Optimum Zigbee based Wireless Control of Industrial Automation Processes

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Abstract- Society in its daily endeavours has become so dependent on automation that it is difficult to imagine life without automation engineering. In addition to the industrial production with which it is popularly associated, it now covers a number of unexpected areas. Trade, environmental protection engineering, traffic engineering, agriculture, building engineering, and medical engineering are some of the areas where automation is playing a prominent role. Automation engineering is a cross sectional discipline that requires proportional knowledge in hardware and software development and their applications. This paper describes the Wireless Control and monitoring of automation processes using a Microcontroller and Zigbee Wireless Protocol.

Keywords: PLC, Ladder Logic, Automation, Microcontroller, Wireless Control

I. INTRODUCTION

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services.They are calledautomated because they perform their operations with a reduced level of human participationcompared with the corresponding manual process. In some highly automated systems,there is virtually no human participation.With increasing cost of manpower, increasing complexity of the manufacturing process and safety requirement, there is an increasing need of automation both in industrial process as well as in machinery used.

Automated manufacturing systems can be classified into three basic types

- Fixed automation
- Programmable automation
- Flexible automation

In this paper the Programmable automation is discussed which is currently in practise in most of the industries in India and many other foreign countries.

II. PROGRAMMABLE AUTOMATION

In *programmable automation*, the production equipment is designed with the capability to change the sequence of operations to accommodate different product configurations. The operation sequence is controlled by a *program*, which is a set of instructions coded so that they can be read and interpreted by the system.

New programs can be prepared and entered into the equipment to produce new products.

Some of the features that characterize programmable automation are

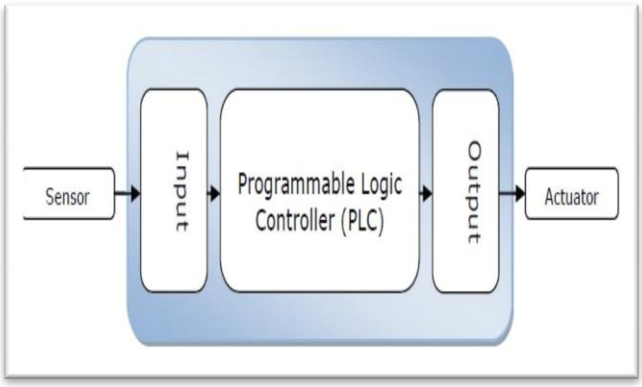
- High investment in general purpose equipment
- Flexibility to deal with variations and changes in product configuration

Examples of Programmable Automation are Industrial Robots, Programmable Logic Controllers etc

III. PROGRAMMABLE LOGIC CONTROLLER:

A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes.PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

The main difference from other computers is that PLCs are armoured for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators. PLCs read limit switches, analog process variables (such as temperature and pressure), and the positions of complex positioning systems. On the actuator side, PLCs operate electric motors, pneumatic or hydraulic cylinders, magnetic relays, solenoids, or analog outputs. The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC.



IV. WIRELESS CONTROL AND MONITORING

The processes in the industry are very well automated and developed in the recent years.

But the control and Monitoring of each machine is still manual. There is no single control for every device in the industry. This project aims at this very point of importance.

The main modules used in the project are:

1. AVR Microcontroller- ATMega16L
2. IR Based Counter
3. On Site First Person Interface

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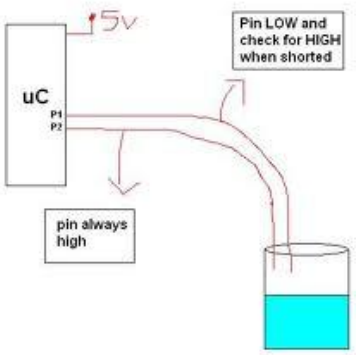
4. Prototype of Conveyer tracks used in the industry
5. Zigbee Module
6. PC Interface

The Project Idea:
There are 4 modules that can be controlled in the industry using this project.
Industrial Product Counter:

In the industry, there are conveyer belts either to transport the products or to convey the raw materials depending on the industry. This is modelled by the Conveyer belt in the prototype. Whenever a person picks up an item from the belt and IR Sensor based counter at the end of the belt counts the item.

Fuel or Water Level Monitoring



In the industry, the fuel and water levels are to be constantly monitored and accounted for. Hence a Water Level Indicator is used for this purpose.

Smoke Detector:

In the industry, even a small fire can cause irrevocable damage. So a fire Detection mechanism based on Smoke Sensing is embedded in the prototype project to prevent the huge losses by pre detecting the fire.

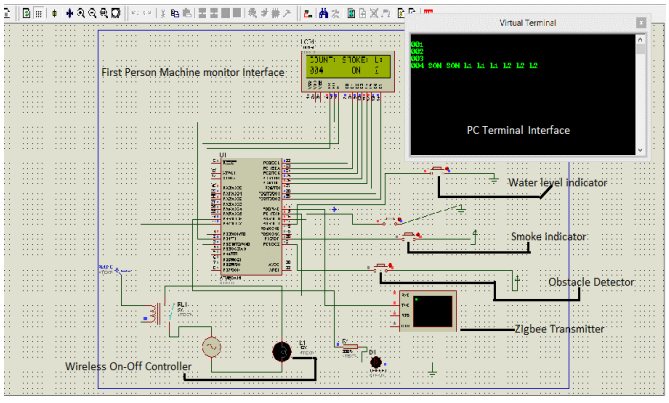
First Person Monitoring Terminal :

A First Person monitor ensures there is an interface for the onsite personnel to have an idea of what is happeningaroundthem and a supervisor can monitor the status of the machinery.

Wireless Control of the Machinery:

In the industry the control of machinery is the key to a profitable and optimum production. SO a Wireless Control using Zigbee ensures uninterrupted connectivity and Superior Control. The prime reason for using Zigbee is its low Cost and high efficiency.
Finally using this module we can monitor the inputs, outputs, machinery in the industry through one pc using a wireless communication. We can automate an industry to a maximum extent using this module.

Circuit Diagram:



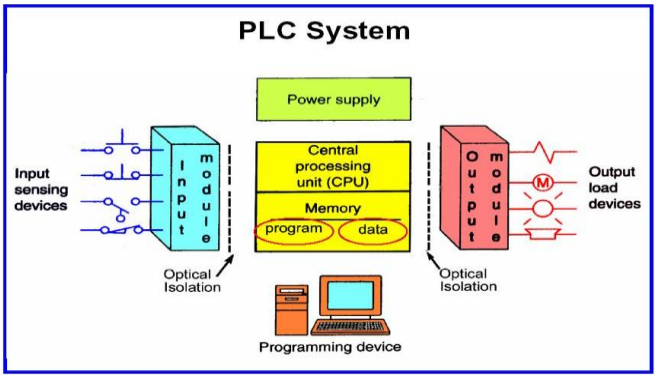
V. PROGRAMMING

PLCs are programmed using application software on personal computers. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Ladder logic is a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. It is primarily used to develop software for programmable logic controllers (PLCs) used in industrial control applications.

The name is based on the observation that programs in this language resemble ladders, with two vertical rails and a series of horizontal rungs between them.
Here is an example of what one rung in a ladder logic program might look like. In real world applications, there may be hundreds or thousands of rungs.

```
----[ ]----------|--[ ]--|------( )
     X           |   Y   |        S
|        |
|--[ ]--|
Z
```

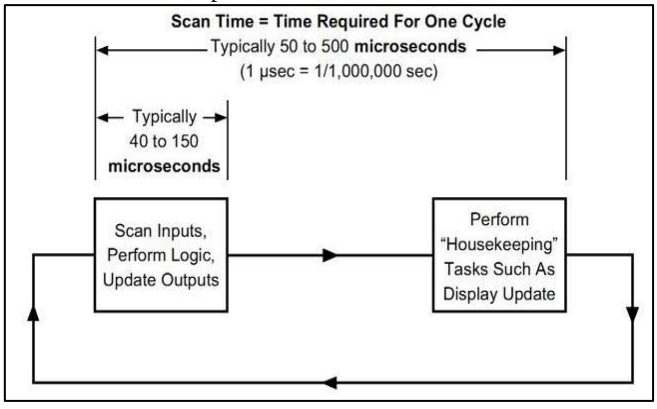
The above realizes the function: S = X AND (Y OR Z).
Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes. In some models of programmable controller, the program is transferred from a personal computer to the PLC through a programming board which writes the program into a removable chip such as an EEPROM or EPROM.
The architecture of PLC is given in the below figure



We used AVR Studio for coding the module.

VI. SCAN TIME:

A PLC performs a repetitive cycle of operations. First, the PLC sequentially scans the input devices and updates a memory table indicating their status. Next, the PLC executes its control programming, or ladder logic. As it processes the ladder logic, the PLC updates a memory table which indicates whether output devices should be ON or OFF. Finally, the PLC uses the output table to actually change the condition of the output devices.



Example: This PLC's are used in the Autoconer machinery which we have observed during our internship program in Bhavanam Spinning Mills. The figure shown below is an Autoconer which produces yarn packages automatically with little or no human intervention by making use of Programmable Logic Controllers which plays an important role in the industrial automation in spinning mills. The PLC's are programmed in such a way that if there is any disturbance or error in the functioning of the machine, the machine automatically stops and the cause for an error in the functioning of the system is displayed on the touch screen display so that the supervisor can detect and rectify the problem easily and the display can be seen in picture given below.

A microcontroller-based design is currently in use in the spinning industry where hundreds or thousands of units will be produced and so the development cost (design of power supplies, input/output hardware and necessary testing and certification) can be spread over many sales, and where the end-user would not need to alter the control. Automotive applications are an example; millions of units are built each year, and very few end-users alter the programming of these controllers.

VII. CONCLUSION AND SCOPE

This paper discusses the current automation scenario in the industry where Programmable Logic controllers (PLC's) are widely used in motion control, positioning control and torque control. Monitoring the whole plant parallel gaining the safety measures is an added asset. Many machinery can be controlled and monitored with respect to the required specifications of output and available inputs. Efficiency of the machinery can be easily evaluated. Continuous monitoring of fuel levels can be made easy with automation. Prevention of fire accident is an added advantage in industries and can be extended by adding a water propellant in the direction of fire. Other sensors like temperature sensors can be interfaced to monitor temperature in boilers and other appliances. By interfacing a noise module permissible noise levels can be maintained in the industry such that it do not affect the health of workers and providing a healthy environment in the industry. There is an abundant availability of pressure sensors used in many industries for a particular purpose all of these can be monitored using one module. Thus preventing damage of machinery and blasts due to unhealthy manhandling. Like this this module has vast applications which can be used in every industry.

REFERENCES

1. Industrial Automation System XXXII National Systems Conference, NSC 2008

2. http://www.pacontrol.com/download/Industrial-Automation-Pocket-Guide.pdf
3. http://en.wikipedia.org/wiki/Automation
4. http://en.wikipedia.org/wiki/Programmable_logic_controller
5. http://en.wikipedia.org/wiki/sensors
6. http://www.atmel.com/avr
7. Shizhuang Lin, Jingyu Liu, Yanjun Fang. "ZigBee Based Wireless Sensor Networks and Its Applications in Industrial", IEEE International Conference on Automation and Logistics, 2007 .pp:1979 – 1983.
8. Handbook of Design, Manufacturing and Automation by Richard C. Dorf, Andrew Kusiak.
9. A web-based computer-aided pneumatic circuit design software by Chiaming Yen, Wu-Jeng Li - 2003 - Simulation Modelling Practice and Theory.
10. Industrial Automation: Circuit Design and Components
11. Wiley-Interscience publication, Author David W. Pessen,Edition illustrated,Publisher Wiley, 1989,ISBN 0471600717, 9780471600718