AUTOMATED ELECTRIC METER READING AND MONITORING SYSTEM USING ZIGBEE-INTEGRATED RASPBERRY PI

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Abstract
Electricity is very important part in our daily life. It is required in our daily routine for many application like home appliances, industrial purpose also for conversion of one energy to another form of energy. That is why it is used properly in our daily life. So it is important to measure it and monitor it. Not only monitor and measure but also distribution of electric bill according to user use. Few years back, there are different meters are there like electromechanical and analog meters. As compared to electromechanical meters automated meter reading systems (AMR) are more accurate and real time system that are utilized in developed countries. The use of ZigBee for Raspberry Pi, using programming language Python,
Keywords: Transceiver, Automated meter, wireless transmission, monitoring system

I. INTRODUCTION

A. Background of the Study
As nowadays electricity requirement increased than few years back from now. Electric meters is the device that used for creating the billing charges, that billing charges are on a month basis & that is computed in terms of kilowatt hours (kWh).

Automatic meter reading (AMR) it is the creation or new invention of automatic collect information of energy meter. After that the collected information is send to base station for other analysis. The main aim is not to reduce manpower its main aim is to collect data from different and difficult places which is not possible or difficult to collect from the premises or from any other places. AMR system is not used only for electric power measurement it is also used for many application like water uses that is consumption of water in developed countries.

AMR system is mainly designed for reduce problems of accuracy of meter reading data. To get these requirement, ZigBee model is integrated in a Raspberry Pi single-board computer (SBC).

B. Problem Statement
As seen in Developing country, electro mechanical meter reading systems is present in premises of consumers and information is collected by using man power in each month. So, that meter has some disadvantages like:

Meter reader person must be required to read that meter of each consumer for reading power consumption. By using of electromechanical meters meter reading changes and errors are more. Calculated bill is used at time when extreme weather conditions occur and meters to be read are not easily accessible to the reading - so it is problematic for consumer and supplier.

Nowadays wireless technology is invented and this wireless technology is widely used for AMR systems and for many other applications in the developed countries but now also used in the developing countries.

Significance of the Study
A smart meter is an electronic device that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing. Smart meters enable two way communication between the meter and the

central system. Unlike home energy monitors, smart meters can gather data for remote reporting. Such an advanced metering infrastructure (AMI) differs from traditional automatic meter reading (AMR) in that it enables two-way communications with the meter. The term Smart Meter often refers to an electricity meter, but it also may mean a device measuring natural gas or water consumption.

Similar meters, usually referred to as interval or timeof-use meters, have existed for years, but "Smart Meters" usually involve real-time or near real-time sensors, power outage notification, and power quality monitoring. These additional features are more than simple automated meter reading (AMR). They are similar in many respects to Advanced Metering Infrastructure (AMI) meters. Interval and time-of-use meters historically have been installed to measure commercial and industrial customers, but may not have automatic reading.

Research by which the UK consumer group, showed that as many as one in three confuse smart meters with energy monitors, also known as in-home display monitors. The rollout of smart meters is one strategy for energy savings. While energy suppliers in the UK could save around £300 million a year from their introduction, consumer benefits will depend on people actively changing their energy use. For example, time of use tariffs offering lower rates at off-peak times, and selling electricity back to the grid with net metering, may also benefit customers.

II. METHODOLOGY

A. Overview

To remove human fault in the conformist metering system, this AMR scheme contributing ZigBee as a wireless protocol is premeditated and established in this. Two common parts will be the significance of this reading. The block diagram of the premeditated design is shown in Fig. I. It includes of 2 imp parts, the transceiver which can performing as Transmitter (premises unit) and a router (for extensive distance dedications) and the receiver (server database at the billing office of the supplier electric company).The key goal of the scheme is transmit real time meter readings of meter by using wireless communication to the base station of the electricity company.
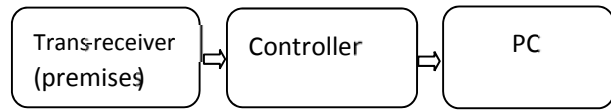

Fig l. General Block Diagram

At the positions unit where metering data are met and handled, records are formerly diffused by ZigBee, after which, the expected data is sent to the PC. The said premise unit is also a unit casing the geographical zone which receives information from the source and passes that files to receiver since each sites division capacity have partial range of wireless coverage to transmit info straight to the checker. The member of staff serving at table of server in the billing office will be extremely-safe databank structure which allows official team members of the electrical energy provider firm to reading and printing that electrical energy bills.

B. Levels of the Study

The stages of this reading, shown in Fig. 2, it will starts since the strategy and construction of the two main parts: the transmitter and the controller or the reception end. The databank server and observing scheme is the subsequent stage. Finally, it will over and done with the estimate of the recommended reading.

Stage 1: Design and Creation of the Transmitter/Router

A block diagram of the transmitter is shown in Fig. 2. Its required function is to send the files that actuality measured to the receiver end. Mostly, it also includes Raspberry Pi that controls the communication from Tx end to Rx and ZigBee section that helps as the transferring chip. When data transmitted through wireless communication over lengthy distances, it is essential to consume some apparatus at determined distances from the source for the moment reception & retransmission of information to the selected receiver. In that method, the said transmitter can also doing as a router, so at the time of execution of the scheme, each locations division can be designed to act both as a sender (when transmitting its data) and a router (for temporarily reception/retransmission of documents upcoming from other adjacent locations divisions) at dissimilar times.
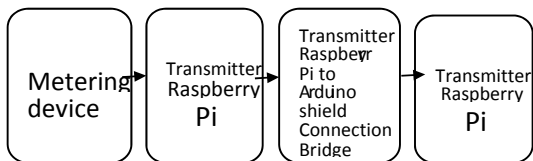
Fig 2. Transmitter Block Diagram

a) Metering device/sensor

Nowadays there are digital meters are available they measures the electric energy consumption and they are connected to the raspberry Pi using some small connection and it is shown in fig. this connection done through some cables like (RJ45 to RS232),DB9 and also by using serial to USB hub. Raspberry is also connected to USB hub. The data will be measured by using the metering device and then convert that electrical signal into digital format and pass it through signal conditioning circuit that is used for voltage current produced by the meter device and which is directly proportional with that actual values of parameters which sensed by sensor.

Here we can use number of electric meter as repeater for long distance or for accuracy purpose, like electric supplier company uses different meters in consumer premises also at D.P. and one at main station. Likewise we install one meter is at consumer premises and another is at base station. For long distance we also use number of repeaters. It used to overcome the problem of accuracy and thefting of electricity. The digital metering device measures power consumption. Here we use only one meter for shrt distance. So requirement of repeaters.

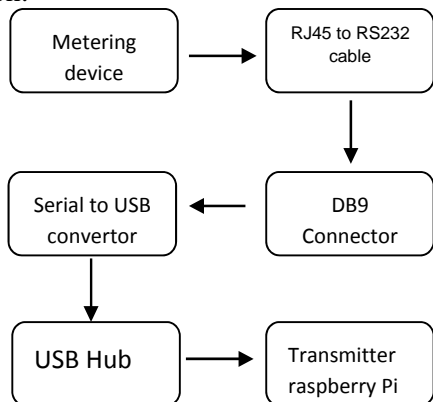ZigBee is used for the transmission of that measured data or reading towards the base station.

Fig.3. Connection Interface between Meter and Raspberry Pi

b) Transmitter Raspberry Pi

The Raspberry Pi 2 delivers 6 times the processing capacity of previous models. This second generation Raspberry Pi has an upgraded Broadcom BCM2836 processor, which is a powerful ARM Cortex-A7 based quadcore processor that runs at 900MHz. The board also features an increase in memory capacity to 1Gbyte.Raspberry Pi is a small device like our mobile size computer which is connect electronic devices in this system. The actual use of raspberry pi is to control and manage actual communication link between Tx. & Rx. Also communicate between Rx. And ZigBee module.

The programming is done on Raspberry Pi is on its Random Access Memory (RAM) at were the information is stored raspberry Pi uses python language as its main programming language which is code reliable and this language syntax provides programmers to provide imp. Concept in very short & few line of code.

ZigBee Module is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. It has developed an embedded antenna of wireless data communication module, which adopts standard ZigBee wireless technology. This module is in line with the Industry Standard applications of wireless data communication module.

This module can achieve transparent data transmission between many devices, and it can form a MESH network. This device has the characteristics of small volume, ultra-low power consumption and low-cost. It can be either as an independent data transmission termination or be easily embedded into a variety of products to form a short-range wireless data transmission solution.

2) Stage 2: Design of Receiver

a) Receiver ZigBee

At receiver side Zigbee module same with one on the Tx. unit which is used for compatibility of that 2 modules at receiver side reading are accepted periodically at e=any time. When the user want it he can easily access. So it is very important that transmission and reception is very accurate and mainly it should be real time operating whenever user want to see

3) Stage 3: Evaluation of the Proposed Study
For checking of different parameters some mathematical calculation will be there. In that we calculate mean square error (MSE) by using this we calculate the transmission time and the accuracy of the proposed system and its different error that occurs in the system

III. CONCEPTUAL AGENDA

We know automatic meter reading system is used for measuring voltage of electric meters to output side. It uses RS232 protocol & and it having serially transmission of data which is collected and send it to the raspberry pi.

Digital meters firstly take reading that is calculate the electric energy consumption. And that digital signal is displayed on the consumer's personal computer. In that it display user id and password by using which we can logging on that page after that it open that page it shows time date and the reading. This data again forwarded by using ZigBee transmitter towards the ZigBee receiver. It is present at base station. Processor part done all calculations and billing process is going on there after the processing of data user required data will be send to the user by using local area network.

Raspberry Pi is processing unit. On the user screen it can display user login and user password window. After the login on this page user can see the name and user id of Suppliers Company it also shows time date etc.

It compares both previous reading and the actual reading so that user can see the how much power can be used and billing of that. It also shows the massage that 'You are using more electricity as compared to the previous month' to the user so it is very useful.

IV. RESULTS

We use three different loads on output side first is charging of laptop 75Wh, charging of cell phone 5Wh, and a small lamp of 10Wh they connected to output that is to the meter. We take different trials for each or for common to all for verification.

After an hour of consumption it gives theoretical values according to that we can calculate the final calculation and compare it with our system reading.

V. CONCLUSION AND RECOMMENDATIONS

Using raspberry Pi and ZigBee module we can easily implement this AMR system. The metering device sense that reading and send it by using ZigBee Tx. towards the ZigBee Rx. The data will be processed and calculation is done in processor part after that data will be send to the user for its verification and billing purpose.

In this we can use registration of new user. Also we can compare previous reading with present reading for the verification. It also show that consumer uses less power or more power compared to previous month or week. So it is very compatible system and can be easily implement

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