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Implementation of Energy Meter Reading System Using an Internet of Things Approach

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Abstract

The technology of e-metering (Electronic Metering) has gone through rapid technological advancements and there is increased demand for a reliable and efficient Automatic Meter Reading (AMR) system. This paper presents the framework for an Internet of Things (IoT) device as an automated industrial meter reader that uploads the collected numeral data to cloud storage for centralized data processing. The implementation of the device is done using Raspberry Pi as the platform. These are more accurate measuring device than the conventional electromechanical meter reading system. Solar energy is one of the best options but in rainy season it faces some problems. So monitoring of Electricity is very important task in our day today's life. So for that some advanced technology is required to measure Electricity accurately and monitor it properly. The device follows a four-step process- Image Acquisition using Raspberry Pi camera module, Optical Character Recognition using feature extraction technique, Internet Upload Mechanism using Google Forms and Online Data Processing using Google Spreadsheet. As compared to electromechanical meters automated meter reading systems (AMR) are more accurate and real time system that are utilized in developed countries.

INTRODUCTION

The project is aimed at evaluating the performance of an operating system on an embedded system. Before delving into its implementation, an introduction is needed to the parts involved in the project. The whole report is centered around the field of embedded systems and the use of Linux to run applications on them. Hence an introduction to Embedded Systems and using Linux as an OS in them is provided [1-3].

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 [6-8]. 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 applications 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. 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 communications 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 [10].

This system reduces the need for human intervention and thus the scope for human error greatly. It also provides for centralized and instantaneous data processing. Here,

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centralization refers to the fact that a particular cloud is used for storage and analysis of the data, resulting in centralized access to the data. The cloud itself may be a decentralized entity. As a result of this centralized and instantaneous data processing, it is not necessary to incorporate the data processing functionality into the hardware itself, thereby reducing the computational complexity of the device considerably. The records can be accessed by authorized users from any Internet-enabled device such as laptop, computer, tablet, Smartphone etc. from any location around the world.

PROPOSED SYSTEM

Proposed system uses camera to take automatic meter reading. For capturing image camera is placed in front of energy meter of house. To get digits separate out & to calculate the bill for the month processor issued with contour algorithm. In this paper, Raspberry Pi is used because it is a sort of minicomputer. We can't install Microsoft Windows on it as it uses a different kind of processor. But you can install several versions of the Linux operating system which feels very much like Windows. If we want to, we can use the Raspberry Pi to surf the internet, send an email and many more using a word processor. Easy to use but powerful, affordable and difficult to break, the Raspberry Pi is the perfect for pursuing computer scientists.

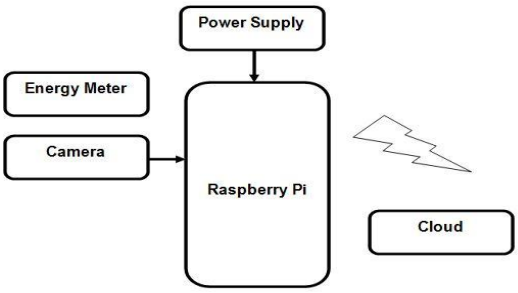

Fig 1: Block diagram representation of proposed system

Raspberry Pi

Raspberry pi B is a portable, powerful and minicomputer, programmable PC that runs in open-source Robot operating system [4]. The board consists of Video Core IV graphics processing unit (GPU), ARMv7-compatible quad-core one, 512 MB of RAM. It has a MicroSD to boot media and for persistent storage. One powerful feature of the Raspberry Pi is the row of GPIO -General Purpose Input/output pins along the edge of the board (refer Fig.1.1). These pins are a physical interface between the Pi and the outside world. At the simplest level, these are called as switches. Seventeen of the 26 pins are GPIO pins; the others are power or ground pins.

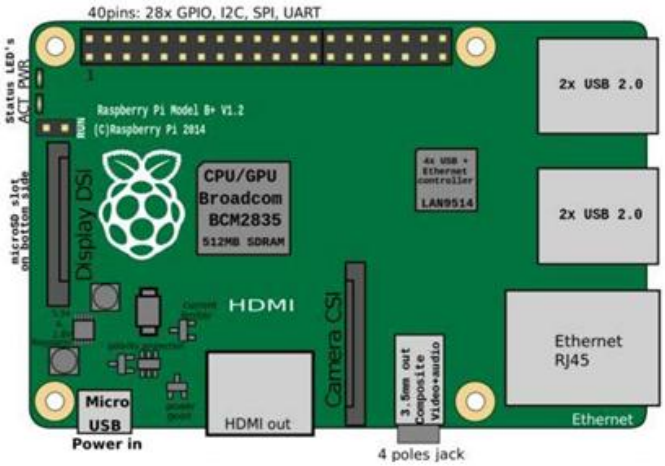

Fig 2: Raspberry Pi Board

It will have 4 USB 2.0 ports, compared to 2 on the Model B, and better hot plug and over current behavior. The old friction-fit SD card socket has been replaced with a much nicer push-push micro SD version. By replacing linear regulators with switching ones we've reduced power consumption by between 0.5W and 1W.The audio circuit incorporates a dedicated low-noise power supply. We have aligned the USB connectors with the board edge, moved composite video onto the 3.5mm jack, and added four squarely-placed mounting holes.

USB Camera

The type of camera used here is an USB camera which has recording function built-in and can thus record directly to any standard storage media, such as SD cards, NAS (network-attached storage) or a PC/server. The camera feeds or streams its image in real time to a computer or a mobile using network. When "captured"

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by the computer, the video stream may be saved, viewed or sent on to other networks via Wi-Fi. When sent to a receiver side, the video stream is saved in cloud.

Regulated Power Supply

There are several ways to convert an AC voltage into the DC voltage. Traditionally, this has been done with a transformer and rectifier circuit. However, in applications that involve providing a DC voltage to only the controller and a few other low-current devices, transformer-based or switcher-based power supplies may not be cost effective. So, Transformer less power supplies which provide a low-cost alternative to transformer-based are used in this robot.

Cloud

Cloud computing is a synonym for distributed computing over a network. Its highlighting feature is the ability to run a program on many connected computers at the same time. Its advantages proved in history include on demand self-service, ubiquitous network access, location independent resource pooling, rapid resource elasticity, usage-based pricing and transference of risk. Some of the Services offered by cloud include 'SaaS' (Software as a Service), 'PaaS' (Platform as a Service), 'IaaS' (Infrastructure as a Service), 'HaaS' (Hardware as a Service) and 'NaaS' (Network as a Service).

Wi-Fi

Wireless Fidelity or Wi-Fi is a local area wireless computer networking technology that allows the Raspberry Pi kit to connect to the network. It uses a bandwidth of 2.4 gigahertz. The Wi-Fi network provides the connection of unique IP address from the Raspberry Pi kit to the devices in receiving end. Using the various encryption technologies in Wi-Fi, the network is made secure. Wi-Fi is provided for the entire process which is fitted along with the robot. The power supply for all the components is provided by DC transformer less power supply. IR sensor signals if a person is trying to cross a restricted area and switches on the lamp. All the data obtained in mobile is uploaded to cloud.

DEVELOPMENT AND WORKING PRINCIPLE

The Raspberry Pi Camera Module is a compact 5MP camera which can be interfaced with the Raspberry Pi using a dedicated flex cable connector. A General Purpose Input Output (GPIO) [9] pin is used to connect a push button switch. When the switch is pressed, the camera captures an image of the meter with the aid of the python-pi camera library and transfers it to the Raspberry Pi for further processing. A mechanical fitting is attached around the camera to ensure that the display section of the meter can be isolated and that a smaller image is available for processing. This reduces the computational requirement and processing time of the device.

The device is built as a proof of concept for Internet enabled meter readers. In this case, it uses the Raspberry Pi Model B+ (Raspberry Pi) as the main hardware platform. The Raspberry Pi has been used in the past to build Internet of Things (IoT) devices for home automation. The presented device uses it for a heavier IoT application that involves digital image processing as well [5]. Along with the Raspberry Pi, the device consists of the Raspberry Pi Camera Module, a battery pack for power supply, and a Wi-Fi adapter to make the device Internet-enabled.

The algorithm for optical character recognition (OCR) is based on an established feature extraction algorithm. The image undergoes four steps to extract the meter reading. The threshold will depend on the particular type of display. In this case, the digits are mapped to black and the background is mapped to white.

The Raspberry Pi is connected to the Internet through a WiFi adapter. The Wi-Fi adapter must be configured when used for the first time. The Wi-Fi Protected Access (WPA/WPA2) key or Wired Equivalent Privacy (WEP) key must be saved in the configuration to enable automatic connection for future use. Google Forms are used to collect time stamped data in a Google Spreadsheet. Other than the Graphical User Interface (GUI) provided by Google, the form can also be filled

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by entering the input data into a Uniform Resource Locator (URL) for Hypertext Transfer Protocol (HTTP) POST request. This is one of the methods which can be used to upload data to a Google Spreadsheet from the Raspberry Pi. Then, the URL for automatically filling the form is found out by exploring the 'Inspect Element' option on the elements of the live form. In this case, A HTTP POST request is made from Raspberry Pi.

RESULTS

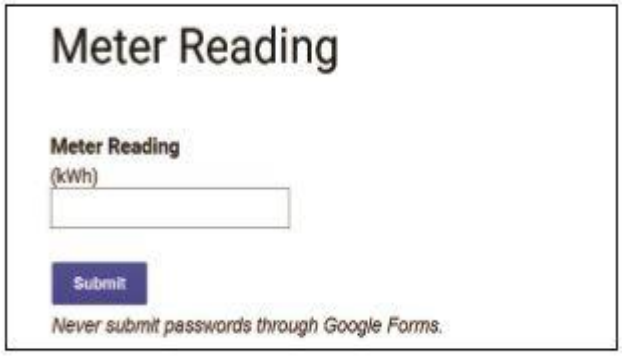

Fig 3: Google form for taking the readings

The responses of the Google Form are collected in the Google Spreadsheet. Settings cannot be done directly in this default response sheet where the data is uploaded because every entry automatically creates a new row which does not have any functions in it. Hence, a new sheet is created in the same spreadsheet. The responses are copied into this new sheet using the IMPORTRANGE function. The function 109 for data processing is written in the next column of the new sheet. Once these settings are done, the output will be automatically updated in the new sheet with every data entry in the default response sheet. The function used in this case is the difference of the current and previous reading. The variety of functions available in Google Spreadsheets coupled with user-defined functions and macros can help to realize heavy analysis functions and data processing.

The processing of the data is handled by the cloud storage and does not require human intervention. It is a continuous process which is updated automatically when the reading is uploaded to the Google Spreadsheet. Hence, it is not considered in the total time lag.

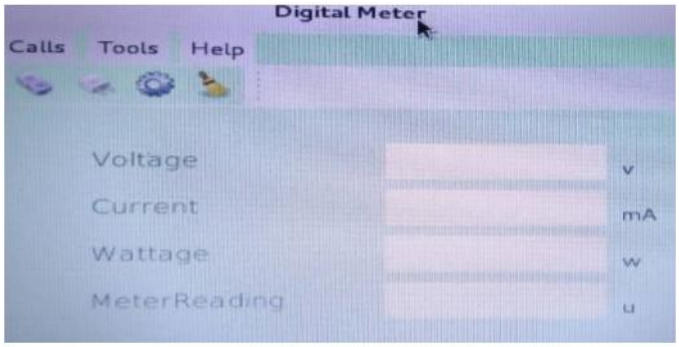

Fig 4: IoT Energy meter web page

Three loads-a charging laptop rated at 76Wh, a charging cellular phone rated at 4Wh, and a lamp rated at 9Wh-were connected to the meter. Twelve (12) trials, each lasting for five (5) Minutes, were carried out to complete an hour of consumption. Theoretical readings were obtained by adding the previous reading to the product of 89Wh and the fraction of hour the trial lasted.

Fig 5: Data base of meter readings

Advantages

The advantages of these electric metering system offers make it a more accurate measuring device than the conventional electro-mechanical meter reading system being used in developing countries like India. AMRs capacity to automatically transmit data real time increases the reliability of this metering system, unlike electromechanical meters which occasionally make use of previous readings as a basis of the consumer's current billing. It also puts consumers at a disadvantage as the accuracy of power consumption readings is being compromised.

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CONCLUSION

In this paper with the help of presented proposed system it is possible to avoid meter reader visit and revisit (if there are any problems in billing) to each house to take reading. Also if consumer gets faulty bill he has to go to MSEB office to correct it and be in long queue. This is avoided here by taking photo of meter reading with camera located in front of meter and sending these readings to server wirelessly, keeping the database updated which is hard to maintain now a day's manually.

Future Scope

In future to reduce cost it may be possible to use single camera for each society or whole apartment energy meter room. Algorithms could be developed to isolate the display and deal with variations in ambient light without using a mechanical fitting. Instead of using LEDs, the debugging of the device can be done using sophisticated user interfaces which give more information regarding the cause and remedies for an error that may have occurred. The online data processing can be done using sophisticated cloud storages like Xively, Nimbits, etc. which specialize in Internet of Things. Further, a separate cloud instance can be created for the specific application. This will eliminate the need to duplicate the Google Spreadsheet and its associated disadvantages.

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