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Industry Monitoring Robot using Arduino Uno with Matlab Interface

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Abstract

In industries, measuring the parameters of machines is still a tedious process which is carried out by some human personnel. This paper mainly focuses on the remedial measures made to reduce human interaction with machines by using Industrial monitoring robot. This robot is hanged over the ropes to measure the parameters of machines in aerial mode. During its travel, the robot collects the parameters from the machines and transmits to control room using ZIG-BEE protocol. The control room interface with the robot is designed using MATLAB GUI model. MATLAB GUI interface shows the parameter readings from the robot and plotted in graph. The robot mainly observes temperature, smoke, toxic gases, Light intensity, defect in manufacturing machines, security purposes using cameras. Any abnormal change in the parameters can be viewed in the graph and remedial measures can be made immediately without any delay, this prevents machine damage to a greater extent. This robot is also used to indicate hazardous conditions like fire, leakage of pipes etc. to the control room using buzzers.

Keywords: ZIG-BEE; Sensors; MATLAB GUI interface

Introduction

In the overview of recent years, it is very affirmative to confirm the presence of industrial robots put into practice. The subject of usage and accessibility in terms of sophisticated environments has limited the possibilities of such robots to utilize or perform up to its capabilities.

Because of the proposed robot's significant features such as mobility, multi-parameter measurement, and wireless transmission of measurement data in harsh environments where other technologies may fail has extended the application of this device to a new level. An industrial robot consists of transducers (sensors) based wireless network through zigbee integration which acts as both receiver and transmitter. The wireless modules continuously transmits data between the host (computer) and the client(robot). The parameters measured are signal conditioned and calibrated with sampling techniques [1]. The in house microcontroller takes care of the necessary actions. Since, the identity or the system and the device address is unique and user defined, The data transmission takes place within a secured mode of communication. The range of communication could be extended by using multiple transceivers which acts as both node as well as range extender. With localization, the measurement in sophisticated environments is advancement for successful application of industrial robot. Various types of sensors could be used depending on the necessity of particular parameter needed to be measured in that particular environment or the surroundings. The goal was to find an economical solution for the robot to traverse through the indoor harsh environment where ground based movement is not possible. Also, to implement the system without disturbing the testing or monitoring environment where alterations and modifications are not feasible. This research is based to data acquisition and monitoring through a real time plot and to apply the same on existing environments by means sure wireless communication [2] (Figure 1).

Goal of Proposed Work

Following are the main goals of this paper:

To ease the difficulty in terms of measurement and monitoring of sophisticated factory environments.

IM-ROBOT is basically a monitoring device which is used to monitor the parameters over a range of machines which are operating underneath. This device is used for measuring, monitoring and data acquisition of several parameters simultaneously. But, in this the device works with the enhanced property of matlab integration techniques and the objective of remote monitoring of sophisticated environments are achieved [3].

Data transmission

In order to transmit the data of the parameters through a mobile robot travelling in an indoor environment on a rope is executed. The usage of mobilisation through a rope simply eliminates the possible interference with any physical body or machine in our case. It also eliminates the complexity of mobilisation and linearity in terms of measurement is achieved. The capability of this device to be implemented on any existing set up without much alterations or modifications required. Also, this cuts down the cost of construction and implementation on existing working environments [4].

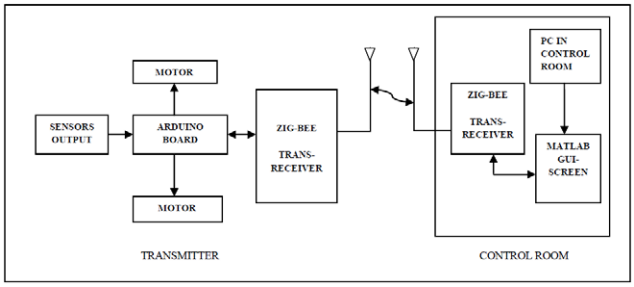

Figure 1: Proposed model of IMR.

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Wireless transmission

The use of radio frequency signal has been chosen as the mode of communication through wireless sensor networks. The use of MATLAB application allows the user to interpret the data in the graphical form which gives the user a better understanding of the change of parameters and take necessary action towards it [3].

Components of the Model

Types of sensors

Light sensor: Light sensor used in this robot is LM324. LM324 is the cheapest and most reliable light sensor. The Sensor senses any change in the light intensity. The cell resistance changes with increase with light intensity. The sensor is interfaced to Arduino analog input pin 0 and readings are transmitted via ZIG-BEE module to the control room. Any hazardous condition like fire, short circuit in electrical boards can be detected by the sensor and indicates to control room without much delay.

Smoke sensor: Smoke sensor used for this purpose is MQ-2. MQ-2 is reliable and has long life when compared to other types of smoke sensors. Smoke sensor is interfaced to arduino analog input pin 1 and readings are transmitted via ZIG-BEE module to control room.

Zig-Bee technology: The transmission and reception between the robot and control room is carried out ZIG-BEE module. The ZIG – BEE module used for this is CC2500 RF Module, A trans-receiver module which provides easy to use RF communication at 2.4 Ghz. This module is a direct line in replacement for your serial communication it requires no extra hardware and no extra coding that works in Half Duplex mode i.e., it provides communication in both directions, but only one direction at same time. This is connected to UART section of arduino board. The TxD and RxD of the board is connected to ZIG-BEE module (Figures 2-4).

Temperature sensor: The temperature sensor that we used in this robot was TMP36. The TMP36 are low voltage, precision centigrade temperature sensors. They provide a voltage output that is linearly proportional to the Celsius (centigrade) temperature. The TMP36 do not require any external calibration to provide typical accuracies of ±1°C at +25°C and ±2° over the −40°C to +125°C temperature range. This sensor is connected to the analog input pin 2 and readings are transmitted via ZIG-BEE module to control room.

Motor driver: As the supply voltage is around 5V to the arduino board, the motors for forward and reverse motion cannot be initiated. The motor requires minimum 12V to drive the robot forward or reverse direction.

This is supplied by the motor drivers. The motor driver used in this robot was L293D. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. the motor direction is decided based on the following Table 1.

The robot uses motor driver L293D to connect it into DC motor which rotates to evaluate the conditions present in the industry. Thus, we came with the equation of motion of DC motor which is generally used by the robot to move around the industry. We interface the motor with Arduino micro-controller to move forward or reverse depending on the situation in which the robot is in. The following is the equation of motion of robot in matrix form is,

$$\begin{pmatrix} V_e \\ i \end{pmatrix} = \begin{pmatrix} K_v & 0 \\ 0 & 1/K_m \end{pmatrix} \begin{pmatrix} \omega \\ T \end{pmatrix}$$

From the equation above,

i = Current flowing through the coil.

ω = Angular velocity of coil.

$T = K_m.i$ where, K_m Torque Constant.

$V_e = K_v.\ \omega$ K_v Back-Emf Constant.

Serial camera: The camera module has an on-board serial interface (TTL or RS232) that is suitable for a direct connection to any host micro-controller UART or a PC system COM port. The camera is powered by 5V. The camera used in this robot is RSV5-C328 Serial Camera. This is most generally used for various security applications.

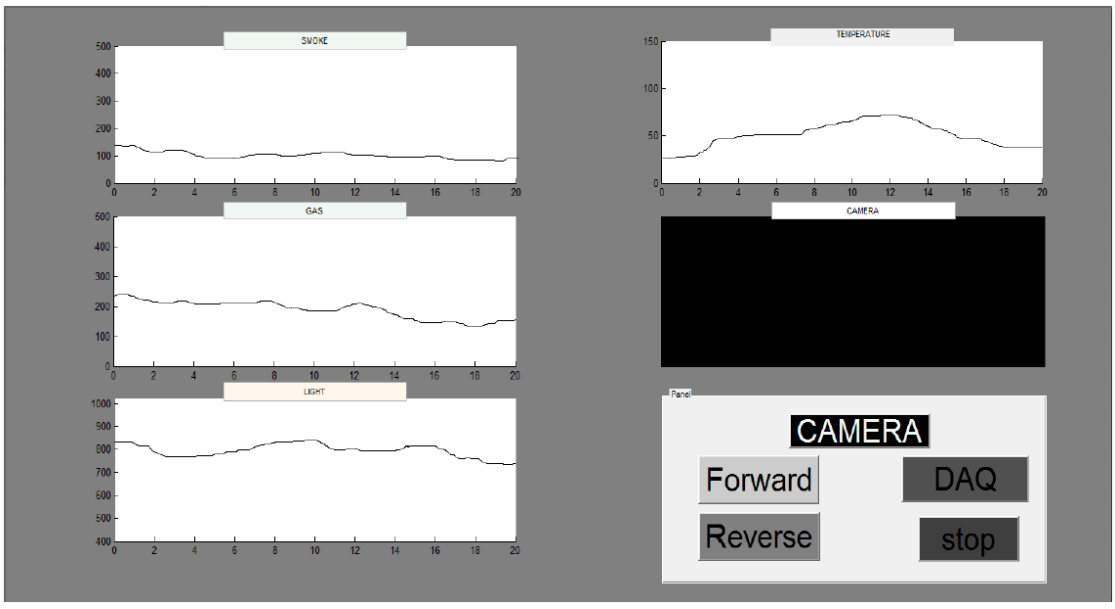

Figure 2: MATLAB interface with IMR.

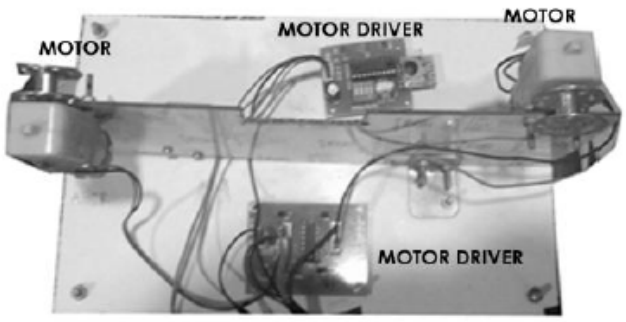

Figure 3: Top view of IMR.

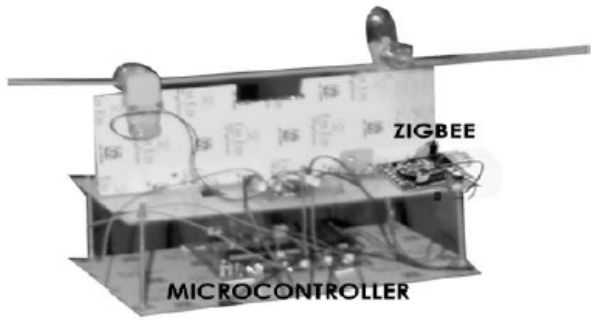

Figure 4: Position of IMR.

Input 1	Input 2	Input 3	Input 4	Motor state
1	0	0	1	Clockwise rotation
0	1	1	0	Anticlockwise rotation
0	0	0	0	Idle (high impedence state)
1	1	1	1	Idle

Table 1: Robotic movements controlled by drivers.

The output of the camera is connected to the arduino board and the image is transmitted to the control room through ZIG-BEE protocol.

Working

To reduce the human personnel and to eliminate errors during measurement, Industrial monitoring robot can be used as a remedial measure.

- This robot consists of various sensors for readings are collected and corresponding graphs are drawn respective to the sensor readings.
- Sensing the physical conditions of the machines which is controlled by arduino microcontroller board [1].
- Arduino micro-controller kit consists of bit Atmel AVR micro-controllers.
- These systems provide sets of digital analog I/O pins that can be interfaced to various extension boards and other circuits.
- The boards feature serial communications interfaces. Sensors are interfaced to arduino board which transmits the data collected to the control room through ZIG-BEE module.
- The control room PC is paired with ZIG-BEE module. The ZIG-BEE module in the control room acts as a receiver.
- The control room PC is designed with MATLAB GUI interface [3].
- The interface consists of various button options, whenever a button is pressed the corresponding instructions are carried from the control room to the robot through ZIG-BEE protocol.
- The robot executes the instructions.
- When the forward button is pressed, the robot moves forward and similarly for the reverse direction.
- When DAQ button is pressed, all the sensors readings are collected and corresponding graphs are drawn respective to the sensor readings [2].

Conclusion

Thus Industrial monitoring robot used to monitor the hazardous conditions and parameters of the machines. The advancement in this type of robots can be made by introducing WIGig (802.11ad), A new protocol for transfer of parameters from robot to the control room. This protocol increases the coverage area of robot, so it can be used in power plants. The speed of this protocol is 10Gbps. This works similar to ZIG-BEE but with higher efficiency.

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