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DESIGN AND IMPLEMENTATION OF SECURED WIRELESS COMMUNICATION USING RASPBERRY Pi

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ABSTRACT: In these days automation using wireless communication has made the systems more smart and automated. Wireless communication is used to monitor the various global parameters. It provides an advanced system for process management via Bluetooth communication. The system comprises of a single master and multiple slaves with wireless mode of communication and a raspberry pi system that can either operate on windows or linux operating system. It is based on multi parameter monitoring hardware system designed using microcontroller that measures and controls various global parameters. Various sensors are interfaced with microcontroller used to control and measure the parameters, they are current, voltage, temperature and light intensity. The hardware design is done with the surface mount devices (SMD) on a double layer printed circuit board (PCB) to reduce the size and improve the power efficiency. Thus Proper use of wireless sensor networks (WSNs) lowers the rate of failures, overall cost of the system, & increases the productivity, efficiency of overall industrial operations.

Keywords: Bluetooth communication, raspberry pi, surface mount devices, wireless sensor networks

INTRODUCTION

The use of wireless technology in industrial automation systems offers a number of potential benefits, from the obvious cost reduction brought about by the elimination of wiring to the availability of better plant information, improved productivity and better asset management. Wireless sensor networks are currently attracting the most attention, as most of the benefits directly relate to this area. Apart from the benefits of eliminating signal and power wiring, wireless sensor networks will open up measurement applications in sites that are hard to access, or where the wiring cost cannot be justified. They will also prove invaluable for the modernization of existing facilities, for temporary installations, or for locations where a power source is not available. Wireless sensor networks also offer enhanced plant asset management through the freeing up of cable resources for higher-priority measurements in existing installations, the replacement of many traditional pressure gauges and temperature indicators, and the ability to make measurements that could not previously be justified. There is also a reduction in 'blind spots' through the ability to make measurements on rotating or moving equipment and in remote locations. A further important point is that, once established, wireless sensor networks are scalable: additional sensors can be added at low cost, and temporary measurements can be easily incorporated for process diagnostics and optimization. Intelligent and low-cost automation of industrial processes are crucial in order to improve process efficiencies, deliver quality products, and ensure timeliness and accuracy of systems. The embedded web server network consists of advanced processor Atmeha and Raspberry Pi. It is having RISC architecture. An embedded web server creates an easy way for monitoring & controlling any device which is at remote place. For designing the system we require smart phone for communication with raspberry pi. We implement a system which is portable, low cost & having less maintenance by using GPRS technology. Therefore the status of different sensors installed at working place is monitored at anywhere in the world. The reporting of this real-time data corresponding to the process plants is therefore be of great use for future analysis. The system comprises of a single master and multiple slaves with wireless mode of communication and a raspberry pi system that can either operate on windows or Linux operating system.

SYSTEM DESCRIPTION

The system consists of an embedded web server ARM11 Raspberry Pi. A wireless sensor network containing the ATMEHA 328 as master controller along with sensors such as LM35 and LDR (Light Dependent Resistors) is used. The system designed with both wireless slaves and wireless master where the communication is a Bluetooth communication. The master module acts a bridge device between slaves and the raspberry pi computer. The master can also communicate with any android devices and compactable with all X86, X64 and ARM architectures that runs any operating system with RS232 functionality. The communication between the master and raspberry pi is wired and the raspberry pi can be operated through remote computing either wired or wireless.

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remote computing either wired or wireless. The Atmeha 328 is programmed by using bootloader in both master and slave module.

All the sensors sense the respective data and send that data towards the controlling unit. Thus all the data is collected by the Slave modules and is maintained at the master module. Here the data is stored in the data base. At this stage signal conditioning is done and only required amount of data is sent forward. Thus a successful communication is achieved between slave and master by using this type of system.

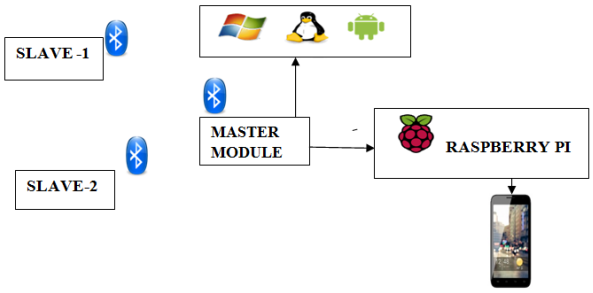

Fig.1: Block Diagram of Overall System

Thus Smart phone will continuously monitor all the data from remote processing unit and compare with the value preloaded process structure.

In this paper, we developed a GPRS-based portable, low-cost communication system which can establish a reliable bidirectional connection for data acquisition. A data acquisition system is used to collect the data in the simplest form. The basic idea behind real-time processing is that the embedded system is expected to respond to the queries in time

a. HARDWARE DESCRIPTION

To develop the overall system we used different hardware's, which are described in this section.

a. ATMEHA 328:

The high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages),programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

b. RASPBERRY Pi MODEL B+:

The Raspberry Pi is a series of credit card–sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools and developing countries. The original Raspberry Pi and Raspberry Pi 2 are manufactured in several board configurations through licensed manufacturing agreements with Newark element14 , RS Components . These companies sell the Raspberry Pi online. RS components produces a version for distribution solely in Taiwan, which can be distinguished from other Pi's by their red colouring and lack of FCC marketing. The hardware is the same across all manufacturers.

c. LIGHT DEPENDENT SENSOR (LDR):

An LDR is made of a high-resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

A photoelectric device can be either intrinsic or extrinsic. In intrinsic devices, the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities added, which have a ground state energy closer to the conduction band - since the electrons don't have as far to jump, lower energy photons (i.e. longer wavelengths and lower frequencies) are sufficient to trigger the device.

d. LM34 TEMPERATURE SENSOR:

The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration or trimming to provide typical accuracies of ±1/2˚F at room temperature and ±11/2˚F over a full −50 to +300˚F temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM34's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies or with plus and minus supplies.

d. POTENTIOMETER:

A potentiometer, informally a pot, is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. The measuring instrument called

a potentiometer is essentially a voltage divider used for measuring electric potential (voltage) the component is an implementation of the same principle, hence its name. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment.

e. LCD AND LED:

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 available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock.

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the colour of the light is determined by the energy band gap of the semiconductor.

f. RELAY AND ALARM CIRCUIT:

Relay and alarm driver circuit is a simple transistor switching driver using NPN transistor. Since the relay and alarm consume more power than a microcontroller, driver is essential.

B. SOFTWARE DESCRIPTION

In computing, an emulator is hardware or software that enables one computer system (called the host) to behave like another computer system (called the guest). An emulator typically enables the host system to run software or use peripheral devices designed for the guest system. Emulation refers to the ability of a computer program in an electronic device to emulate (imitate) another program or device. Many printers, for example, are designed to emulate Hewlett Packard Laser Jet printers because so much software is written for HP printers. If a non-HP printer emulates an HP printer, any software written for a real HP printer will also run in the non-HP printer emulation and produce equivalent printing. A hardware emulator is an emulator which takes the form of a hardware device. Examples include the DOS-compatible card installed in some old-world Macintoshes like Centris 610 or Performa 630 that allowed them to run PC programs and FPGA-based hardware emulators. Emulation is a strategy in digital preservation to combat obsolescence. Emulation focuses on recreating an original computer environment, which can be time-consuming and difficult to achieve, but valuable because of its ability to maintain a closer connection to the authenticity of the digital object.

Microcontroller is usually programmed through a programmer unless you have a piece of firmware in your microcontroller that allows installing new firmware using an external programmer.

RESULTS

The individual testing of different modules are done and the final setup is made by arranging all the devices in proper manner.

Fig.2: Hardware of master module

The temperature sensor LM35 in slave module sense temperature above −50 to +300˚F master module displays as high temperature and then relay and alarm circuit is tuned on.

Similarly, LDR in slave module changes based on the amount of visible light that falls on it and it displays low intensity in master module.

Fig .3: Hardware of Slave-1

Voltage measurement is done by using potentiometer. AC (alternating current) and DC (direct current) also measured. Current measurement is by using ammeter. The slave-2 module circuit is same as that of slave-1.

Fig.4: Temperature measurement in slave module

Thus the parameters are measured is transferred to the master module and then the data's are sent to raspberry pi which is used as web server transfer data to mobile using GPRS technology.

CONCLUSION

The importance of automation technology continues to increase in the process industry. The barriers between information, communication and automation technology are in the operational context gradually disappearing. The latest technologies, which include wireless networks field bus systems and asset management systems, are boosting the efficiency of process systems.

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