Industrial Automation Based on BLE

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Abstract

Wireless communication technologies ease the process of industrial and process automation. Data from the sensor nodes can be fed to the control system or can be used for analysis by a human counterpart using wireless technologies. This project provides data to transmit and receive automatically using BLE (Bluetooth Low Energy) to turn on and off the motor without the help of human in oil industry. The main aim of the project is to turn on and off the motor in oil industry while pumping the oil from the oil tank safely through relay which is controlled by microcontroller using BLE technology. The data is transmitted and received through BLE w hen the keypad switch is pressed. This technology minimizes the dependency of humans. This system uses a BLE, Keypad and Relay which is interfaced with PIC 18F4620 microcontroller. Once the keypad switch is pressed the data goes through transmitter side BLE through receiver side BLE via microcontroller. If the transmitter side data and receiver side data is matched the motor turn on the relay switch. If the receiver side data is not matched with transmitter side data the motor turn off the relay switch. Here use 40 motors, 80 relay switch and 8 microcontrollers. For each microcontroller 10 relay switch and 5 motors are used. The data is transmitted and received through BLE. Here the keypad switch is used for data processing.(oil industry)

I.INTRODUCTION

Many accidents occur due to short circuits, gas leakages, etc. will not allow an ordinary person to enter the accident area so as to reduce further damage. Such accidents are increasing day to day due to lack of awareness, precautionary measures and ignorance. However, one can avoid or reduce the possible damage by taking necessary actions so that the spread of fire due to such accidents is minimized. For taking such actions information of the area and surroundings needs to be monitored without human risk. Wireless communication technologies ease the process of industrial and process automation. Data from the sensor nodes can be fed to the control system or can be used for analysis by a human counterpart using wireless technologies. Several wireless technologies have been developed and utilized for this purpose in the last decade. This project "Industrial Automation Based on BLE", proposes a data to transmit and receive automatically using BLE (Bluetooth Low Energy) when pressing the keypad switch without the help of human. Once the switch is pressed the data goes through transmitter side microcontroller via receiv er side microcontroller by using BLE. If the transmitter side data is matched with receiver side data the motor turn on the relay switch. If the transmitter side data is not matched with receiver side data the motor turn off the relay switch.

A. Project Overview

The major problem faced in oil industry is that when turn on and off the motor by the human while pumping the oil will produce spark. To reduce this human risk, the proposed system is designed in such a way to transmit and receive the data automatically using BLE to turn on and off the motor. This project uses PIC18F4620 as the main controlling unit. The BLE, Relay and Keypad are interfaced with the microcontroller.

The data is transmitted and received through BLE when keypad switch is pressed. If the transmitter side data and receiver side data is matched the motor turn on the relay switch. If the receiver side data is not matched with transmitter side data the motor turn off the relay switch.

This project use 40 motors 80 relay switch and 8 microcontrollers. Each microcontroller is used to control 5motor through 10 relay switches. The keypad switch is used for data processing

II.LITERATURE REVIEW

In recent years, model-based testing (MBT) of automation systems has gained in importance. However, increasing size and complexity of manufacturing plants also lead to larger models, which again cost time and manpower for modeling tasks. D.Erdenechimeg el at (2016) recommended that an the use of MATLAB and LABVIEW Simulation tools to develop an embedded control system including implementation and testing on hardware. The demonstration emphasizes how to design, simulate, and test a complex system that incorporates multiple domains such as mechanical, electrical, and hydraulic. Mallikarjun Kande PMeena et al (2015) recommended that an Smart sensing, devices, and monitoring are essential to localized motor condition monitoring and service applications.

A Smartphones may be used as the computational platform that acquires motor parameters from wireless sensors using a compatible local communication. Considering the widespread use of Bluetooth Low Energy (BLE) in smartphones, a BLE enabled sensor network. Michael Cheffena el at (2016) recommended that an the large bandwidth available at the mm Wave spectrum can open the way for a wide variety of new industrial automation capabilities. With the use of wireless smart cameras and vision technologies, applications such as remote visual monitoring and surveillance, intelligent logistics product tracking, image guided automated assembly, and fault detection can be realized.

D.Erdenechimeg el at (2016) presented the use of MATLAB and LABVIEW Simulation tools to develop an embedded control system including implementation and testing on hardware. The demonstration emphasizes how to design, simulate, and test a complex system that incorporates multiple domains such as mechanical, electrical, and hydraulic that are typically isolated across different software platforms and not simulated in a common framework. We will demonstrate this process in case of the automation of producing of explosives of mining industry: creating an automated system design for emulsification by using technology of proportionally mixed liquid.

Tao Zheng el at (2015) presented a novel medium access control protocol (MAC) defined as Wireless Arbitration(WirArb)which grants each user channel access based on their different priority levels. The proposed MAC protocol supports multiple users and each user is pre-assigned a specific arbitration frequency which decides the order of channel access. With this mechanism we can ensure that the user with highest priority will immediately gain channel access and we can guarantee a deterministic behavior. To evaluate the proposed MAC we use a discrete time Markov chain model (DTMC) to mathematically formulate the WirArb protocol. Our results show that the proposed protocol provides high-performance to ensure deterministic real-time communication and bandwidth efficiency.

Smart sensing, devices, and monitoring are essential to localized motor condition monitoring and service applications. Mallikarjun Kande P Meena et al(2015) presented a unique approach to the smart device is the use of low-cost wireless sensors for machine condition measurement. Smartphones may be used as the computational platform that acquires motor parameters from wireless sensors using a compatible local communication. Considering the widespread use of Bluetooth Low Energy (BLE) in smartphones, a BLE enabled sensor network was selected for this study. An experimental setup was created to emulate the industrial environment and evaluate the performance of the communication infrastructure for successful deployment of intelligent condition monitoring. The network performance measurements were carried out to assess the BLE performance with several AC and DC machines operated using different of
loads in a laboratory with many structural obstructions.Also, an optimal placement of a wireless gate-way was explored.

In recent years, model-based testing (MBT) of automation systems has gained in importance. However, increasing size and complexity of manufacturing plants also lead to larger models, which again cost time and manpower for modeling tasks. Kevin Pinkal Oliver Niggemann et al (2017)presented an approach to solve this problem is to subdivide the overall model into several separated models of usual components of automation systems which are reusable. Therefore, we introduce the Synchronized Depth First Search (SDFS), which uses a sub-divided automaton model to generate test cases. The underlying automaton model needs to incorporate synchronous transitions in order to synchronize processes among each other and thus forming an overall model to test with.

Isidro Calvo Itziar Cabanes el at (2017) proposed the design of an industrial in formatics course, following the project-based learning methodology, and reports the experience of four academic years (from2012–13 to 2015–16). Industrial Informatics is a compulsory course taught in the third year of the B.Sc. degree in industrial electronics and automation engineering at the University of the Basque Country (UPV/EHU), Spain. The course had students develop an embedded controller for a 2DoF SCARA robot that drew a specific trajectory. The robot was built with the LEGO Mindstorms kit and the controller was implemented with NXC , a C-like programming language for the NXT brick. In this activity, students became aware of their learning needs and had to work proactively, both autonomously and in teams. The course design achieved several objectives: 1) students learned the course material; 2) soft skills demanded by employers were reinforced;and 3) the material was structured into project tasks for students to perform. The article analyses two indicators: 1) qualification marks and 2) student satisfaction

The large bandwidth available at the mm Wave spectrum can open the way for a wide variety of new industrial automation capabilities. Michael Cheffena el at (2016) proposed the use of wireless smart cameras and vision technologies, applications such as remote visual monitoring and surveillance, intelligent logistics product tracking, image guided automated assembly, and fault detection can be realized. Vision capabilities can enable robots, machines, and other industrial automation systems to meaningfully interact with objects and safely navigate through their surroundings. Allowing them to adapt to changing manufacturing-line conditions opens a wide range of new industrial automation applications. In this article, we discuss the opportunities, challenges,

and design principles of industrial wireless communication over the mm Wave spectrum. Open research issues are identified and discussed. In addition, performance analysis of mm Wave industrial systems with respect to channel capacity is conducted using a realistic physical statistical based channel model.

Juhás Martin el at (2018) presented the Augmented Reality is a progressive tool in the field of education and in the
learning systems. The subject of the article is the introduction of a learning system focused on the teaching of subjects from the field of industrial automation. However, the modularity and versatility of its design mean that the system is universally applicable to the teaching of any technical subject matter. The solution is built on an open source platform, which underlines the low cost of the system. The use of the A-Frame framework in combination with the AR.js project allows for a combination of learning information and real-world images on commonly available mobile devices in augmented reality to be offered. Additionally, the information is supplemented by real-time process information from the process level control elements of selected subsystems of the complex production line AFB Factory by Festo Didactics.

A. Proposed Embedded System Design

The above mentioned papers reveal about the concepts of industrial automation for transmitting the data using BLE and Smartphones.

This project had come out with a prototype as a way of finding a solution to transmit and receive the data automatically in industry. Also this technology minimizes the dependency of humans. This system automatically transmits and receives the data using BLE and keypad switch when any faults happen in oil industry.

This system uses a BLE Keypad and Relay which is interfaced with PIC 18F4620 microcontroller. When the keypad switch is pressed the data is transmit and receive by BLE using microcontroller. If the transmitted data and received data is matched the motor turn on the relay switch. If it does not matched the motor turn off the relay switch.

III.BLOCK DIAGRAM

Figures 3.1 show the block diagram of Industrial Automation Based On BLE. Keypad, BLE and Relay is interfaced with PIC18F4620 microcontroller. To switch on and off 5 motors this project uses two microcontrollers and two BLE for transmitting and receiving the data. Once the keypad switch is pressed the data goes through transmitter side BLE through receiver side BLE via microcontroller. If the transmitter side data and receiver side data is matched the motor turn on the relay switch. If the receiver side data is not matched with transmitter side data the motor turn off the relay switch.

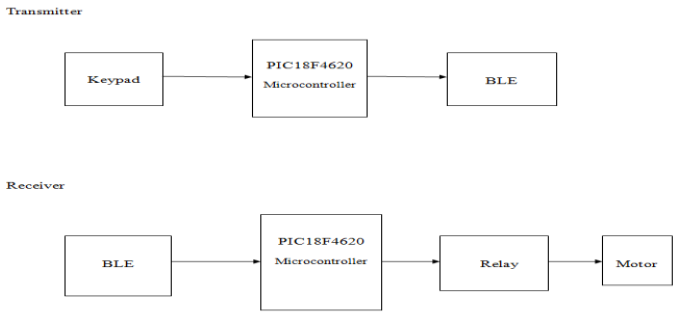

Fig. 1. Block Diagram

A. PIC 18F4620 Microcontroller

The 18 series inherits most of the features and instructions of the 17 series, while adding a number of important new features:

- call stack is 21 bits wide and much deeper (31 levels deep)
- the call stack may be read and written (TOSU:TOSH:TOSL registers)
- conditional branch instructions
- indexed addressing mode (PLUSW)
- extending the FSR registers to 12 bits, allowing them to linearly address the entire data address space
- the addition of another FSR register (bringing the number up to 3)

The RAM space is 12 bits, addressed using a 4-bit bank select register and an 8-bit offset in each instruction. An additional "access" bit in each instruction selects between bank 0 (*a*=0) and the bank selected by the BSR (*a*=1). A 1-level stack is also available for the STATUS, WREG and BSR registers. They are saved on every interrupt, and may be restored on return. If interrupts are disabled, they may also be used on subroutine call/return by setting the *s* bit . he auto increment/decrement feature was improved by removing the control bits and adding four new indirect registers per FSR. Depending on which indirect file register is being accessed it is possible to post decrement, post increment, or pre increment FSR; or form the effective address by adding W to FSR.

In this project, controlling unit Raspberry Pi3 is the core. All the coding is done on the MPLAB IDE. The BLE,Keypad and Relay is interfaced with PIC18F4620. By pressing the Keypad the data is transmitted through transmitter BLE via receiver BLE using microcontroller . If the transmitter side data and receiver side data is matched the motor turn on the relay switch. If the receiver side data is not matched with transmitter side data the motor turn off the relay switch.

B.Relay

Relay is interfaced with PIC 18F4620. When the data is transmitted the motor turn on the relay switch. In this project, use 80 relay switch, 8 microcontroller .For each microcontroller 10 relay switch is used. If the transmitted data is not matched with receiver side data the motor turn off the relay switch. The relay is connected with receiver side microcontroller.

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid state relays. Relays are used where it is necessary to control a circuit by a separate low power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor.

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C. 4x4 Keypad Matrix

The keypad is interfaced with transmitter side PIC18F4620 microcontroller.When the keypad switch is pressed the data is transmitted through transmitter side BLE through receiver side BLE via microcontroller. Here the keypad switch is used for data processing unit.

Matrix keypad use a combination of four rows and four columns to provide button states to the host device, typically a microcontroller. Underneath each key is a push button, with one end connected to one row, and the other end connected to one column.This 16-button keypad provides a useful human interface component for microcontroller projects.Convenient adhesive backing provides a simple way to mount the keypad in a variety of applications.

D. Bluetooth Low Energy

The Bluetooth Low Energy is interfaced with PIC 18F4620 one in transmitter side and other in receiver side. It is used for transmitting and receiving the data when pressing the keypad switch. In this module has RXD TXD GND SET pin. For RXD pin 1k resistance has been connected in series. For TXD pin also 1k resistance has been connected in series.

HC-12 wireless serial port communication module is a new-generation multichannel embedded wireless data transmission module. Its wireless working frequency band is 433.4-473.0MHz, multiple channels can be set, with the stepping of 400 KHz, and there are totally 100 channels. The maximum transmitting power of module is 100mW (20dBm), the receiving sensitivity is -117dBm at baud rate of 5,000bps in the air, and the communication distance is 1,000m in open space.

IV.SCHEMATIC DIAGRAM

This project is to design a Industrial Automation Based On BLE for transmitting and receiving the data automatically using keypad switch.

The proposed system is developed with PIC18F4620 microcontroller. Bluetooth Low Energy, 4x4 keypad matrix, and relays are interfaced with the microcontroller unit. Here BLE'S are used for transmitting and receiving the data. In this project 80 relay switch,40 motor and 8 microcontroller are used. . For each microcontroller 10 relay switch and 5 motors are used. The data is transmitting and receiving through BLE. Here the keypad switch is used for data processing.

If the transmitter side data and receiver side data is matched the motor turn on the relay switch. If the receiver side data is not matched with transmitter side data the motor turn off the relay switch.

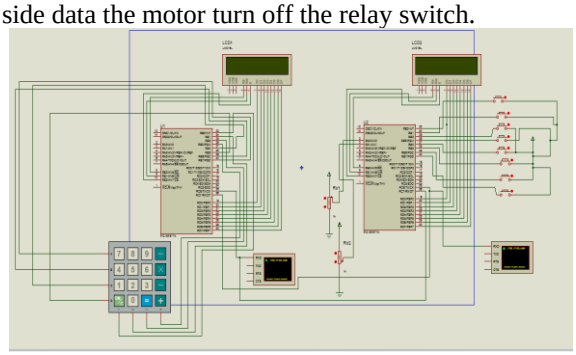

Fig. 3. Schematic Diagram

A.Implementation

The system is developed as mentioned in the schematic diagram shown in figure 4.1. The Industrial Automation Based On BLE has been designed with PIC18F4620. The coding is done on MPLAB software and is dumped into the PIC18F4620 kit.

Transmitter side BLE RXD pin is connected to the transmitter side PIC microcontroller TX pin RC6 and receiver side PIC microcontroller RX pin RC7. Receiver side BLE RXD pin is connected to the receiver side PIC microcontroller TX pin RC6 and transmitter side PIC microcontroller RX pin RC7. Here two BLE's are used one in transmitter side and other in receiver side. So enables the pins RC6 and RC7 when communicate through BLE

4x4 Keypad matrix pins are connected to PORTB pins as general purpose input and output pins. RB0-RB3 as output pins and RB4-RB7 as input pins. The relay unit are connected to PORTB pins as general purpose input and output pins through a relay driver. RC0-RC4 is set as output pins. RC5-RC7 is set as input pins.

LCD is interfaced with PORTD and PORTE of PIC microcontroller. All the data pins (D0-D7) are connected to RD0-RD7 and is configured as output

pins. The reset and enable pins of LCD are connected to RE0 and RE2 respectively.

V. EXPERIMENTAL RESULTS

A. Experimental Setup

Figure 6.1 shows the Experimental setup of this project. PIC 18F4620 is the main controlling unit in this project. Keypad switch is interfaced with the transmitter side PIC 18F4620 microcontroller to transfer the data when switch is pressed. The data is transmitted and received through BLE when the keypad switch is pressed.

Once the keypad switch is pressed the data goes through transmitter side BLE through receiver side BLE via microcontroller. If the transmitter side data and receiver side data is matched the motor turn on the relay switch. If the receiver side data is not matched with transmitter side data the motor turn off the relay switch. Here use 40 motors 80 relay switch and 8 microcontrollers. For each microcontroller 10 relay switch and 5 motors are used.

The data is transmit and receive through BLE. Here the keypad switch is used for data processing. The data is already stored in the microcontroller using transmitter and receiver code.

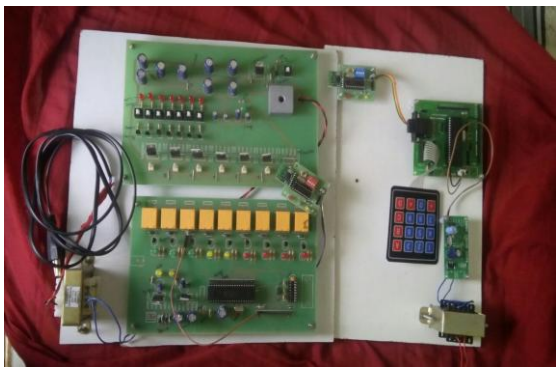

Fig. 4. Industrial Automation Based On BLE

B. Result Analysis

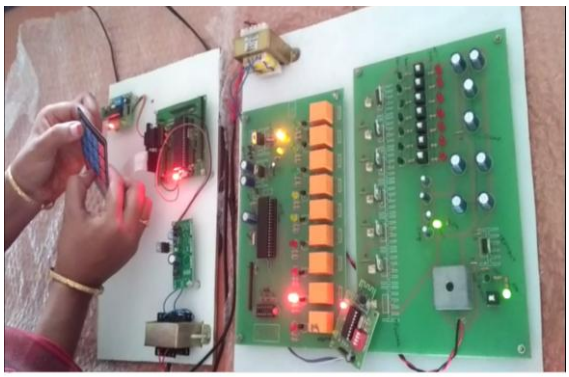

Figure 6.2 When the motor '1' is ON

Figure 6.2 shows the motor turn on the first relay switch when the transmitted side data and received side data is matched.

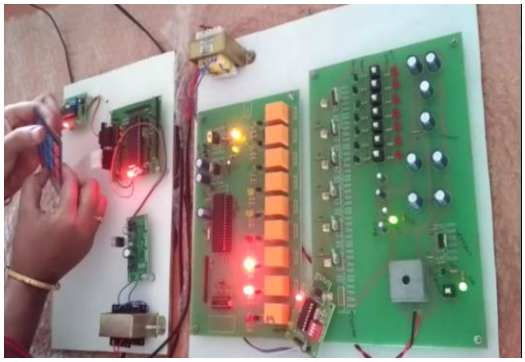

Figure 6.3 When the motor '2' is ON

Figure 6.3 shows the motor turn on the second relay switch when the transmitted side data and received side data is matched.

Figure 6.4 When the motor '3' is ON

Figure 6.4 shows the motor turn on the third relay switch when the transmitted side data and received side data is matched.

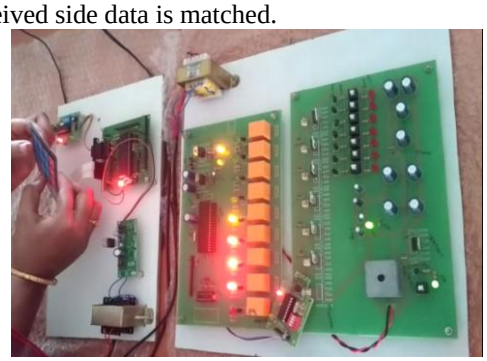

Figure 6.5 When the motor '4' is ON

Figure 6.4 shows the motor turn on the fourth relay switch when the transmitted side data and received side data is matched.

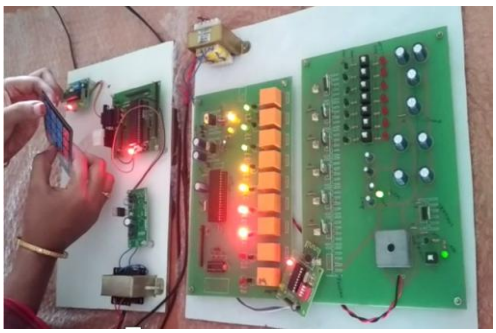

Figure 6.6 When the motor '1' is OFF

Figure 6.4 shows the motor turn off the first relay switch when the transmitted side data and received side data is not matched.

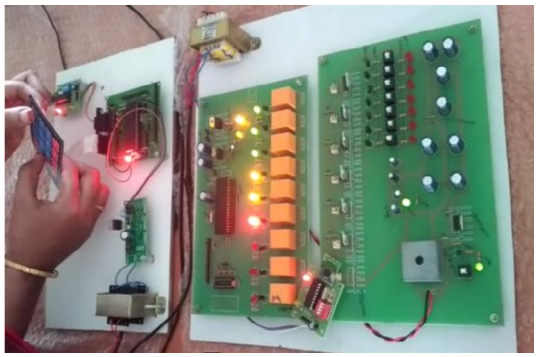

Figure 6.7 When the motor '2' is OFF

Figure 6.4 shows the motor turn off the second relay switch when the transmitted side data and received side data is not matched.

Figure 6.8 When the motor '3' is OFF

Figure 6.8 shows the motor turn off the third relay switch when the transmitted side data and received side data is not matched.

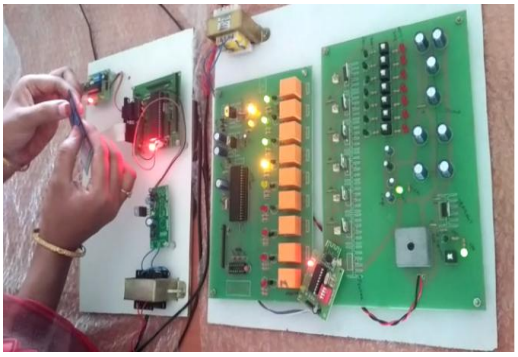

Figure 6.9 When the motor '4' is OFF

Figure 6.8 shows the motor turn off the fourth relay switch when the transmitted side data and received side data is not matched.

VI. CONCLUSION

This project is to acquire data wirelessly from industry easing the process of data acquisition and storage. By using BLE technology we can transmit and receive the data to turn on and off the motor automatically without the help of human. The potential of BLE has been justified as a suitable technology for the above said purpose.

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