Development of Continuous Data Acquisition Algorithm

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ABSTRACT

With the recent advances in the smart grid technology and the distribution of smart meters we can easily determinethe usage of electricity of consumers at any moment. Data collection is the essential operation for smart grid. In the smart grid the smart meter will generates the electricity usage and data collector unit will collect the usage periodically from the meters. This paper actually focus on the data acquisition using cloud based technology and also gives direction to smart meters, smart grid, and advance metering infrastructure (AMI). Smart grid uses two way flows of electricity and information and for that deployment of smart meters in large amount should be done. Nowadays development of E-energy takes place which allows customers to became active participants and control their consumption using cloud based technology and this algorithm application will show consumption with providing the recharge facility to customers. To achieve efficient status monitoring, control and billing large amount of smart meters should be deployed and produce large amount of data. Than that data will be sent to the cloud and stored as well so that customers will able to know the real time consumption of electricity usage.

Key words: *Smart grid, Cloud based technology, Smart meter*

1. INTRODUCTION

Energy savings nowadays is very important aspect. This requires intelligent distribution, monitoring and management of energy. A solution of this problem is advance meter reading (AMR) which means to collect data from different kind of meter. In this way we can measure usage of water, gas and energy can be remotely monitored. This is in differing with the manual meter reading which is actually based on people we have employed to collect the data from the meters. That is having lots of disadvantage and error of prone thus the get into modern buildings may be limited for security reasons; to collect data from meters from homes, different apartments, buildings that require a lot of time and usual data is collected once a month or once in a two months which may be a too small resolution. Automatic meter reading is the technology of automatically collecting consumption, analysis, and status datafrom water meter or energy meter devices like gas devices, electric devices and transferring that information to a server for billing process, problem solving, and examining it. This technology mainly saves providers the cost of periodic trips to each physical location to read a meter data. Another benefit is that billing made by the utility that would be from real time consumption so accuracy will be maintained. This timely information coupled with analysis can help both utility providers and customers for better control the use and production of electric energy, AMR technologies include mobile and network technologies based on telephony platforms, radio frequency (RF), or power line, transmission. So we should have particular infrastructure for such problems andthat would be advanced metering infrastructure (AMI).[1]

2. REVIEW OF RESEARCH PAPERS

2.1 PAPER – 1 Cloud-based smart metering system (IEEE 2013, Authors: Peter Dukan, Attila Kovari)

This paper gives direction to the potential of smart meters and cloud based technology. Several developments has been started in the field of energy efficiency and energy savings. These developments are user friendly appearance and we can say real time data processing of smart meters which optimizing the consumption of

consumers. This application is cloud based web application on the server side. Cloud based energy management solutions require standardized communication between smart meter and server. For that we are using M-bus standard which provides us local communication and we are using gateways and data collectors to send information to web server through internet. The highly safe storage of such amount of data and large availability of service for users can be ensured by computing power and data storage capability of cloud technology. In the cloud based solution users are served by information technology services available on the web. These services divided on the servers of service providers and operational details are hidden from users. Cloud based solution provides cost effective service to the millions of users. We are using Saas(software as a application) to serve the need of enquiries generated by user and function of Saas to provide transferring information and display the consumption to user.

2.2 PAPER – 2 A Data Collection Algorithm Using Energy Maps in Sensor Networks (IEEE 2007, Authors: Abdelmorhit EL RHAZI, Samuel PIERRE)

This paper gives brief information about new data collection mechanism based on distributing cluster methods which uses energy maps and apply the Qos requirements to reduce consumption. Energy map gives visual presentation of how energy and material flows through the process and also gives information about different network area's consumption using energy maps. This algorithm uses data aggregation and second is filtering methods. These both methods are used to minimize the transmitted messages over a network and its used to reduce power consumption and increase the network coverage. Foe data collection algorithm two methods are used data aggregation and data filtering to collect the information and to filter the network messages simultaneously. In this paper comparison between data collection algorithm and TAG (tiny aggregation) algorithm is shown. TAG algorithm is all about generic aggregation service for networks. It processes aggregates into the networks by computing data as flows through the sensors and it discarding the irrelevant data and collect relevant data. It is the rooting algorithm means, all the packets communicated from sink node to all network nodes. And if we got any queries than as a solution we can use language similar to SQL (structured query language). TAG algorithm is having two phases distribution phase and collection phase. In distribution phase queries pushed down from sink node to single node and in the collection phase aggregate values are rooted up continuously from child node to parent node. This algorithm uses clustering building method in which nodes are split into the set of clusters and that will satisfy application requirements and also reduce the energy consumption and increase the network life.

2.3 PAPER – 3 ,Utilities Look to the Skies for Monitoring the Power Grid (IEEE 2004,Published by IEEE computer society)

In this paper the power utilities looking to the skies to help them to collect meter information about electricity usage. Actually they are using satellites to acquire the data on the real time basis so that accuracy could be maintained. This system is developed by hunt power which also providing metering equipment and services to the most power utilities. In this phenomenon a network of 25 satellites are there and it will be in the low earth orbit used to collect data from meters at any location. A particular time duration is fixed for collection of data and in this approach the time duration is about 15 minutes and it is also having ability to query the meters in the 6 minutes. Each satellite is linked with the smart meter unit having size of 8*8*8 inch box with external whip antenna. It is having 148-150 MHz UHF transceiver capable of two way communication with satellite. It is designed in such a way that it will be fit into existing metering installations. The communication occurred serially, wireless and wired. And it queries the collection unit on demand and converting the usage information into transmittable form. It provides two levels of password protection. Data collected by satellite from diverse subscribers is then sent on a periodic basis from every 15 minutes in real time to gateway earth station and then to the gateway control centre where messages are stored , processed, sorted ,and rerouted.

2.4 PAPER – 4 A genetic algorithm based power consumption scheduling in smart grid buildings (IEEE 2014, Authors: Eunji lee, HyokyungBahn)

As we see the recent advancement in the smart grid technology and increasing dissemination of smart meters electricity usage can be detected at any moment and send them to the utility office for further process. Nowadays utility office adopting different prices at different time. This paper gives brief information about new power

consumption scheduling algorithm for smart buildings which adopts smart meters and real time pricing of electricity. Normally the prices are high at peak hours for example in the afternoon on hot days in the summer. Consumer can detect the price change through smart meters and reduce electricity usage when the prices are low and increase usage when prices are high. To achieve all economic benefit of dynamic pricing it is imperative that electric devices equipped with automatic price aware scheduling mechanism requires so that minimum action came from the consumers. For this smart socket have been developed and placed between appliance and electricity outlet, and monitors electricity usage information of appliance and it is also having ability to communicate with smart meters and control electrical state of appliance. In this algorithm standardized communication protocols for smart appliance are developed and it also establishes HAN (home area network) whose function is to perform communication with smart meters and controlling remotely.

2.5 PAPER – 5 Efficient Data Collection for Smart Grid Using Wireless Sensor Networks(IEEE 2013,Authors: Kwangsoo Kim, Hyochan Bang, Seong-il Jin)

The focus of this paper is on central data collection quickly and without collisions. As a solution we divide a tree in which network constructs several branches and each meter having its own data collection path unit to leaf meter. The novel method used to avoid the collisions between query and query responses and in between query responses. Nowadays wireless sensor networks begun to use in the smart grids including advance meter reading (AMR) and advance metering infrastructure (AMI), here AMI and AMR are used to achieve the load balancing. It roughly consists of centralized server, smart meters and DCU (data collection unit). A server manages lots of DCU's and a DCU manages hundreds of smart meters. In this system WSN (wireless sensor network) used in between smart meter and DCU. A DCU in a smart meter is similar to sink node in a sensor network and smart meter acts as a sensor node. DCU's periodically collect power consumption and status data from all meters in the system within the time interval and transmit the data to server. After collecting metering values it will create dynamic price for consumers than calculate cost according to the consumption of electricity usage than to settle on the basic charge for exchanging power at power exchange and after that calculate total power consumption. One drawback is that while collecting electricity usage if some data is lost than billing process will not completed accurately and even if usage utility will show more consumption than complaint can be occurred. So as a solution conventional DCU's are developed by electric utilities which will be collect data without collisions.

3. Data acquisition

It is the process of measuring electrical or physical phenomenon such as voltage, current, temperature, and pressure with the computer. It consists of data acquisition measurement hardware current sensor, computer with programmable software. The aim is to measure of quantity, the data and that will be stored in the cloud. The user will be able to access his account also able to know his consumption.

Fig 1 Data acquisition flow

3.1 Current sensor

For the data acquisition we have to use acs712 current sensor of 5 ampere. Actually it is a device which detects electric current (ac or dc) and generates signal proportional to it and this current sensor gives analogue output so we have to use analogue to digital converter. And for that we need mcp3008 ic which is analogue to digital conversion integrated chip to the raspberry pi. This enables raspberry pi to interpret analogue voltages that is emitted by analogue based sensor and then reflect the measure of any physical characteristic.

Fig 2 ACS712 5a current sensor[26]

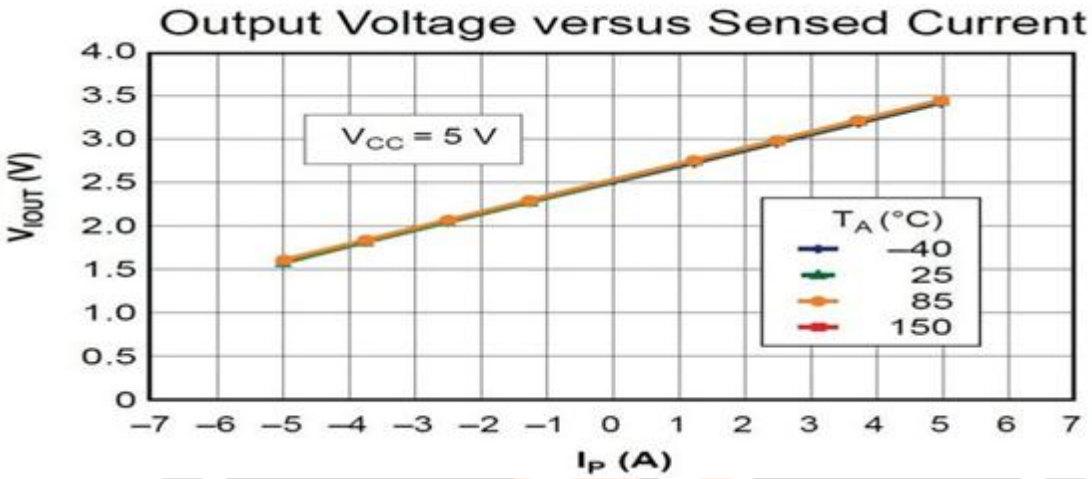

Fig 3 Output voltage vscurrent[27]

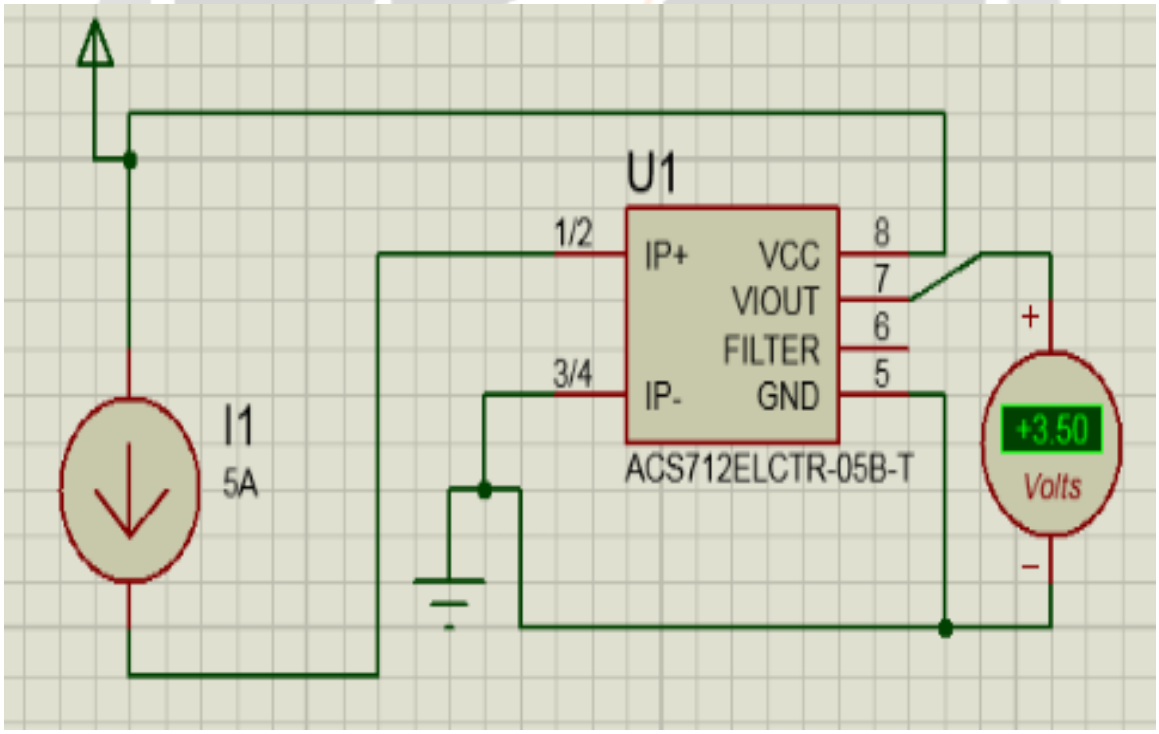

Fig 4 Simulation output

4 Advance metering infrastructure (AMI)

Advanced metering infrastructure (AMI) is the integrated system of smart meters, communications networks, data management systems which enables two way communications between utility and consumer. Advanced Metering Infrastructure *(*AMI*)* are systems which measure data, collect data, analyse energy usage information, and communicate with meters like as electricity meters, gas meters and water meters on request. These systems include hardware, software, communications, energy displays and controllers, customer associated systems, meter data management (MDMS) software. Government agencies and utilities are turning toward advanced metering infrastructure (AMI) systems as they are part of larger Smart Grid initiatives. Advance metering infrastructure extends current advanced meter reading technology with giving two ways meter communications, and commands to be sent toward the home for multiple purposes, including time-of-use pricing, demand-response actions. The network between the measurement devices and business systems allows collection of data and distribution of information to customers, suppliers, utility companies. This allows these businesses to findings contribute in demand response services. Customers can use information submitted by the system to change their normal consumption patterns to take benefit of less prices. AMI differs from traditional advance meter reading (AMR) in that it enables two-way communications with the meter.

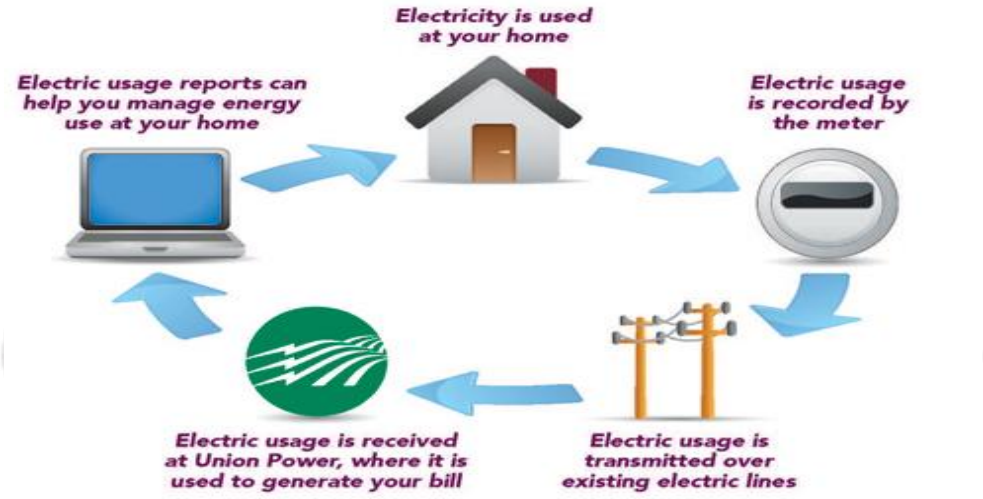

Fig 5 Advance metering infrastructure (AMI)[10]

5. Data sheet of Raspberry Pi B+ model

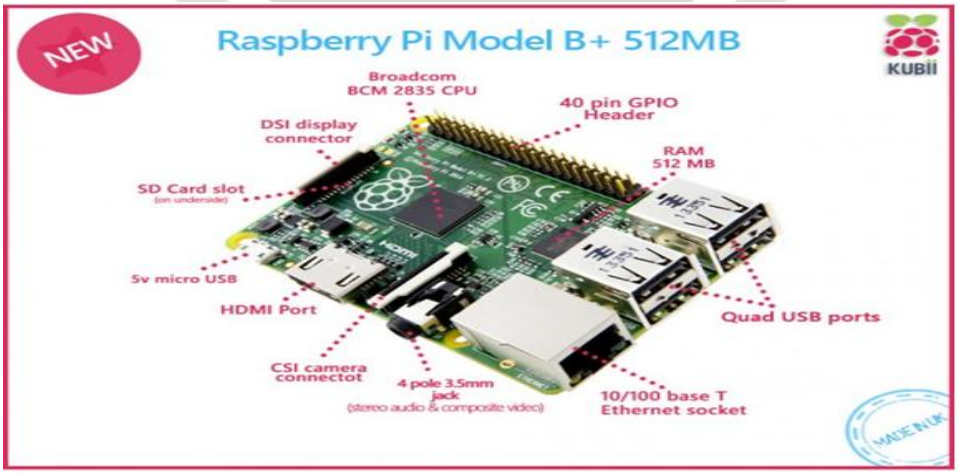

Fig 6 Raspberry pi B+ model [14]

Product Name: Raspberry Pi Model B+

Product Description: The Raspberry Pi Model B+ incorporates a number of enhancements and new features. Improved power consumption, increased connectivity and greater IO are among the improvements to this powerful, small and lightweight ARM based computer.

Chip: It uses Broadcom BCM2835 SoC

Core architecture: It's having core architecture of ARM11

CPU: 700 MHz of Low Power and ARM1176JZFS Applications Processor

GPU: Dual Core Video Core IV® Multimedia Co-Processor Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure

Memory: It's having RAM of 512MB SDRAM

Operating System: It Boots from Micro SD card and running a version of the Linux operating system

Dimensions: It's having dimensions of 85 x 56 x 17mm

Power: It's having Micro USB socket 5V, 2A

Ethernet: 10/100 Base T Ethernet socket
Video Output: HDMI (rev 1.3 & 1.4) Composite RCA (PAL and NTSC)

Audio Output: 3.5mm jack, HDMI

USB: 4 x USB 2.0 Connector

GPIO Connector: 40-pin 2.54 mm (100 mil) expansion header: 2x20 strip Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply lines

Camera Connector: It's having 15-pin MIPI Camera Serial Interface (CSI-2)

JTAG: Not populated

Display Connector: It consists of Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane

Memory Card Slot: Its having SDIO

6. Results

- Login page

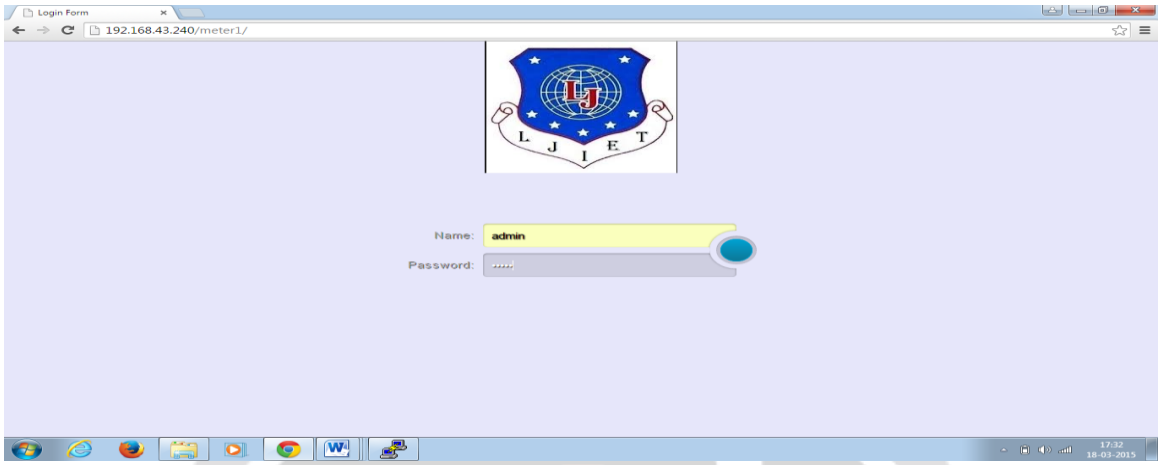

Fig 7 Login page

- Consumption page

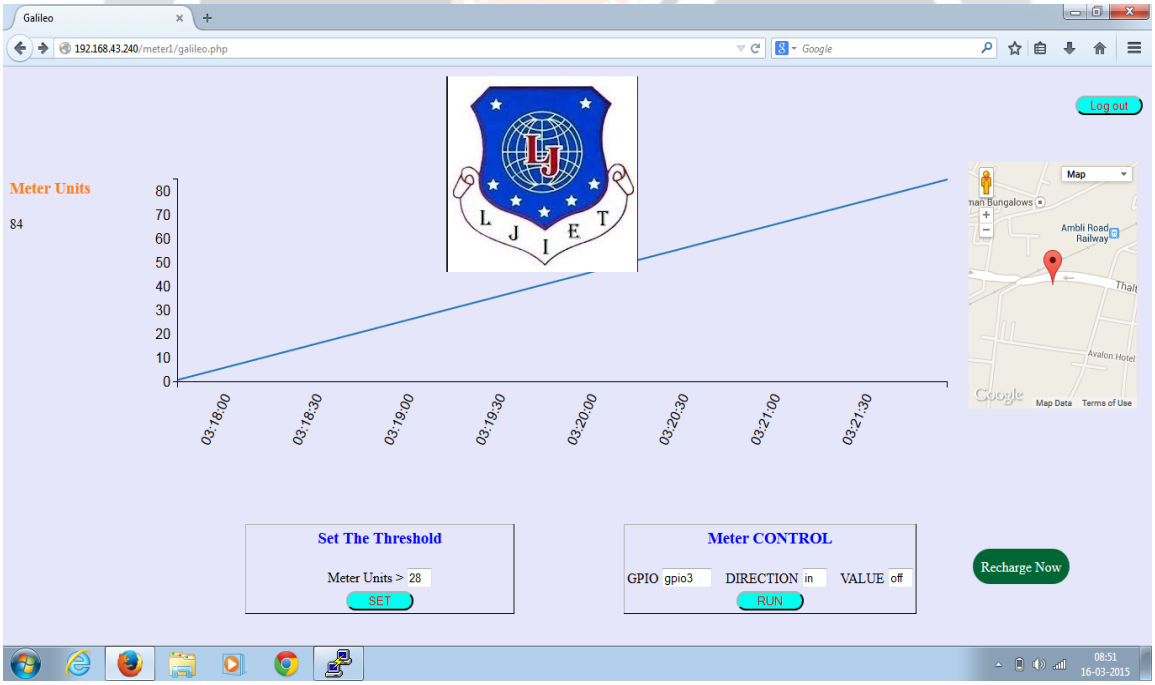

Fig 8 Consumption page

- Recharge page

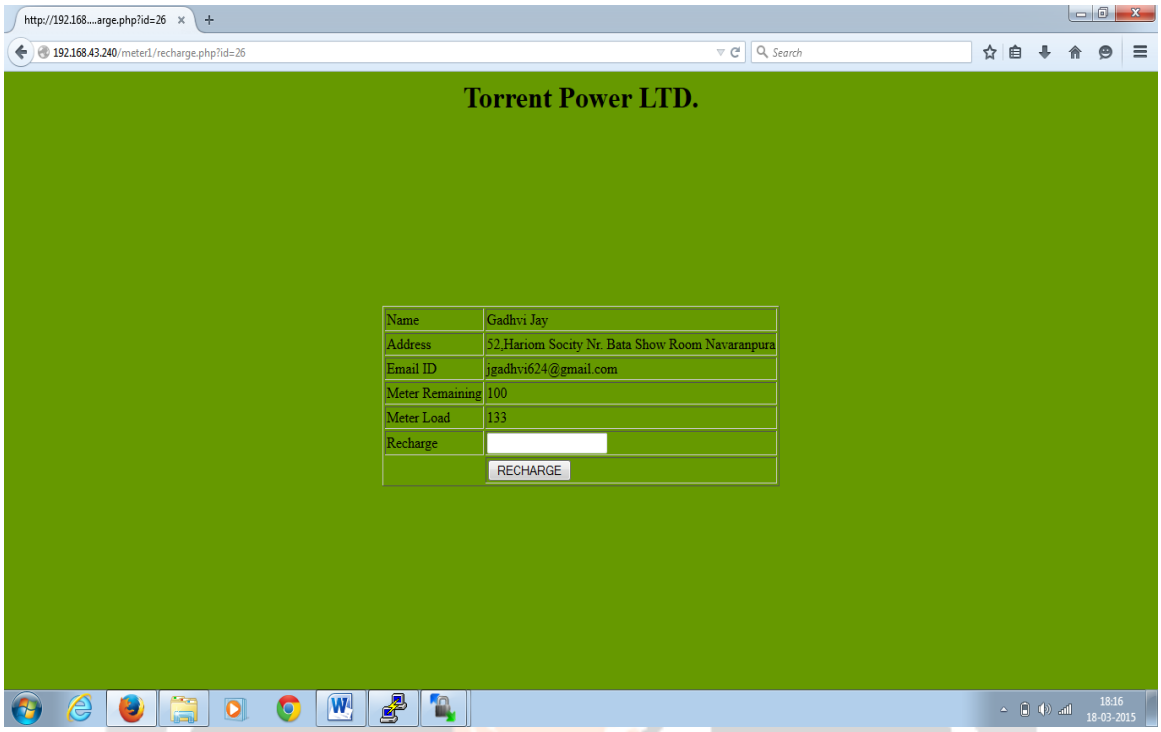

Fig 9 Recharge page

- Output voltage and meter units in putty

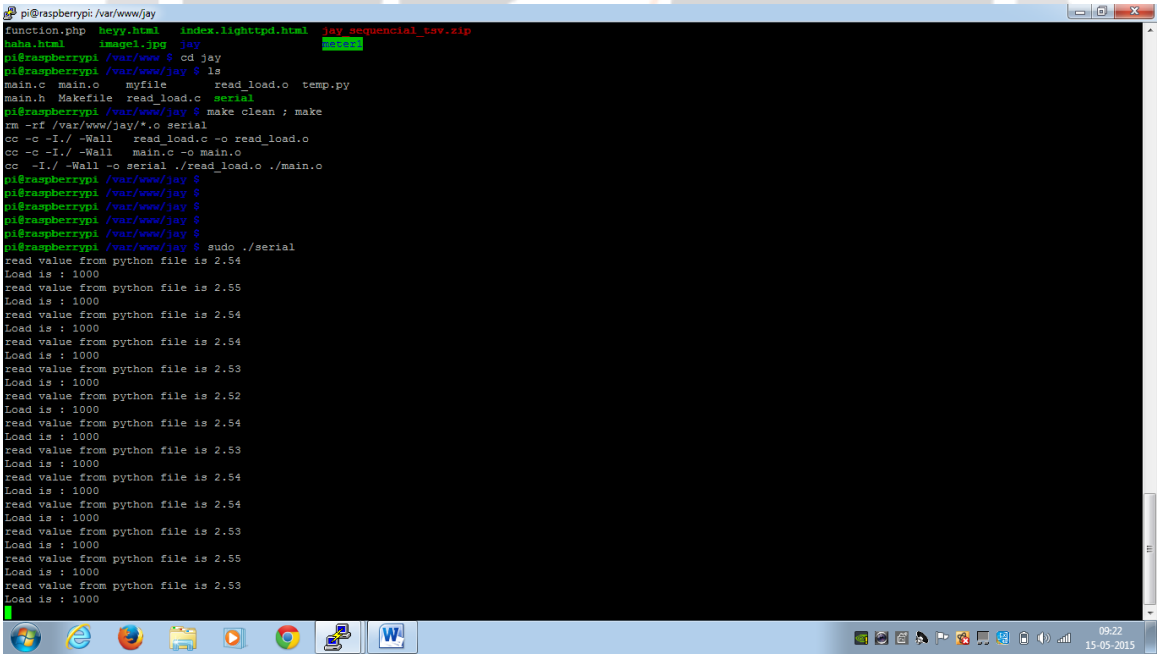

Fig 10 Output voltage and meter units

7. Conclusion

As we know nowadays the meter data collection is done manually with the data logger equipment, this project overcomes this problem and data collection will be done totally automatically by using AMI(advanced metering infrastructure) ,data acquisition, IOT(internet of things) , cloud based technology and this will reduce human efforts as well.

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