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Automated Electric Meter Reading and Monitoring System Using E Board Computer via Ethernet

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ABSTRACT

In recent years, automated meter reading systems (AMR) are being utilized in most developed countries like the United States and other European countries. The advantages these electric metering system offers make it a more accurate measuring device than the conventional electromechanical meter reading system being used in developing countries. 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. The integration of single board computer Raspberry Pi, through the programming language C++, has successfully facilitated the reading and wireless transmission of the voltage or power consumption of the user. Through C++, the raw data transmitted to the router through Ethernet communication the received data to be uploaded in the website.

Keywords--- ***ARM11,Micro controller (AT89S52) 2.4 GHz RF Transceiver, Current Sensors, Load, Energy meter.***

INTRODUCTION

The struggle between global warming and human beings is well recognized by the international society. Scientists devoted their effort into the development of renewable energies while governors/administrators audit and control energy consumption based on regulation. In view of the compulsory energy consumption control in near future, researchers have developed energy aware technology such as ZigBee. ZigBee is a wireless sensor network for home and building automation. Recently, ZigBee has been widely adopted for both metering as well as energy management.In the existing automatic meter reading technology, the meter reading process is done by the help of manpower. But this method is subjected to several disadvantages like errors during calculation, absence of consumer during billing time and extra expenses for the billing process. The project „Automatic Energy Calculation Through Wireless Smart Meter Using Zigbee‟ aims to minimize these difficulties by providing automatic energy calculation through wireless medium. This method can eliminate the problems such as manpower requirement for billing and errors during calculation etc., and can provide necessary information such as tariff variation and due date for payment etc. to the consumer through the wireless medium. The wireless technology can be implemented by having a Zigbee enabled transceiver interfaced with the EB section server as well as in the consumer side.

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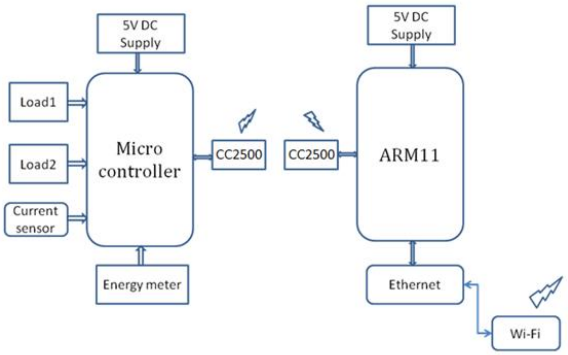
System Architecture



RASPBERRY PI BOARD:

Raspberry Pi is a credit-card-sized single board computer developed in the UK by Raspberry Pi foundation with the intention of stimulating the teaching of basic computer science in schools. It has two models; Model A has 25 6Mb RAM, one USB port and no network connection. Model B has 5 12Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARMl176JZF -S 700 MHz processor, Video Core IV GPU, and an SD card. The GPU is capable of Blu-ray quality playback, using H.264 at 40MBits/s. It has a fast 3D core accessed using the supplied OpenGL ES2.0 and Open VG libraries. The chip specifically provides HDMI and there is no VGA support. The foundation provides Debian and Arch Linux ARM distributions and also Python as the main programming language, with the support for BBC BASIC, C and Perl, detailed description of Raspberry Pi board has been given in Fig. 2 (Raspberry Pi user guide). Python was chosen as the main programming language, as it is generally accepted to be both easy to learn and a fully fledged , programming language suitable for real world applications. With the addition of NumPy, SciPy, Matplotlib, IPython, and PyLab, Python can be used for computational mathematics as well as for the analysis of experimental data or control systems. Due to the unique advantages of the Raspberry Pi system, this technology holds great promise for providing solutions within the developing world. The most distinctive feature of the Raspberry Pi when used for educational purposes is the GPIO module.

Figure: Raspberry Pi Board

ROUTER:

The ARM11 is connected to a router with a wired serial connection. The router runs open source embedded Linux software, providing networking functionality to connect the internet. This essentially provides internet access to the ARM11 board. Router acts as an IoT application gateway and interconnects. A private IPv6 network using a Virtual Private Network (VPN) is used for connecting the IoT application gateway to the server.

The server collects sensor data forwarded by the application gateway and store in a database for further processing and then to be viewed via a website. Data can be viewed in terms of previous day, week, and month time periods graphically. In the present setup, heterogeneous sensing units are designed and developed indigenously for intelligent home monitoring systems to integrate with IoT networks.

Figure 2: Internet Router

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The Linux-OpenWRT software provides the networking architecture to participate in many types of networks. These networks are abstracted into devices, which generalizes management and configuration. This abstraction requires device drivers which operate in the kernel space, making development difficult. A TUN/TAP device driver acts as a virtual network device with its output directed to a user space program instead of a physical device. This simplifies the development of a network device, as a user space program is easier to develop.

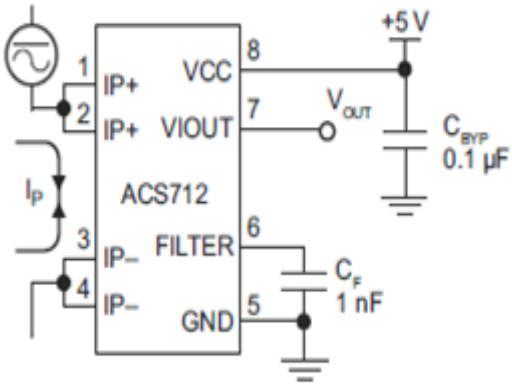
Linear Current Sensor:

Description

The Allegro® ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and over current fault protection. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

Features and Benefits

- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
- 5 µs output rise time in response to step input current
- 80 kHz bandwidth
- Total output error 1.5% at TA = 25°C
- Small footprint, low-profile SOIC8 package
- 1.2 mΩ internal conductor resistance
- 2.1 kVRMS minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0 V, single supply operation
- 66 to 185 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage



Typical circuit diagram

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CC2500:

Applications:

- Sensor Networks / Data collection.
- Wireless metering.
- Access control / Identity discrimination.
- Home Automation.
- Smart house products / Security Systems.
- Remote control / Remote measurement system.
- Weather stations.
- Multi Slave Communication.
- Up to 250 Device can communicate with each other.

Working:

This RF Module can be used for applications that need two way or Multiway wireless data transmission. It features MultiMaster and Multislave and reliable transmission, Small Size and best range in its class protocol is self controlled and completely transparent to user interface. The module can be embedded to your current design so that wireless communication can be set up easily for wireless data transmission. It supports adjustable data rate with reliable transmission distance.

Specifications:

- Working Voltage : 4.5 To 5.5 Volt
- Frequency of Operation : 2.4 GHz
- Output RF Power : 1 dbm
- Typical Operating Range : 30 meters
- UART baud rate : 9600 (8 bit data, no parity, 1 stop bit) *Can be Changed

Features:

- Automatic switching between TX and RX mode.
- FSK technology, half duplex mode, robust to interference.
- 2.4 GHz band, no need to apply frequency usage license.
- Protocol translation is self controlled, easy to use.
- High sensitivity, reliable transmission range.
- Standard UART interface, TTL (3-5V) logic level.
- Stable, small size, easier mounting.
- No tuning required, PLL based self tuned.
- Error checking (CRC) of data in built.

µC (AT89S52) :

The AT89S52 is a low-power, high-performance CMOS 8- bit microcontroller with 8K bytes of in-system programmable Flash memory. The Atmel AT89S52 is a powerful microcontroller provides advantages like high flexibility and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes one is idle and other is power saving mode [5].

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LCD DISPLAY:

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence. The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in colour or monochrome. Liquid crystals were first discovered in 1888.[2] By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide, and the CRT became obsolete for most purposes.

MCP3208:

The Microchip Technology Inc. MCP3204/3208 devices are successive approximation 12-bit Analog to-Digital (A/D) Converters with on-board sample and hold circuitry. The MCP3204 is programmable to provide two pseudo-differential input pairs or four single ended inputs. The MCP3208 is programmable to provide four pseudo-differential input pairs or eight single ended inputs. Differential Nonlinearity (DNL) is specified at ±1 LSB, while Integral Nonlinearity (INL) is offered in ±1 LSB (MCP3204/3208-B) and ±2 LSB (MCP3204/3208-C) versions.Communication with the devices is accomplished using a simple serial interface compatible with the SPI protocol.The devices are capable of conversion rates of up to 100 ksps. The MCP3204/3208 devices operate over a broad voltage range (2.7V - 5.5V). Low current design permits operation with typical standby and active currents of only 500 nA and 320 µA , respectively .The MCP3204 is offered in 14-pin PDIP, 150 mil SOIC and TSSOP packages. The MCP3208 is offered in 16-pin PDIP and SOIC packages.

Ethernet LANs

The most widely used local-area network (LAN) access method - defined by the Institute of Electrical and Electronics Engineers (IEEE) - is the 802.3 [1] standard. Ethernet has become so popular, that most Apple computers and many PCs are fabricated directly with 10/100 Ethernet ports for home use. These ports enable you not only to create a small home network, but also to connect to the Internet via a Digital Subscriber Line (DSL) or cable modem, which requires an Ethernet connection. A 10/100 port was created for a network interface, which supports both 10BASE-T at 10 megabits per second (Mbps) and 100BASE-T at 100 Mbps.

Ethernet is a shared-media LAN, which means that all stations on the segment use a part of the total bandwidth. Depending on the type of Ethernet implemented, this total bandwidth is a 10 Mbps (Ethernet), 100 Mbps (Fast Ethernet), or 1000 Mbps (Gigabit Ethernet). In a shared Ethernet environment all hosts are connected to the same bus and compete with each other for the bandwidth. In such an environment packets meant for one machine are received by all the other machines. Thus, any machine in such an environment placed in promiscuous mode will be able to capture packets meant for other machines and can therefore listen to all the traffic on the network using the carrier sense multiple access with collision detect (CSMA/CD) mechanism like in Point-to-Multipoint communication.

A switched Ethernet environment - in which the hosts are connected to a switch instead of a hub - is called a Switched Ethernet. The switch maintains a table keeping track of each computer's MAC address and delivers packets destined for a particular machine by

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sending it to the port on which that machine is connected.

The switch is an intelligent device that sends packets to the destined computer only and does not broadcast to all the machines on the network. It means each sender and receiver pair has the full bandwidth available for use e.g. Point-to-Point case. Ethernet LANs use Media Access Control (MAC) address to determine how traffic is transferred between network segments. Ethernet hubs, defined by Open System Interconnection (OSI) model physical layer (Layer 1) repeat only the physical signal; the hub does not look at a source or destination address. Ethernet bridges and switches use the source and destination MAC address, defined by the OSI data link layer (Layer 2) to build an interface table and to determine which segment should receive the frame. Routers use the network address, found at the OSI network layer (Layer 3) to build a routing table.

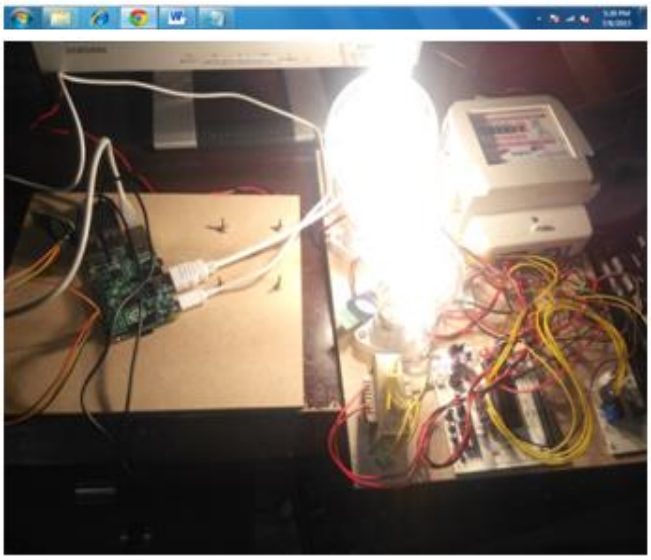
Existing Work:

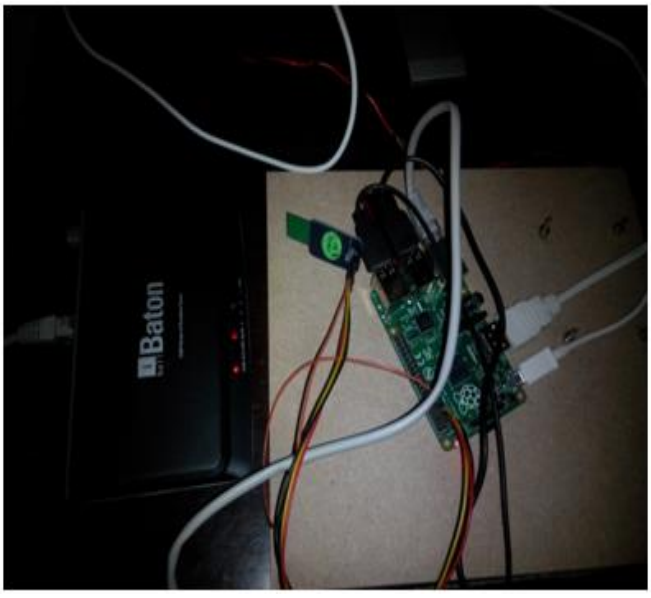
Existing System used a complex approach in order to gather data and upload to webpage using MySql database and external web server, Modbus, which are very heavy for the SBC type Board and also no front GUI system was designed for day to day monitoring.

Proposed Work:

Proposed Work included a small light weight Web server designed on Raspberry pi board, which will make the system to work much faster and based on IoT technology the data will be uploaded to the Internet via Ethernet protocol, which is much faster communication protocol then Modbus.

EXPERIMENTAL RESULTS





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CONCLUSION

The proposed AMR system, which incorporates Ethernet module in a Raspberry Pi, has been successfully implemented. The Raspberry Pi-to-Arduino Shields connection bridge interfaced the Ethernet module to the Raspberry Pi. The use of the Ethernet module made the wireless transmission of the meter data possible through the router the output can be observed in web. The transmitted data were received through web in mobiles or in system and were converted into CSV file through Python. The CSV file was utilized so data, specifically the voltage consumption, can be accessed by consumers through the built website.

FUTURE SCOPE

Future work will include a comparative study between the proposed system and other wired system, focusing on energy efficiency, Smart Grid capabilities and installation and Maintenance costs.

Further implementations will be done in order to extend the proposed system to other standards or technologies of lamps, luminaries or lightning communication and control protocols.

BIBLIOGRAPHY

1.W. Kastner, G. Neugschwandtner, S. Soucek, and H. M. Newmann, “Communication systems for building automation and control”.
2. D. Snoonian, “Smart buildings”.
3. M. Moeck, “Developments in digital addressable lighting control”.
4.C.Gomez, and J. Paradells, “Wireless home automation networks: a survey of architectures and technologies”.
5. V. Chunduru, N. Subramanian, “Effects on power lines on performance of home control system”.
6.Lighting Research Center, Rensselaer Polytechnic Institute, “Reducing barriers to the use of high-efficiency lighting systems”.
7. M. Aliberti, “Green networking in home and building automation systems through power state switching”.

Reference Websites:

1. http://www.garmin.com/products/zigbee
2. http://www.alldatasheet.com
3. http://www.mathworks.com
5. http://www.national.com/ds/LM/LM35.pdf
6. http://www.nxp.com/documents/user_manual/UM10139.pdf

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