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RASPBERRY PI BASED INDUSTRIAL PROCESS MONITORING AND CONTROLLING THROUGH WI-FI

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***ABSTRACT*- This paper proposes an advanced system for process management via a credit card sized single board computer called raspberry pi based multi parameter monitoring hardware system designed using wi-fi and microcontroller that measures and controls various parameters. The system comprises of a single master and multiple slaves with zigbee and a raspberry pi system that can either operate on windows or Linux operating system. The parameters that can be tracked are current, voltage, temperature, light intensity and water level. The hardware design is done with the surface mount devices(SMD) on a double layered printed circuit board(PCB) to reduced the size and improve the power efficiency.**

***KEYWORDS*- Raspberry pi, Wi-fi, Zigbee, PIC Microcontroller**

I.INTRODUCTION

The entire system is designed with the double layer SMD based embedded board with different sensors and a raspberry pi that can compile and communicate the data received from the sensors. The raspberry pi when operated on the Linux operating system can perform multi-tasking.The Raspberry pi is a low cost credit card sized Linux computer which has the ability to interact with the outside world and has been used in a wide array of digital maker projects. An open source operating system that uses Linux kernel called Debian is used on the embedded Raspberry Pi device in an operating system called Raspberry. Linux kernel has been ported to variety of CPUs which are used not only for computers but also for ARC, ARM, AVR32, ETRAX CRIS, FR – V, H8300, IP7000, m68k, PowerPC, SuperH and Xtensa processors.

A printed circuit board (PCB) uses conductive tracks, pads and other features etched from copper sheets to connect the electronic components laminated onto a non-conductive substrate. Surface mount technology (SMT) is a technique where the components are placed directly onto the surface of printed circuit boards (PCBs). Both technologies can be used in a combination i.e. the components that cannot be mounted can be used with through hole technology. In industrial automation, there are different manufactures producing their own PLCs. The PLCs in an industry is connected with distributed control system (DCS) by protocols such as RS232/485, USB and Ethernet. The DCS has multi-level

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hierarchical network structure for communication. Due to the hierarchical network structure, the communication becomes complex and high in cost. Complete network from field level to control level is not formed. The java simulators can be used as front end panel for monitoring and control. The java servers used to control the process in a field. Internet of Things (IoT) is a fast developing technology that connects all devices with internet.

The PIC micro device has program memory for the firmware, or coded instructions, to run program. It also has file register memory for storage of variables that your program will need for computation or temporary storage and for data going to and coming from the peripherals circuits. It has a number of peripheral device circuits on the same chip. Some peripheral devices are called I/O ports. These are pins on the microcontroller that can be set high or low to send signals, light LEDs, drive speakers – just about anything that can be sent through a wire. Often these are bi-directional and can be configured as inputs allowing the program to respond to an external switch, sensor, or to communicate with some other external device.

MP LAB-IDE is a software program that runs on your PC to provide a development environment for your embedded system. Wi-Fi was developed to be used for mobile computing devices, such as laptops, in LANs. Linux, Free BSD and similar Unix-like clones have much courser support for wi-fi. Due to the open source nature of these operating systems, many different standards have been developed for configuring and managing wi-fi devices. LANs to be deployed without cabling, typically reducing the costs of network deployment and expansion.

II.SYSTEM DESCRIPTION

A.Master Module

The raspberry pi acts as master module. The master can communicate with any android devices and compactable with all X86, X64 and ARM architectures that runs any operating system. The raspberry pi can be operated through remote computing either wired or wireless.

B.Slave-1Module

The interfacing of physical parameters like Temperature, Light intensity and Water level identifier are in Slave-1 module. Data acquired from each parameter is collected in Slave-1 and sent to Master module through Zigbee. The relay and driver are also connected to the microcontroller for controlling purpose.

C.Slave-2 Module

The interfacing of physical parameters like voltage and current in Slave-2 module. Data acquired from each parameter is collected in Slave-2 and sent to Master through Zigbee. The relay and driver are also connected to the microcontroller for controlling purpose. The in-built analog to digital (ADC) converter is used to measure the voltage and current.

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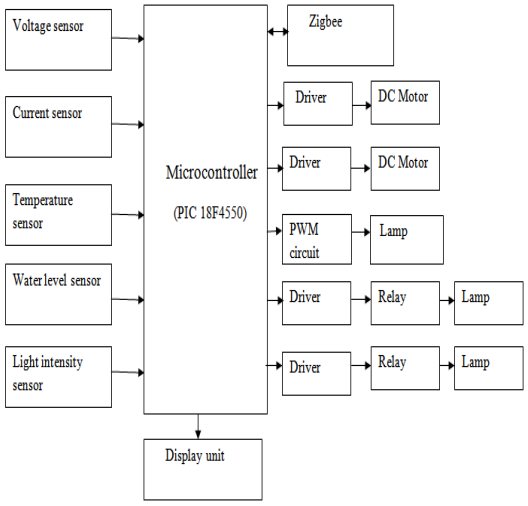
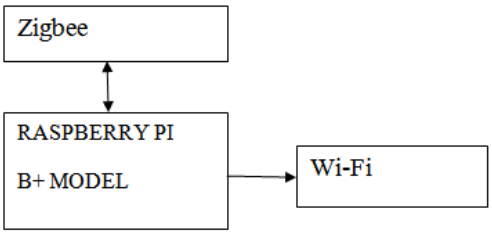


(a) Block diagram of Slave-1 and Slave-2 Module



(b) Block diagram of Master Module

III. SOFTWARE SPECIFICATION

The following software tools are required for designing, compiling and debugging.

A.Raspbian operating system

Raspbian is a free operating system based on debian optimized for the raspberry pi hardware. Raspbian comes with over 35,000 packages and pre-compiled software bundled in a nice format for easy installation on Raspberry Pi. Raspbian is still under development to improve stability and performance of as many Debian packages as possible.

B.MPLAB for PIC

MPLAB is a software program that runs in PC to provide a development environment for embedded systems.The capabilities of MPLAB IDE vary according to which device is selected. We will add two files for the project, a template file and a linkers script. Add some code to the template file to toggle an i/o bit. These code can run in PIC microcontroller.

IV. HARDWARE SPECIFICATION

The following are the hardware requirements for this process monitoring system.

A.Raspberry Pi Model B+

Raspberry pi is based on the Broadcom BCM2835 system on a chip(SoC) that includes an ARM1176JZF-S 700 MHz processor, Video Core 4 GPU, and was originally designed with 256 megabytes of RAM and later upgraded to 512 MB. The system has either Secure Digital (SD) or MicroSD sockets for boot media and persistent storage. The other features of raspberry pi model B+ are 700 MHz clock speed, four individual USB host ports, 10/100 Base T Ethernet port and HDMI audio and video output.

B.PIC 18F4550

PIC18F4550 is ideal for low power ad connectivity applications because of availability of three serial ports: FSUSB (12 Mbit/s), I²C and SPI (up to 10Mbit/s) and an asynchronous serial port (EUSART). The features of PIC18F4550 microcontroller are

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32Kbyte program memory, 2Kbyte data memory, 35 I/O lines, 13 channels 10-Bit analog to digital converter, USB V2.0 complaint, two external clock modes, 8* 8 Single-Cycle hardware multiplier, Single- Supply 5V In-Circuit Serial Programming (ICSP), In-Circuit Debug via two pins and wide operating voltage range (2.0V to 5.5V).

V.HARDWARE DESCRIPTION

A.Master module

Raspberry pi plugs in to TV or Monitor. The Raspberry Pi foundation recommends Python .Any language which will compile for ARMv6 can be used in this module. It is installed by default on the Raspberry Pi as C, C++, Java, Scratch and Ruby. It has 5V micro USB connector, RCA Video, 5mm Audio Standard headphone socket, HDMI Audio & Video, 10/100/Mb Ethernet.

Top side of Master Module

lave-1 Module

The design information includes the following

1) Width – 81.74 mm
2) Height – 75.5 mm
3) Trace width – 0.4 mm
4) Number of vias – 97

The main functionality of the Slave-1 module is as follows.

1)Temperature measurement

The current temperature is converted to an appropriate voltage level using a 3 pin integrated circuit temperature sensor unit (IC LM35DZ). The three pins are ground (GND), voltage source (Vs) and output voltage (V out). Analog to Digital converter (ADC) converts the signal into digital value that is fed as input to the microcontroller. Christo Ananth et al. [2] discussed about a system, GSM based AMR has low infrastructure cost and it reduces man power. The system is fully automatic, hence the probability of error is reduced. The data is highly secured and it not only solve the problem of traditional meter reading system but also provides additional features such as power disconnection, reconnection and the concept of power management. The database stores the current month and also all the previous month data for the future use. Hence the system saves a lot amount of time and energy. Due to the power fluctuations, there might be a damage in the home appliances. Hence to avoid such damages and to protect the appliances, the voltage controlling method can be implemented.

2) Light Intensity measurement
A light/dark activated switch that is present in the Slave-1 is used to measure the light level which will turn on and off accordingly. A Light Depended Resistor (LDR) is used to measure the light level. The circuit has a transistor switch with the base connected to

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a voltage divider. The voltage divider has 50K potentiometer plus the protective resistor and LDR. When the light falls on the surface of LDR, the resistance of the LDR is changed. The more the light, the less the resistance, the less the voltage drop across it and vice versa. As the voltage drop increases, the VB of the BC547 transistor and ICE will also increase. The pulse width modulation is used for control the light intensity.

3) Water Level identifier

IC CD4066 bilateral switch CMOS IC is used to identify the water level through LEDs. When the water is empty in the tank the circuit is open and 180K resistor pulls the switch to open and so the switches and LEDs are off. When the water begins to fill the first wire is connected to the reservoir in the S1 and the positive supply is shortened by the water. This closes the S1 and turns on the LED1. As the water level increases in the tank, LEDs 2, 3 and 4 are switched on in sequence. If it is increased the threshold value the pipe valve will be turned off.

lave-2 Module

The slave-2 address is manually set using the address switch and the address is also known to the master module by its program. The design information includes the following

1) Width – 80.32 mm
2) Height – 75.72 mm
3) Trace width – 0.4 mm
4) Number of holes – 152
5) Number of vias – 52

The main functionality of the Slave-1 module is as follows.

1)Voltage measurement

Voltage measures the potential energy of an electric field to cause an electric current in an electrical conductor and most of the measurement devices can measure voltage. The two types of voltage measurements are direct current (DC) and alternating current (AC). The main challenge in measuring the voltage is noise. The potentiometer is used to measure the variable voltage in Slave-2 module. If voltage suddenly increased, relay will turned off the machine.

2)Current measurement

The current is measured with ammeter that contains the external resistors that is added to extend the usable range of the movement connected in parallel. The current divider circuits are formed with parallel resistances.

D.Relay and Driver circuit

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

irmware Update

USB HID boot loader firmware is a free tool that can be downloaded from microelectronics website. Also no additional OS drivers are required for this firmware update. The five basic steps to boot load the program in PIC 18F4550 are as follows.

1) The board is connected to PC and once the device is recognized by the OS the grey USB will turn red which indicates that the USB link is established successfully.
2) The connect button is clicked within 5 seconds and the chip enters the boot loader mode.

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3) The HEX file load is chosen to load the program into the chip after browsing the file using browse for HEX button.

4) Boot loader is started by clicking on the begin upload button. THE show activity button can be used to view the boot loader operation.

5) Reset chip boot loader firmware will automatically reset the MCU, after which the newly loaded program will start in 5 seconds.

VI. FUTURE WORK

The system can be enhanced for wave form representation of data in an excel sheet using raspberry pi. The additional slaves can be added for measures various other parameters. A dedicated video processor can be used in raspberry pi to display graphical and three dimensional view of the industry.

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