updated by consumer Exact opposite procedure

is takes place. Updated values are stored in database and also these values are forwarded towards controller via internet connectivity by http request. Finally controller send updated value to transducers and they start working accordingly.

VI. PERFORMANCE ANALYSIS

The web application or cloud application is user interface to control and monitor the data. The snapshots of web based application is shown below

A. Web Application Home Page



Fig. 6. Home Page

User can find any urgent notice on home page in alert section. Various service providers with their energy consumption charges detail with links is available. Online bill payment facility is also provided on home page. Again energy saving tips prepared by Tata power is also available on home page. Consumer or admin can login to his/her profile by opening login page and start monitoring and controlling his appliances.

B. Admin Facility

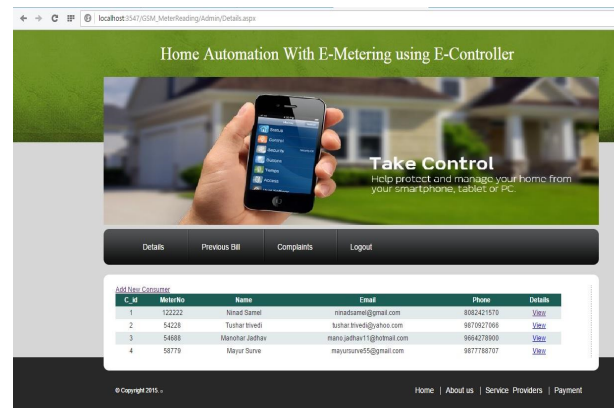


Fig. 7. Admin Login Page

Admin is an authorized person who can register new consumer by clicking "Add new consumer" link also he can check every consumers generated bill in current month. Complaint

box facility is also provided on application admin can read, resolve or manage complaints by checking complaint tab.

C. Smart Home facility

The snapshot shows device status link, this tab is used for Home Automation purpose. Five control buttons are provided for consumer where he can control his fan, fan speed, light intensity, bulb status and gas sensor status. Consumer can select required status and update, where device which are connected to microcontroller can change its status physically. Web application show current room temperature, humidity

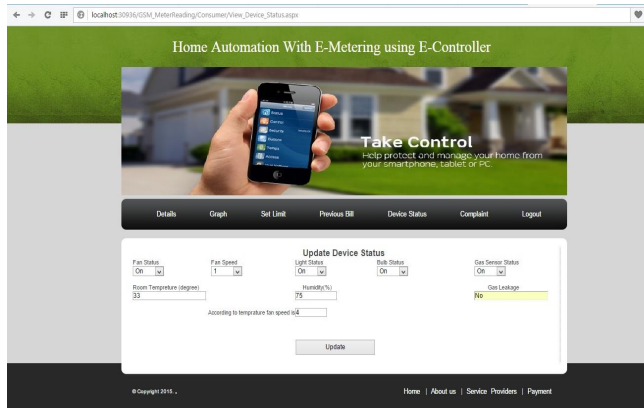


Fig. 8. Home Automation facility to Consumer

with gas leakage notification Application shows expected fan speed for current room temperature (Works like smart AC). If gas leakage is detected SMS will send to registered mobile number of particular consumer.

D. Other Facilities

1) *Current Energy Consumption Details:* Consumer can check his current bill generated with all details Again consumer can set a limit of energy consumption on a website if energy consumption is exceed by limit one email is send to the consumer

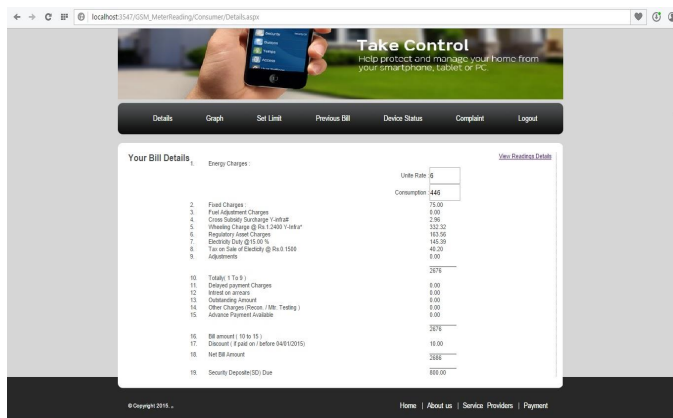


Fig. 9. Current Energy Consumption and bill details

Consumer can check his previous bill amount detail by using "Previous Bill" tab.

2) *Reading Details:* "View Reading Details" link shows a detail of consumer's energy consumption and it updates every 5 to 10 sec. This detail is sent from hardware i.e. Current sensor IC which is connected to the microcontroller through web services.

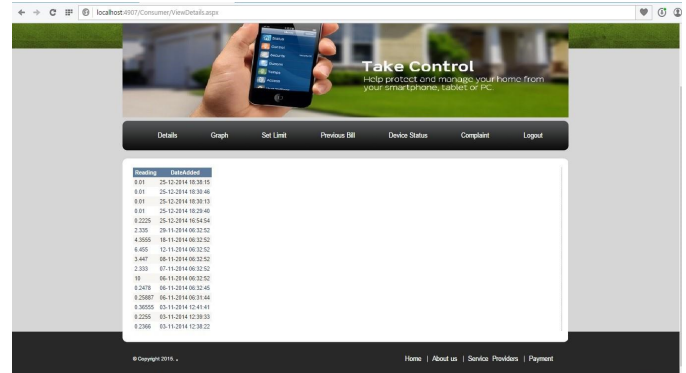


Fig. 10. Updated Energy Consumption

3) *Setting Limits and Complaints section :* Consumer can set the limit of energy consumption in KWh. If the energy consumption is near or crosses its limit one email and SMS will sent to the registered consumer. User need not go to energy consumption office for compliant of loss of energy or bill, he can directly send a compliant to service provider through compliant box

4) *Energy Consumption Graph:* Energy consumption graph facility is also provided to consumer so consumer can get to know monthly consumption or yearly consumption

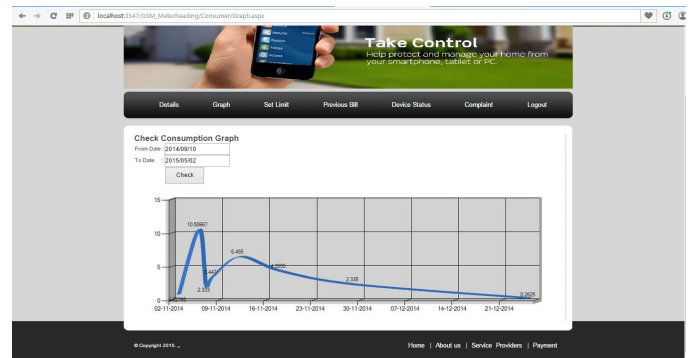


Fig. 11. Graph of energy consumption

VII. CONCLUSION

The paper contains a system which having both the facilities of Home automation and Real Time Energy controlling and monitoring is available on single web application. Multiple Energy service provider can use same web application by changing admin login and its depends upon the size of

database. Energy consumption per 5 to 10 Seconds is also available with Graphical presentation. System uses industrial purpose microcontroller which consumes less power as compared with the servers. System provides comfort and efficiency to the consumers.

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