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Real time industrial automation using embedded PLC

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ABSTRACT
Industrial automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. The correct incentive for applying automation is to increase productivity, and/or quality beyond that possible with current human labor levels so as to realize economies of scale, and/or realize predictable quality levels. In the scope of industrialisation, automation is a step beyond mechanization. Whereas mechanization provides human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements while increasing load capacity, speed, and repeatability. Generally PLC Is used for the task of industrial automation, here we introduce new concept in automation is use of "Embedded PLC"for the industrial automation which overcome all the limitation of conventional PLC. For the purpose of automating some task we use neumerous wired or wireless sensors with Embedded PLC. It provide smooth control over the Industrial Systems. After investigated the conception and features of PLC and embedded system, in this paper the development of low-cost embedded PLC for Industrial Controls & Monitoring. This paper describes the real-time industrial automation using Embedded PLC.

Introduction

Wireless Sensor Network (WSN) are a trend of the last few years due to the advances made in the wireless communication, information technologies and electronics field [1]. The developments of low-cost, low-powered, multifunctional sensors have received increasing attention from various industries [2]. WSN is a wireless network composed of autonomous and compact devices called sensor nodes.

A sensor network is designed to detect desired phenomena, then collect, process the data and transmit this information to users. Sensor nodes in WSNs are small sized and are capable of sensing, gathering and processing data while communicating with other connected nodes in the network, via radio frequency (RF) channel. The sensor nodes scattered in a sensor field where each sensor nodes collects data and route the data back through a multi-hop hybrid wireless communications.

The design of the sensor network is influenced by factors including scalability, operating system, fault tolerance, sensor network topology, hardware constrains, transmission media, and power consumption [6]. The developments is low-cost, low-powered, multifunctional sensor have received increasing attention from various industries [2].There are two kinds of sensor used in the network. One is the normal sensor node deployed to sense the phenomena. The other is a gateway node that interfaces sensor network to the external world. Sensor such as magnetometer, accelerometer, light and temperature are among the types of sensor being used depending on the application. following figure shows the typical WSN.

Example of Industrial Application

In past few years when WNS is new in industrial applications, wired technology used to automate or use complex wired network of sensors.

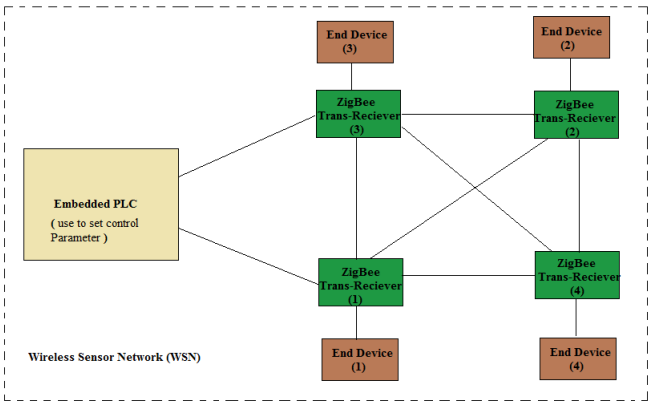

Figure 1. Typical Network of WSN

Figure shows typical application used in Industries. Here temparature of heating device is measured & transmitted to controller through temparature transmitter using wired technology& all this is control using controll room.the Process monitoring & controll is a combination of architecture , mechanismused in industries for monitoring & control the achieve of spesific process to be completed.

In given example, the heater is ON for Processing & complete some task, for this some specific temparature is needed (set temparature) up to this temparature heater is ON & above Set temparature heater must be OFF. Again below the specific temparature Heater again going to be ON.

All the temparature is set by control room through controller. All the time by time temparature is store by controll room. The temparature is sensed & transmitted by Temprature transmitter device.

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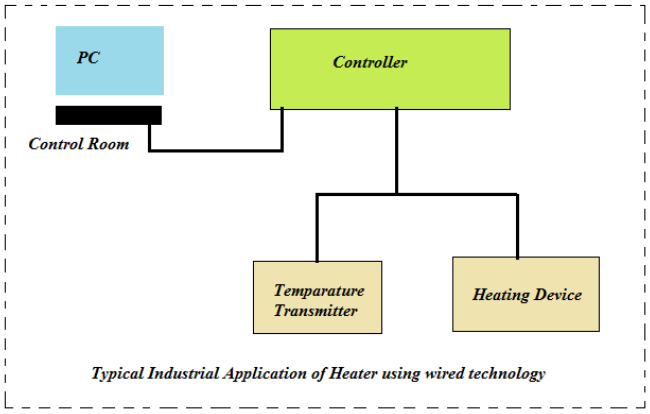

Figure 2 Typical Industrial Application

This process look very simple for one heater , suppose many number of heaters & other sensors are connected then wired network is very complex. Its very difficult to manage wired network for number of sensors. One fault in sensor stop working of whole system or for troubleshooting fault whole system must be stop. Most of the process control applications are mission critical and have stringent requirements. Failure of a control loop may cause unscheduled plant shutdown or even severe accidents in process-controlled plants.

Methodology

The main aim of this project is to use the wireless sensor network to monitor & control the actual temperature at random section of an environment and obtain successful throughput of the data transferred by the sensor. The sensor is developed using Embedded PLC while the transmitter utilizes ZigBee technology. Information is sent by the temperature sensor will then be processed by the Embedded PLC

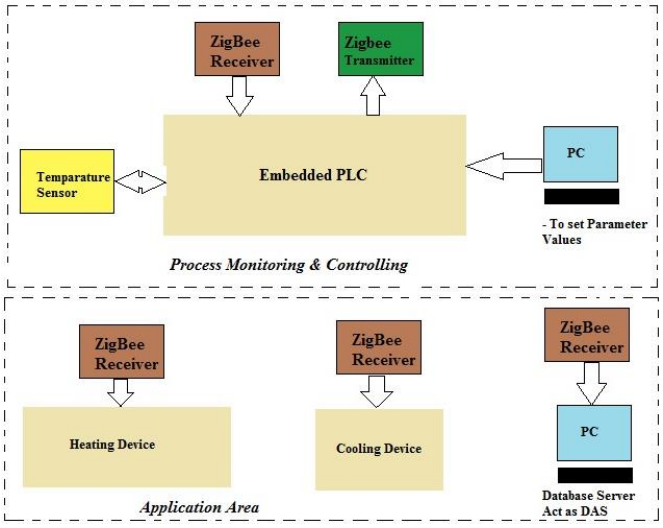

Figure 3 Application of Embedded PLC.

This WSN overcome the limitaion of wired system used in Industrial automation. Following figure shows the flow of Automation Process.

At the begaining, All sensors & Embedded PLC are initialised. Heater is on then temparature increasing step by step this increase in temparature is sensed by temparature sensor. This sensd temparature is then sent to embedded PLC through Zigbee Transmitter.when temparature exceed the set values then Embedded PLC send the controll signal & OFF the Heater & ON the Cooler, teparature is deacreasing & sensed by sensor. If temprature below the set values then again Embedded PLC send controll signal & ON the Heater , Off the cooler. the temparature recorded peridiocaly & send to data aquision system i.e DAS to save into database.

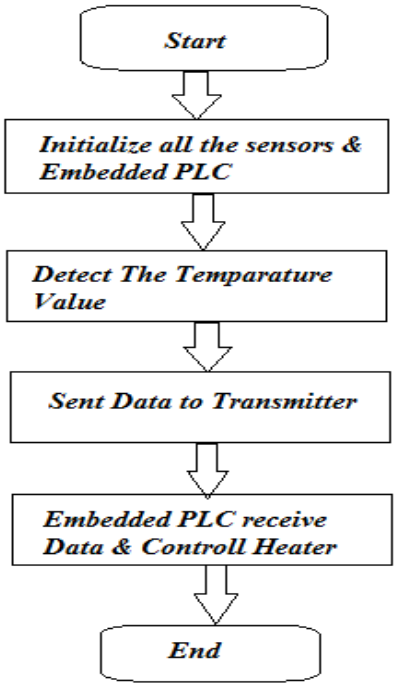

Figure 4 Flow of Process

The main limitaion of wired technology is the complexity of network for number of sensors is minimised here, there is no wired network. If one sensor or Transreceiver stop working then its easy to locate the faulty sensor or Transreceiver & replace it with new one without disturbing others. Also One of the benefits of using Zigbee is the distance between the sensor node and the base station can exceed 200 m for outdoor implementation. Therefore, it is very suitable for applications that involved outdoor monitoring and control.

Sensor

Temperature sensors are devices used to measure the temperature of a medium. There are 2 kinds on temperature sensors: 1) contact sensors and 2) noncontact sensors. For this we use Temparature sensor LM35 D is a noncontact sensor. Hardware device producing measurable response to change in physical condition such as temperature or pressure. Sensor measures physical data by obtaining continual analog signal d directly from the environment. [3][4]

LM 35 D Produce analog output in respond to temparature , this analog singnal is pass to Embedded PLC & appropriate control is then taken.

Transreciever Module

Sensor nodes make use of ISM band which gives free radio,huge spectrum allocation and global availability. The various choices of wireless transmission media are Radio frequency, Optical communication (Laser) and Infrared. Laser requires less energy, but needs line-of-sight for communication and also sensitive to atmospheric conditions. Infrared like laser, needs no antenna but is limited in its broadcasting capacity. Radio Frequency (RF) based communication is the most relevant that fits to most of the WSN applications. WSN's use the communication frequencies between about 433 MHz and 2.4 GHz. The functionality of both transmitter and receiver are combined into a single device know as transceivers are used in sensor nodes.[8][11]

For ZigBee, it is open specification for low power wireless networking aiming for control and monitoring application,

where low power consumption is the main requirement. ZigBee comply with IEEE 802.15.4 standard and operates at 2.4GHz frequency with maximum data rate of 250kbps. This frequency band has the lost potential for large scale WSN application due to its high radio data rate. ZigBee product also utilizes 128 bit Advance Encryption Standard (AES) encryption for security purposes and therefore is suitable for various WSN applications. ZigBee, offers indoor communication range up to 30m and outdoor line of sight range up to 100m. While ZigBee PRO, offers indoor communication range up to 100m and outdoor line of sight range up to 1500m.

Figure 5 Zigbee Module.

Embedded PLC

"Embedded PLC" Most Innovative Technology now a days. It overcome most of the drawbacks of conventional PLC. It provide smooth control over the Industrial Systems. After investigated the conception and features of PLC and embedded system, in this paper the development of low-cost embedded PLC for Industrial Controls & Monitoring.

Generally PLC Has 8 Digital/Analog I/O Ports, but Embedded PLChas 64 I/O ports. Which is Much gtrater than ordinery PLC. Also Embedded PLC support various communication protocol such as LIN,CAN etc. which provide fast & secure communiation between PLC's.also have the large inbuilt memory.esay to interface wireless field such as Zeegbee, GSM etc.

In previous , it is not easy to Interface Various Equipmet/Devices/Sensors to the PLC.also communication protocol supported by PLC are not Highly effective. They have speed limitations.the main difference is that, the ordinery PLC's Size. They are bigger in Size & not easy to configure the same PLC for other application. It is very difficult task for engineer also it is coast effective.[5][7]

Embedded PLC

The Embedded PLC features additional modules which also enable the microcontroller to be connected to external devices. The Embedded PLC may be used as a stand-alone controller which communicates to remote devices through communication modules. Numerous modules, such as RS- 232 communication module, real-time clock, ethernet controller, GSM module etc. are provided on the board and allow you to easily experiment with your microcontroller.

Embedded PLC need to configure the requirements of different costumers' requirements. In different field, the requirements of commuters are totally in various changing. So we need to use the modularization design for the hardware configuration of embedded PLC. Those will convenience to the further expedition or modification. The most important characteristic for the embedded PLC is reliability. If misoperation and signal disturbance can not be managed on time, it will mortal to the whole production. And the relative management incarnate from the I/O interface. There need several modules in the hardware frame of embedded PLC.

They are calculation module, communication module, antiinterference module, storage module and I/O module. Moreover, there need some expedition module and arranged interfaces on the practical condition. The detailed frame is From the former figure we can clearly know the main controller is the central part of the whole hardware system.

Add the relative circuits such as storage, power supply and clock circuit and so on. It can connect with local extension I/O module through self integrated universal serial bus. The fieldbus CAN interface connect with long distance extension I/O interface or other equipments. Ethernet interface connect with network, I/O interface connect with sensors, RS-232 interface connect with PC or the third party equipments and RS-485 interface connect with field devices or instruments. All these will achieve the control of local equipments or long distance devices, in order to increase the flexibility and expansibility of this system.[9]

The functions of embedded PLC reflected in the CPU performance. So it is very important to chose the CPU while selecting the PLC. Here we introduce the PIC 18F66J60. The development system in this article is aiming at the pony commercial installations. And this kind of chip can completely satisfy all the functions. The most important thing is to provide correct power design before designing the hardware system. PIC 18F series emulate power supply isolate to the digital power supply in order to reduce noise disturb. The outside power supply is 3.3V, the chip output power is bigger and the voltage accuracy is high, available in 40,64,80,100 Pins configuration. It also support Vrious communication modules like LIN, CAN,Ethernet,USB.[12][10]

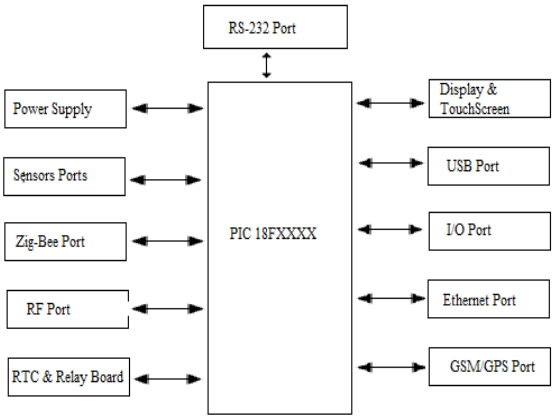

Figure 6. Basic Block Diagram of Embedded PLC

Software Description

The PIC was programmed using MicroC software that utilized C language. A program was developed to receive analog signal from the sensor circuit and display the output on the computer screen. The C program was converted into hex file before uploaded to the PIC using the PICKIT ver2 programmer from MICROCHIP.[11] Few functions such as display, receive and delay were written in one main program and were called upon when needed. This limits the size of the program and eventually limits the memory space and processing time.

the ZigBee nodes also need to be programmed to include it own Personal Area Network ID (PAN ID). This is done through the X-CTU software with AT command. The PIC based sensor nodes extremely resource limited and therefore the operating system or the program should be as small as possible. Sensor nodes usually are installed in an unmanned area for periods ranging from month to years. Therefore, the hardware and software used in the sensor node must work on low power.

Beside hardware development, the overall objective of this implementation is to set up a WSN topology using Embedded PLC in Industrial Automation consisting of several nodes for different position in a specified environment.

However this paper shall present the communication result a WSN with a single node to be tested in 3 different positions into industries.

Result & Discussion

These outputs are basically temperature values, send by the wireless sensor via the ZigBee transmitter to the Embedded PLC receiver at the some environment. The results are displayed on hyper terminal of PC.

The temperature from the wireless sensor network for Industrial Process, outside and room temperature is much closer to the actual temperature. Although there are obstacle between the Embedded PLC and the sensor node, the data at the Embedded PLC still remains the same. Experiment is carried out at ground level.

Conclusion

This paper present a wireless sensor network system based on ZigBee technology and Embedded PLC for simple application is temperature sensor by exploring its system framework and technology characters. The experiment was also done to prove its feasibility. And the sensor node has successfully transmitted sensor data to the base station located in the same environment. It is a preliminary work toward a better design of Embedded PLC based wireless sensor node and a complete WSN Automation. The system possesses low cost, low power, wider coverage, and especially the character of mobility on wiring to remove the limitation of traditional wired network system.

Acknowledgement

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