RASPBERRY PI BASED INDUSTRIAL PROCESS MONITORING BY USING WIRELESS COMMUNICATION

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ABSTRACT: *Wireless communication is widely used in various fields like automation, military etc. The advanced technologies in wireless sensor network (WNS) lowers he data rate failure and increases its productivity in automation. This paper proposes a design and implementation of industrial process monitoring by using raspberry pi and wireless communication. The system consists of a single master and multiple slaves with wireless communication based on WSN and a raspberry pi system that can either operate on raspbian linux operating system. The parameters that can be tracked are current, voltage, temperature, and water level. The Android app is made to control industrial automation automatically using cloud. Manager manages this app with specific username and password. Manager can control this app automatically or manually.*

Keywords- *Wireless communication, raspberry pi, industrial, Internet of Things (IoT).*

INTRODUCTION

Wireless communication is the best technology and it is widely used in industry for automation purpose [2]. For industrial automation, a remote laboratory is also used to comprising different programmable logic controller (PLC) manufacturers. This facility helps an environment for remote users to learn many topics in automation, when user uses different PLC together [3]. In industry the PLCs are connected with distributed control system (DCS) by using protocols such as RS 232/485, USB and Ethernet [5].Now-a-days data acquisition system is widely popular in industry for remote monitoring and controlling of system status and physical parameters. Data acquisition means to collect the data in form of physical quantity or in time varying quantity and convert that data into A/D, then display that data on LCD and also use that data for future work [6].

Wireless communication means transfer of data between two or more points that are not connected to each other by any electrical conductor and this distance may be short or long distance [11]. Wireless data communication is a very important component of mobile computing. This contains various technologies differ in local availability, coverage range and performance [13]. Internet of Things (IoT) is fast growing technology and in this all devices are connected to internet [4].

In this paper, an RF transreceiver module CC2500 is used for wireless communication. The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications[14].

In this paper, we develop a current transformer (CT) across every machine in slave2, which produce an alternating current (AC) in its secondary which is proportional to AC in its primary. Also a voltage transformer (VT) or power transformer (PT) across every machine in slave2 to measure voltage. The combination of CT and VT is called as instrument transformer [15].

II. SYSTEM DESCRIPTION

The Fig 1.Shows design of whole system containing two wireless slaves and one wireless master module where the communication is a half-duplexcommunication. The master module act as medium of communication between two slaves and raspberry pi. Master module can communicate with any android devices and it is also compatible with all X64, X86. The communication between master module and raspberry pi is wired and raspberry pi can be operated through remote computing either wired or wireless.
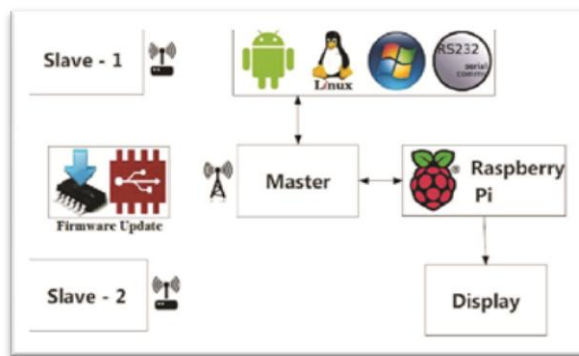
Figure 1:Block diagram of the process monitoring system using Raspberry pi.

1)Master Module:

A fig 2 show the master module and it is consists of Raspberry pi and RF transreceiver CC2500 module. The raspberry pi is connected to master module. Master module collects the data from slave1 and slave2 modules wirelessly by using RF transreceiver CC2500 module. This collected data also provided touser by using Industrial Automation application through cloud from master module.
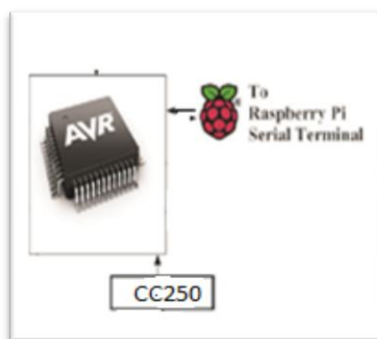

Figure 2:Block diagram of master module.

2)Slave-1 Module:

Fig 3 shows the slave1, which is consists of interfacing of physical parameters like temperature, light intensity and water level identifier. All these parameters are set to a reference values. According to these set reference values, master module work and collect these values and transfer this data to master module. If the values of these parameters go low or high from the set value then alarm get ON and the faults get corrected primarily by slave1 itself. All this information also transfers to master module by using RF transreceiver CC2500 module. The relay and alarm are connected to AVR ATMEGA 8 microcontroller for controlling purpose.
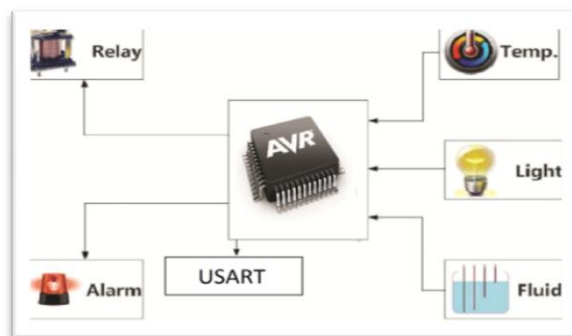

Figure 3:Block diagram of Slave-1 module.

3)Slave-2 Module:

In this node, the two conditions i.e. over current and short circuit are monitored. The current through the load is converted into voltage using a resistor across a current transformer and that analog voltage is given to ADC. A current transformer (CT) is used for measurement of alternating electric currents. When current in a circuit is too high to, a current transformer

produces a reduced current and produces accurately proportional current to the current in the circuit, which can be conveniently connected to measuring and recording instruments.
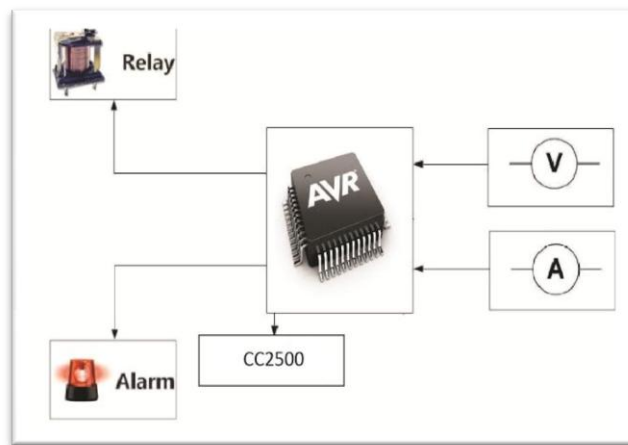

Figure 4:Block diagram of Slave-2 module.

III. SOFTWARE SPECIFICATION

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

A. AVR STUDIO FOR ATMEGA 8

AVR studio is an Integrated Development Environment (IDE) by ATMEL for developing applications and it is based on 8-bit AVR microcontroller. Prior to installation of AVR Studio firstly you have to install the compiler WinAVR. This will allow AVR, Studio to detect the compiler. Software simulator simulates the code flow in PC and then they support all debugging modes s MikroICD [16].

B. AVR STUDIO FOR ATMEGA 16

ATmega16 is an 8-bit high performance microcontroller and it is from Atmel's Mega AVR family. It has low power consumption. Atmega16 is based on enhanced RISC architecture with 131 powerful instructions [17].

C. Diptrace

Diptrace is quality schematic capture and PCB design software that is used to create simple and complex multi-layer board from the schematic to the state of ready manufacturing files. The Direct3D mode is the fastest mode and thus it is recommended for usage for most typical Windows PC. OpenGL mode is bit slower than Diect3D mode and so it is used for different operating systems. [18]

D. Raspbian operating system

Raspbian is a free operating system and it is based on Debian optimized for the raspberry pi hardware. Raspbian is pre-compiled software bundled in a nice format for easy installation on Raspberry Pi. Raspbian is still under development [12].

IV. HARDWARE SPECIFICATION

The hardware requirements for this process monitoring system are as follows:

A. Raspberry Pi Model B+

Raspberry pi is the Broadcom BCM2835 system on a chip (SoC). It 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 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 [12].

B. AVR ATMEGA 8

The Atmel 8-bit is AVR RISC-based microcontroller. It also has 1KB SRAM, 512B EEPROM, an 8-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging.. By executing instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

C. AVR ATMEGA 16

Atmega16 can work on a maximum frequency of 16MHz.ATmega16 has 16 KB programmable flash memory. It is also has static RAM of 1 KB and EEPROM of 512 Bytes. There are 32 I/O lines which are divided into four 8-bit ports designated as PORT A, PORT B, PORT C and PORT D.ATmega16 has various in-built USART, ADC, etc. [17].

V. HARDWARE DESCRIPTION

A. Master module

Master module consists of only Raspberry pi and RF CC2500 module.

- **More GPIO**. The GPIO header has grown to 40 pins, while retaining the same pin out for the first 26 pins as the Model A and B.
- **More USB**. We now have 4 USB 2.0 ports, compared to 2 on the Model B, and better hot plug and overcurrent behavior.
- **Lower power consumption**. By replacing linear regulators with switching ones we've reduced power consumption by between 0.5W and 1W.

B. Slave-1 module

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. LM35 series is precision integrated circuit temperature sensor whose output voltage can be linearly calibrated in degree Celsius i.e. Linear + 10.0 mV/°C scale factor with 0.5°C accuracy guarantee and rated for full -55°C to +150°C range. It operates in 4 to 30 volts and draws less than 60 μA.

2) Light Intensity measurement

A light/dark activated switch that is present in the Slave-1 is used to measure the light level A Light Depended Resistor (LDR) is used to measure the light level. The circuit has a transistor switch with the base connected to 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 V_B of the BC547 transistor and I_{CE} will also increase.

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.

C. Slave-2 module

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

1) Current measurement

For Current measurement, current transformers is used which reduce high voltage currents to a much lower value and provide a convenient way of safely monitoring the actual electrical current flowing in an AC transmission line using a standard ammeter. The principal of operation of a current transformer is no different from that of an ordinary transformer.

2) Voltage measurement

For measurement of voltage, voltage transformer gets used inelectrical power system for stepping down the system voltageto a safe value which can be fed to low ratings meters and relays. Commercially available relaysand meters used for protection and metering, are designed for low voltage. A voltage transformer theory is just like a theory of general purpose step down transformer.

Industrial Automation App

Android app is built for Industrial Automation to control Temperature, Light intensity and Water levels automatically or manually. This app is based on could computing and for that app Manager have specific username and password. Manager gets information of every parameter on that app and he can control industrial automation using that app easily.
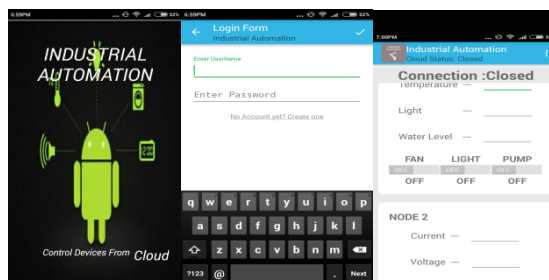

V. CONCLUSION

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. Also controlling action can be set for some predefined cases in the master module which enables the automatic operation at certain cases. A dedicated video processor can be used in raspberry pi to display graphical and three dimensional view of the industry.

Top view of slave-1 and master module
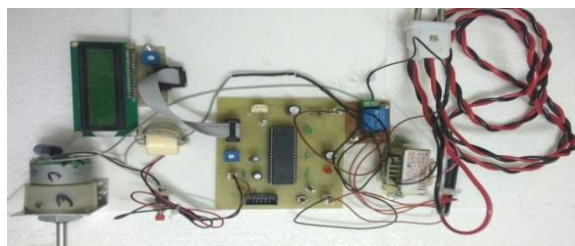
Top view of slave -2 module

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