ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE) Vol 1, Issue 2, June 2016

Industrial Automation and Control of Mechanical Equipment Using Secured Wireless Communication

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Abstract: **-- A rapid growth in the industries in the recent years has led industrial monitoring and control especially in the automation process to its extremes. Thus requiring an efficient way to monitor and control the industrial processes through wireless communication these days. Wireless communication is a cheap and easy way to provide network communication at places where there is no wired infrastructure. In addition, because the communicating entities can freely move, one can place the monitoring system wherever it is required without the cost incurred with cabling when adopting the wired communication approach. This project presents a drilling system as in device where it could be remotely controlled and moved to different locations sensing temperature, speed of drilling motor, etc, by means provided. This allows us to take control over real time operations.**

Keywords**-- industrial monitoring and control, wireless communication, drilling system, remotely controlled, control over real-time operations**

I. INTRODUCTION

The global competition, these days has driven the industry constantly to improve process operations involved, quality of product and its productivity, dependability and conformity with guidelines. This prompts a fast development in the limits of Industrial Supervisory and Regulatory, especially in the domain of automation practices. This is all due to involvement of extensive automation in all likely industry and the simplicity of maintainability is increased through the advancement in the computerized tools.

Thus an effective technique of supervising and governing of the industrial practices is required for current industrial scenario.

Many applications are wireless oriented these days. The methods followed in the industry are extremely computerized and improved of late. Yet the mechanism and supervising of all system is accomplished by manual operations. Till now no definite regulation for all machines in industrial practices has been made.
Some Problems with wired technology are listed below:

Pre-planning of required constraints, advanced setup and increased costs of maintainability of the wired system.
Complexity in resolving problems.

Reduced adaptable structure due to pre-set links. Pre-set links need to be planned with additional volume for assembling cabinets, junction boxes and to make it available for expansion in future.

Revolving apparatus may cause continuous winding of wires that causes in weariness and transmission crash.

Wireless centred industrial automation is key interest in current industrial scenario. Such a system can aid the process industry to bring together more data from activities, forecast maintainability of machine, advance labour force productivity via factory-wide network connectivity and make low-cost connectivity solutions available. Wireless tools are desirable as it removes the problems accompanied with wired networks.

Key Benefits of wireless technology:

Data transferring is free from wear and tear. Reduced costs of maintainability and installation. Provides chances of deployment in mobile, and revolving apparatus, and unfriendly and distant locations.

Gives opportunity to implement MEMS (Micro-Electromechanical Systems) technique, benefits of which consists like cost efficiency, less power, greater performance sensing and incorporation.

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IFERP

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Moderately dependable transmission without costly connectors. In recent times wireless network based on ZigBee approach, is been standardized for Industrial Applications. The wireless network established through of personal computer for industrial application using Zigbee can be adopted at small-scale and large-scale industries. By the aid wireless technology, the industry can overcome the limitations offered by the wired networks. The industry also achieves the benefit from the mobility and freedom of design offered by wireless technology.

The Zigbee based wireless supervising and governing agency is a welcomed innovation in the industries run by automation techniques like Textile, Automotive Manufacturing etc. The project aims at this very idea of importance. Zigbee is a specification for a suite of security, networking and application software layers using small, low-data rate communication technology, and low power.

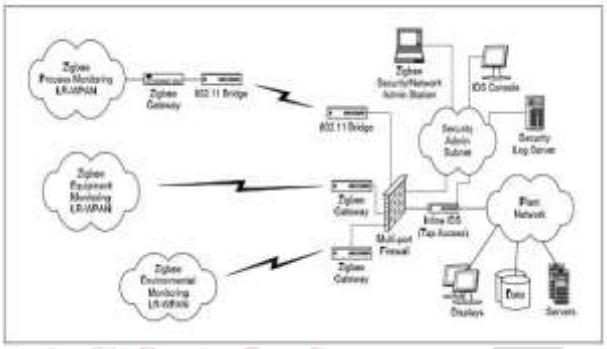

Fig 1.1: Example of ZigBee Networks Deployed in an Industrial Enterprise Environment.

Features of Zigbee Protocol:

- It has low duty-cycle that increases the battery life.
- It has low latency.
- It favors for several network topologies i.e., static, dynamic, star and mesh topology.
- Connects Up to 65,000 nodes in a network.
- Facilitates collision prevention.
- Provides link quality signalling.
- Has clear channel assessment.
- Provides info about retires and acknowledgements in the transmission of data between nodes.

II. LITERATURE REVIEW

This section contains the brief descriptions of the literature survey. The consolidated information of literature survey has been presented below as a case study. The literature review has been done by referring to the international journals, IEEE papers, and research work on wireless technology and its implementation. Some of the papers which have provided important information related to project have been discussed in this chapter.

Mats Anderson: The wireless communication [1] is being employed in industrial processes for more than three decades. Amongst the first applications of wireless communications were Cranes and Automated Guided Vehicles (AGV) in storehouses, using the patented transistors for achieving variable controls of moving machines.

For the past 13 years [1], the renowned technologies for industrial applications include standardized radio technologies like Bluetooth technology, Wireless LAN / WLAN (IEEE 802.11), and IEEE 802.15.4.

S. Palanisamy, S. Senthil Kumar, and J. Lakshmi Narayanan: In a 2011 IEEE paper [2], have proposed that for a micro-level and macro-level industries, wireless network based on personal computer with Zigbee for industrial application could be adopted. Accordingly the personal computer is interconnected to all processors and controllers by Zigbee. This eases the computer to constantly supervise all the data from distant processing unit and also relates the supervised value with the value pre-set in the process structure. The computer takes necessary actions, on encountering any error.

Soyoung Hwang and Donghui Yu: In a 2012 International Journal paper [3], these researchers have proposed a remote controlling and monitoring system with the design and its implementation using ZigBee networks.

The system focuses on a home network. The client system can control and monitor the proposed system via a smartphone and home web services.

Sridutt Tummalapalli and M V D Prasad: A 2013 IJETT [4] paper focuses on getting the flexibility of Field Programmable Gate Arrays with a layered architecture that provides the up keeping of the Operations in an effective way and the ZigBee wireless technology collectively onto single

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IFERP

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integrated application. It is an archetype technology where the data and control statements are communicated using ZigBee Standard protocols and a node is more flexible using FPGA.

Yanyu Zhang, Peng Zeng, Guang Yang, Jinying Li: These researchers in a 2013 IEEE paper [6] proposes an online and remote machine condition monitoring and fault diagnosis system based on Wireless network for Industry automation – Process automation.

This system monitors the status of the target motor systems using vibration transmitting continuously. Once the features of vibrating signals are extracted, the wireless vibration transmitters send feature data to host computer via (WIA-PA) sensor networks.

The extracted data is further processed in the host computer to make diagnosis for the motor system using the customized expert system.

Juan V. Capella, Albert0 Bonastre and Rafael Ors [12]: This research paper expresses the chance to use Bluetooth for wireless short-scale transmission of data for industrial environment. Here a scattered line control system built on Bluetooth is suggested for a bridge crane system. The composition is principally built on the usage of dispersed nodules linked via Bluetooth.

Zigbee protocols used in the wireless technique are constructive to the industry due to its extended battery life, dependable and secured communication. Moreover Zigbee can establish connection up to 6500 nodes. Besides for the Zigbee based sensor network, the power consumption is very low.

Matthias Bauer, Gunther May and Vivek Jain [13]: This paper suggests that, in recent times, the communication fo industrial systems is mainly due to wireless communication only. The wireless systems have to take necessary actions to manage with the necessity of industrial processes, especially timing limitations, so as to attain advantages of flexibility and cost saving abilities. The article focuses the aid of wireless Point-to- Point communication in field level by means of modular gateway architecture in conjunction with Industrial Ethernet protocols.

III SCOPE OF PROJECT

The Zig-Bee module used in the experimental model is operational up to 20 meters range.

- The experimental model could turn anti-clockwise and clockwise direction subject to the availability length of cable connectors.
- The experimental model can go up and down up to certain height.
- The model can drill soft materials such thermocol, paper.
- The model is driven by connecting power cable to it.
- The model can go to a distance depending upon the length of power cable.
- The Zig-Bee module is programmed by the manufacturer and the same is purchased and used for
- the project purpose only.
- The Zig-Bee module comes in a pair. One of them is interfaced with Laptop at the user end and other at the robot end.
- The pick and place robot serves the purpose of remotely accessed drilling machine.
- The tool end of pick and place robot is replaced by user built drill bit.

IV OBJECTIVES

- To communicate with robot through wireless channel using Zigbee.
- To provide thermal shutdown features.
- To measure RPM of drill bit and display the measured value at remote/user end.
- To control the speed of rotation of drill machine by PWM method.
- To drill on a Thermocol, Paper and other soft materials.

V METHODOLOGY

Concept:

This project proposes a system for remotely monitoring, sensing and responding to real time events in drilling operation there by allowing us to control from a far place using wireless sensor network (WSN) by means Zigbee.

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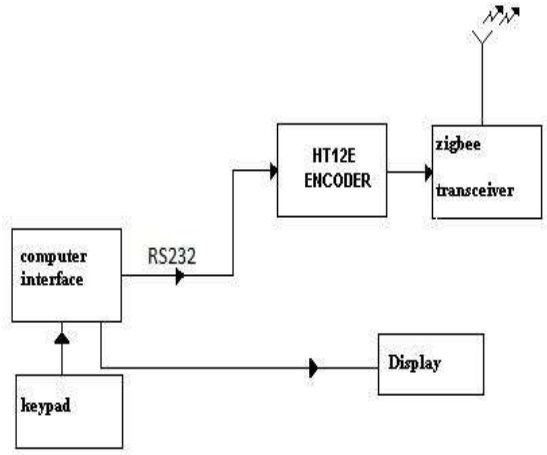
Design:



The following figure shows model of proposed project

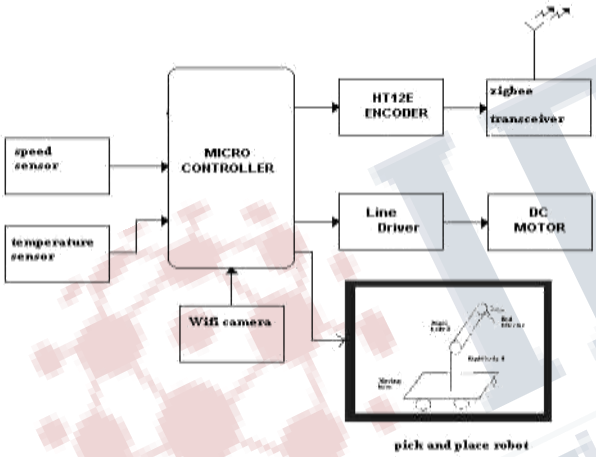


Fig 5.1 Model of proposed project

The following figure shows module of base station for controlling and remotely monitoring events:x` Fig 5.2 Model of base station for controlling and remotely monitoring events

A brief description of components used in the proposed module is given below:

Speed sensor: To rectify then speed of the drilling bit of the drill machine. I am using Hall Effect sensor to sense the speed of the drill bit.

Temperature sensor: I am using LM35 for measuring drill temperature to provide automatic thermal shutdown feature. So LM35 will do the best job. As its IC based easy to interface, easy to mount, widely available, mercury free, low cost and gives direct centigrade as output. Microcontroller: The microcontroller beholds the entire program soft code in it. In this project, P89V51RD2 of 80C51 family is used. This controls the entire project and all the commands are processed by it.

HT12E Encoder: It's an oscillatory circuit in microcontroller, which supplies clock frequency for microcontroller.

Line Driver: An interfacing device between microcontroller and DC motor for bidirectional rotation of motor. Zigbee Transreciever: A wireless module for trans-receiving data between base and remote station. It usually comes in pair.

DC Motor: Used to rotate the drilling bit in possible directions. It also used for the movement robot arm.

Pick-and-Place robot: Commercially available Pick-and-Place robot is used for mounting of drilling bit on to its tool end and for movement of drilling machine from one place to another.

Computer interface: To control and monitor the entire process of drilling operation from remote place.

Keypad: Acts as Controllers of the proposed system

Display: Used to display various data of the process, such as speed, temperature etc.

Process:

The proposed project deals with drilling machine, which will be controlled & regulated by the computer keypad remotely from far place by means of Zigbee. At the base station there will be a Zigbee transceiver which will read the signals issued from the keyboard of computer and transmit the data to another Zigbee transceiver placed at remote place which is interfaced with a pick and place robot. The microcontroller which is interfaced with robot receives the data signal connected to its end via Zigbee and correspondingly reads the temperature of surrounding using temperature sensor and as well senses the rpm of motor by Hall Effect sensor and will feed its value back to the base station. Based upon the value received it is up to the user in charge at base station area to adjust the motor speed based upon the requirements. In addition to this there is also a camera placed on the robot which will acquire the image of surrounding area alerting us where the robot is standing currently as well to locate the drilling point for drilling purpose. This could be viewed on the computer at base

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The robot here used is a movable pick and place robot on which the drilling bit is mounted. It can start drilling by means of information provided by base station from remote area. The locomotion of the robot can also be controlled.

Hardware Used:

Microcontroller P89V51RD2, MAX232 for TTL to RS232 conversion and vice versa, ADC0804, LM35 IC for temperature sensing, Hall Effect sensor for RPM Measurement, Zigbee wireless interface, Robot chassis, Geared DC Motor for Robot, DC motor's for drill and to-&-fro of robot, Pair of Wheels.

Software Used:

Keil IDE for code development and simulation, C51 Compiler (Compiler is part of Keil), Flash Magic, Hyper Terminal.

Commands Used to control the robot through Laptop Interface:

U – Used to lift the robot arm up.

D - Used to move the arm toward down.

A - Used to rotate the robot arm in Anti-Clockwise direction.

C - Used to rotate the robot arm in Clockwise direction.

R – Used to move the robot towards right side.

L - Used to move the robot towards left side.

F - Used to move the robot in forward direction.

B - Used to move the robot in backward direction.

r - Used to run the drill bit mounted on the robot arm.

i - Used to increase the RPM of the drilling bit mounted

Fig 5.3: The photo image of experimental model along

With computer interface is shown in figure. on the robot arm.

d - Used to decrease the RPM of the drilling bit mounted on the robot arm.

s - Used to stop the motion of drilling bit and thereby drilling process.

VI CONCLUSION

An experimental wireless drilling robot (prototype) is built. All the hardware mentioned in the project is interfaced separately with microcontroller and output is shown. Microcontroller generates about 25 milliamps of current which is too low for DC motor to drive. In order to generate high value of current (600 milliamps approx.) L293D driver circuit is used. LM35 is used as a temperature sensor to detect temperature of drill. ADC0804 translates the analog output of LM35 to digital signal so that it can be processed by microcontroller. Hall Effect sensor is used for measuring RPM of drill machine and the measured RPM value is transmitted wirelessly through CC2500 wireless module which works as 2.4 GHZ. In many shop this module is sold in the name of ZigBee. The experimental model built can move in To and Fro directions. The arm of prototype built can rotate in Clockwise and Anticlockwise directions. The drill bit mounted at tool end of prototype can go up and down based on the drilling requirements. The experimental model built can move to right and left directions. The model is controlled from laptop which is relatively away from the model built via pair of ZigBee.

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