International Journal of Engineering Research and General Science Volume 4, Issue 3, May-June, 2016
ISSN 2091-2730

IOT based Energy Management System by Using Raspberry pi ARM cortex

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Abstract— The purpose of this paper is to acquire the remote electrical parameters like Voltage, Current, and Frequency from Smart grid and send these real time values using IoT. This project is also designed to protect the electrical circuitry by operating an Electromagnetic Relay. The Relay can be used to operate a Circuit Breaker to switch off the main electrical supply. User can send commands in the form of IVR messages to read the remote electrical parameters. This system also can automatically send the real time electrical parameters periodically (based on time settings) in the form of SMS and Web application. This system also sends SMS alerts whenever the Circuit Breaker trips or whenever the Voltage or Current exceeds the predefined limits, we use Raspberry pi as the heart of the project to control all the work involved.

Keywords— GSM Modem, Internet Of Things(IoT), Express SCH for Circuit design, Proteus for hardware simulation,IVR-Interactive voice response, Microcontroller (Raspberry pi).

INTRODUCTION

The time complicated interlocking and operation controlling requirements involved in Energy Management, which lead to necessity of automation of the undergoing process. In this respect, Energy Management automation, which is the creation of a highly reliable, self-healing power system that rapidly responds to real time events with appropriate actions, ensures to maintain uninterrupted power services to the end users with smart monitoring and maintaining of databases.

PROPOSED METHOD

This research paper aims at continuously monitor the load conditions of the specific location. It also monitors the temperature of the devices present in the specific location. If the load increases beyond the specific location rated capacity, the microcontroller will automatically shut down the specific location and intimates the same to the operator by sending a message through a GSM modem. A modem provides the communication interface. It transports device protocols transparently over the network through a serial interface. A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. If the temperature of the specific location increases, then the microcontroller will automatically starts the cooling system for the specific location. At any point, if the operator wants to know the loads conditions and the temperature, he has to send a predefined message to the modem which is interfaced with the microcontroller and the controller acknowledges the operator with the required information.

1. Sensing different electrical parameters (voltage, current, temperature).
2. Update Webpage with real time data using IoT.
3. Forwarding the electrical parameters over GSM network.
4. Producing buzzer alerts (if necessary).
5. Automatic circuit breaking operation.

An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are Microprocessors and Microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result. Here we use the most advanced microcontroller kit called the Raspberry Pi Arm Cortex for data acquisition and data processing.

The research IOT based Energy Management System by Using Raspberry pi ARM cortex using according to the instructions given by the above said microcontroller. Distributed transformers are prone to damages due to the rise in oil temperature when there is an overload or huge current flows through the internal winding of the transformer. When the oil temperature rises, it increases the probability of getting damages in the transformers. The transformers are to be monitored very cautiously during these situations. The proposed system consists of a monitoring unit that is connected with the distribution transformer for the purpose of monitoring the same. Hence, we introduce a simulation model which details the operation of the system to rectify the mentioned problem. The monitoring system is constituted by three major units, namely,

1. Data processing and transmitter unit
2. Load and Measurement Systems
3. Receiver and PC display unit

We have designed a system based on Raspberry Pi that monitors and controls the voltage, current and oil temperature of a distribution transformer present in a specific location. The monitored output will be displayed on a PC at the main station that is at a remote place, through RF communication. The parameters monitored at the distribution transformer are compared with the rated values of the transformer. Additionally the breakdowns caused due to the overload and high voltage are sensed and the signals are transmitted to the main station using RF communication. The software in the PC compares the received values with the rated measurements of the distribution transformer and shuts down the transformer so that it can be prevented from damages and performances can be enhanced quiet to a remarkable level. The controller consists of a sensing unit which collects the essential parameters such as current, voltage and the oil temperature within the distribution transformer. The digital display connected to the processing unit displays corresponding parameter values at the specific location for any technical operations. The controller also senses the overload and high current flow conditions in the internal windings that may lead to breakdown of the corresponding unit. The microcontroller is programmed in such a manner so as to continuously scan the transformer and update the parameters at a particular Time interval. The parameter values sensed by the microcontroller are transmitted through the RF transmitter connected to the microcontroller unit. The transmitted signals are received at the main station using the RF receiver. The received signals are then passed to the PC. The software loaded in the PC is used to monitor the changes in the parameters that are measured from the distribution transformer. When a remarkable change is noticed in the measured values it controls the unit by ending it from any serious damages.

The values of voltage, current and temperature of the transformer is directly applied to Port A (one of the input ports of the microcontroller). Along with this, a display is connected in the Port B (another input port of the microcontroller). The RF transmitting section and the load variation control are connected to the Port C (one of the output ports in the microcontroller).

The monitoring PC is connected to the main station. The microcontroller at the specific location monitors and captures the current, voltage and temperature values for a particular period of time interval. The captured values are stored in the data register and displayed using the LCD display.

The monitored voltage, current and temperature values of the transformer are transmitted using the RF transmitter for each and every time interval. Any antenna tuned for the selected RF frequency can be utilized for the transmission of the RF signal but the antenna has to exhibit a unidirectional radiation pattern. In the receiver side of the proposed system, the receiver antenna converts the RF signal into electrical signal and acquires the information which has been transmitted by the transmitter. Based on the received information, controlling operation is performed. If the receiver receives the transformer parameters which is greater than the fixed threshold level, then immediately the units is shutdown so as to protect the same. The voltage level is reduced using transformers and power is transferred to customers through electric power distribution systems. Power starts from the transmission grid at distribution specific location where the voltage is stepped-down (typically to less than 10kV) and carried by smaller distribution lines to supply commercial, residential, and industrial users. Novel electric power systems encompassing of power transmission and distribution grids consist of copious number of distributed, autonomously managed, capital-intensive assets.

Real Time System Design

Real time systems have to respond to external interactions in a predetermined amount of time. Successful completion of an operation depends upon the correct and timely operation of the system. Design the hardware and the software in the system to meet the Real time requirements. Designing real time systems is a challenging task. Most of the challenge comes from the fact that Real time systems have to interact with real world entities. These interactions can get fairly complex. A typical Real time system might be interacting with thousands of such entities at the same time.

Architecture and Working of GSM Networks

A GSM network consists of several functional entities whose functions and interfaces are defined. The GSM network can be divided into following broad parts. The Mobile Station (MS), The Base Station Subsystem (BSS), The Network Switching Subsystem (NSS), The Operation Support Subsystem (OSS). The added components of the GSM architecture include the functions of the databases and messaging systems: Home Location Register (HLR), Visitor Location Register (VLR), Equipment Identity Register (EIR), Authentication Center (AuC), SMS Serving Center (SMS SC), Gateway MSC (GMSC), Chargeback Center (CBC), Transponder and Adaptation Unit (TRAU)The MS and the BSS communicate across the Um interface, also known as the air interface or radio link. The BSS communicates with the Network Service Switching center across the A interface.

In a GSM network, the following areas are defined:

Cell: Cell is the basic service area: one BTS covers one cell. Each cell is given a Cell Global Identity (CGI), a number that uniquely identifies the cell.

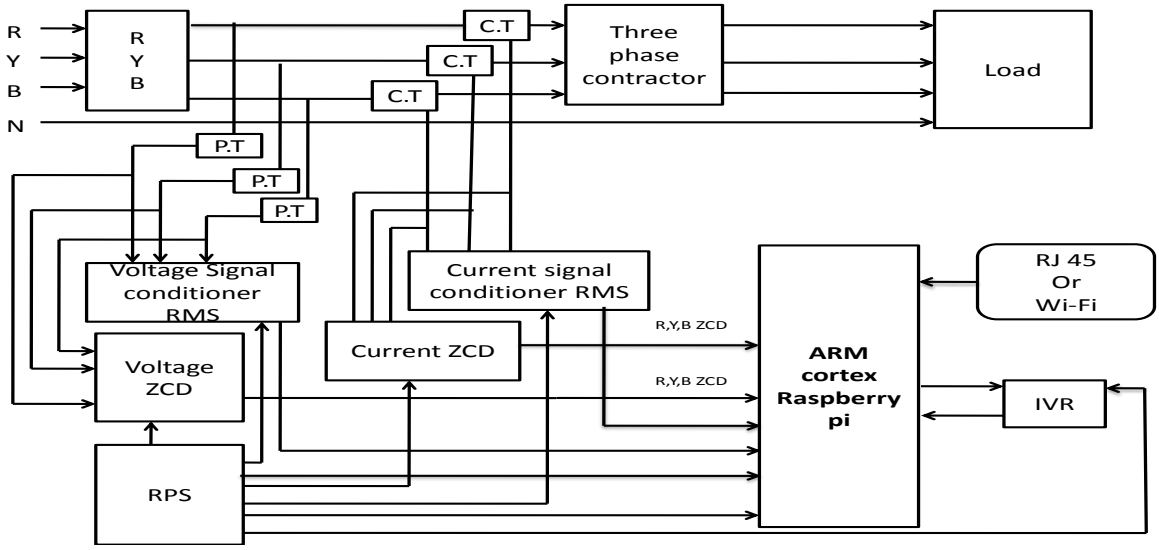
Location Area: A group of cells form a Location Area. This is the area that is paged when a subscriber gets an incoming call. Each Location Area is assigned a Location Area Identity (LAI). Each Location Area is served by one or more BSCs.

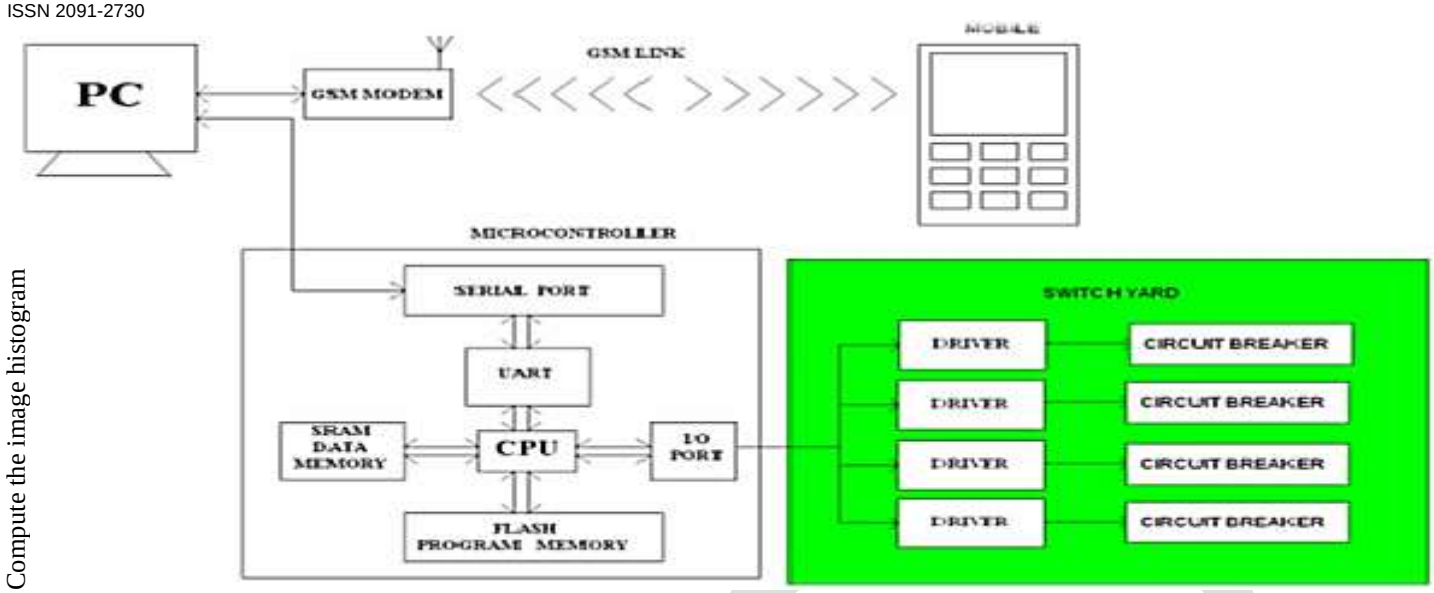
MSC/VLR Service Area: The area covered by one MSC is called the MSC/VLR service area.

PLMN: The area covered by one network operator is called PLMN. A PLMN can contain one or more MSCs.

BLOCK DIAGRAM OF THE PROPOSED RESEARCH PAPER

The circuit was designed using Proteus software. This software was used to design a sample for the power supply which was incorporated on the receiver system. The receiver sections were designed by this computer aid. In designing the power supply, the software has a menu that contains the various components of the circuit. One has to identify which menu contains the component for the power supplies were selected. The components that were selected are: diodes (1n4001) capacitor (220µF and 10µF) and regulator 7805. A step down transformer of 240/12V AC Was also selected was also selected. These components were laid out and their pins were joined appropriately with lines. These lines are similar to the conductors on the printed circuit board (PCB). The same procedure was followed in the design of the receiver circuit. The receiver was constructed on printed circuit board (PCB) of 30mm x 14mm x 1.5mm dimensions. The PCB was etched in accordance with the receiver circuit shown below with various integrated circuit (IC) pin hole drilled. The Raspberry pi, circuit breakers and the relays were all inserted on the board to form a complete receiver unit. The implementation of the system involves two steps which are: Setting up the system and inter facing with graphic user interface (i.e. application software). The application software for the system has been developed by using a high lever language C-programming debugger. The debugger contains a high speed simulator and a target debugger that let you simulate an entire Raspberry pi system including on chip peripherals [4] [5].





Compute the image histogram

The system was tested by connecting a GPRS modem and RS232 cable to the PC. The RS232 cable is connected to microcontroller through an interface MAX 232Ic. The microcontroller PIC16F877A is connected to the circuit breaker through a relay. When the circuit is powered by connecting it to 240 V AC supply, the incoming AC voltage is rectified by bridge rectifier. The voltage is then reduced to 5V by a regulator which serves as an input to the microcontroller. The system was tested manually by pressing a knob on the software to activate the circuit breaker. Secondary, the system was tested remotely by sending an SMS message to the GPRS or modem through the PC to RS232 cable to the microcontroller and it also worked. Below is the screen shot of the system control Panel with circuit breaker turned ON. Thus the automation of electrical power specific location is designed and implemented using GSM technology [6]. This brings out the efficient way of power transmission and distribution in electrical specific location though it is carried out using wireless mobile communication technology. AT commands are used to communicate the GSM modem and the microcontroller. Cellular phones have been invading all over the globe. Cellular phones enable people to communicate over a wide area by using a network of radio antennas and transmitters arranged in small geographical area called cells.

By using a rooming facility provided by cellular phone providers, communication could be effective wherever you are on a globe. Technology can explore more benefit on the utilization of cellular phones. The GPRS was able to read the data sent by cell phone at a frequency of 900MH. The GPRS uses packet switching method to transfer data, which means that data is sent over the time, which has less traffic. The Raspberry pi is a low power, high performance CMOS 8-bit computer. It provides high-flexible and cost effective solution to the control applications. The above schematic diagram explains the interfacing section of each component with micro controller and GSM module. [6]

SCOPE OF THE RESEARCH

Our research paper "IOT based Energy Management System by Using Raspberry pi ARM cortex" is mainly intended to operate the devices like fans, lights; motors etc.., through a GSM based mobile phone. The system has a GSM modem, temperature, current, voltage sensors and the devices to be operated through the switches like Relay which are interfaced to the microcontroller. The micro controller is programmed in such a way that if a particular fixed format of SMS is sent to GSM modem from mobile phone, which is fed as input to the microcontroller which operates the appropriate devices. A return feedback message will be sent to the mobile from GSM modem. The temperature at the place where devices are being operated can be known. In future we can use this research paper in several applications by adding additional components to this research paper. This research paper can be extended by using GPRS technology, which helps in sending the monitored and controlled data to any place in the world. The temperature controlling systems like coolant can also use in places where temperature level should be maintained. By connecting wireless camera in industries, factories etc. we can see the entire equipment from our personal computer only by using GPRS and GPS technology. The monitoring and controlling of the devices can be done from the personal computer and we can use to handle so many situations. By connecting temperature Sensor, we can get the temperature of dangerous zones in industries and we can use personal Computer itself instead of sending human to there and facing problems at the field. The

temperature sensor will detect the temperature and it gives information to the micro controller and micro controller gives the information to the mobile phone from that we can get the data at pc side.

CONCLUSION

An IOT based Energy Management System by Using Raspberry pi ARM cortex has been designed and developed toward the implementation of an intelligent building. The developed system effectively monitors and controls the electrical appliance usages at an elderly home. Thus, the real-time monitoring of the electrical appliances can be viewed through a website. The system can be extended for monitoring the whole intelligent building. We aim to determine the areas of daily peak hours of electricity usage levels and come with a solution by which we can lower the consumption and enhance better utilization of already limited resources during peak hours. The sensor networks are programmed with various user interfaces suitable for users of varying ability and for expert users such that the system can be maintained easily and interacted with very simply. This study also aims to assess consumer's response toward perceptions of smart grid technologies, their advantages and disadvantages, possible concerns, and overall perceived utility. The developed system is robust and flexible in operation. Local and remote user interfaces are easy to handle by a novice consumer and are efficient in handling the operations. In future, the system will be integrated with co-systems like smart home inhabitant behavior recognitions systems to determine the wellness of the inhabitant in terms of energy consumption. Hence smart management of energy and monitoring of data in real time from anywhere is possible.

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