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Design and Implementation of Application Software for User Friendly Operation of Industrial Robot

S. Anitha[1], K. Lakshmi Joshitha[2]
[1]M.E-Communication systems, Sri Sairam Engineering College, Chennai, India.
[2]Assistant professor of ECE, Sri Sairam Engineering College, Chennai, India.
Email: anithasias@gmail.com lakshmi.ece@sairam.edu.in

Abstract-With the sophistication of life of the human with many embedded technologies use of sensors in all the intelligent systems has become unavoidable. The robot vehicle designed here is wirelessly controlled with the joystick and can find application in the areas where human cannot have access. The first objective of the work is to create the Graphical User Interface (GUI) in PC to interface joy stick with the industrial robot. The robot movement and its position can be controlled easily by a joystick and monitored through application software. Microsoft visual studio is used to develop Graphical User Interface for the application. The Joystick Reference Value is stored in joystick library code and robot control code accesses the joystick reference data and process to send the command to the robot. The interfacing is done through the USB port. The combination of joystick library code and robot control code is used to implement a user friendly robot. The second objective of the system is to provide live video monitoring and temperature and Gas detection in hazardous environment in industries. ZigBee protocol is used as the communication medium between rover robot and PC.

Keywords—Joystick, Robot, Graphical User Interface, Visual studio, Zigbee, Television tuner card, wireless Audio Video camera, Gas sensor, Temperature sensor, Universal Serial Bus.

I. INTRODUCTION

Technological advancement in the field of science has paved the way to the invention of sophisticated machines, which could assist us and simplify our work. One such valuable invention of humankind is robots. The design of robots became more and more sophisticated, with the increase in the capacity of the machines to do work. Robots have now emerged as machines that could follow along with a human by holding hands. Today, with the advancement of science and technology, the researchers are coming up with innovative ideas to create robots that could simplify the sophisticated tasks, which are otherwise done with intense hard work, with work force. Robotics is a developing science.

The objective is to build a cost effective and efficient robotic system for industrial application. It is to provide require tracking and surveillance in hard to reach and hazardous environment, thus acting as a substitute for human in hazardous environment. The important objectives of robotic systems in industries are saving of man power, and ability to work in any hostile environment. The robot system is very useful in industries, for monitoring the devices and persons can control the robot by sitting at any place. Various applications are Danger seeker, Chemical industries, Oil refineries and defense applications. The paper has been organized as follows. Section II describes various developments related to the work. Section III presents the proposed model. Section IV describes about the hardware details. Section V deals with the creation of application software, Section VI gives the results and discussions. Section VII concludes the paper with the future work.

II. RELATED WORKS

The evolution of the robotics and low power systems has led to wireless sensors that are low power devices which are static or dynamic.[1] shows a wireless navigation mobile robotic system design for both path finding and trajectory execution in an indoor maze environment. This system consists of the mobile robot, trajectory planner, motion controller, visual sensor (CCD camera), zigBee wireless communication device and a maze terrain. Breadth First Search (BFS) and modified Depth First Search (DFS) algorithms were used to compute the path from a decided source to desired destination. PC based controller used as robot position controller maze solver and trajectory planner. The system in reference [2]shows the robot will be an alternate source for human soldier in the war field. The robot uses two barrel gun turret through which bullets can be fired and it uses two cameras in synchronization with the turret to get a safe firing limit. The robot is radio operated, self powered, has back tracking facility, in case of loss of connection from the base station. The robot can be controlled from a base station by using radio frequency.

A technique to find sideslip of robot based on wheel traces during traverse in terrain [3]. This algorithm uses a robust Hough transform enhanced by fuzzy reasoning to calculate the angle of inclination of the wheel trace in accordance with the vehicle reference frame. Any deviation of the wheel trace from the planned path of the robot shows presence of sideslip that can be detected and measured. An Internet-based and sensor-driven architecture, which can guarantee the non-distortion-transfer of control information and reduce the action time difference between local simulated virtual robot and remote real robot,[4] couple the remote monitoring and control together.

A hybrid structured wirelessly controlled robot with humanoid and vehicle types to perform home security tasks. It includes the smoke and temperature detection sensors and the CCD camera mounted on the head of robot to capture the guarded videos. Reference [5] gives the stable and fast movement robot with reduced energy consumption. When the robot enters humpy grounds or crosses small doorsills, the robot structure is

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changed as humanoid type to pass the non-flat grounds. Therefore, this hybrid-structure security robot provides flexible adaptations to different types of ground conditions in home. A new environment monitoring system of household security robot in [6] is composed of sensor nodes for monitoring temperature and humidity, gas leaking, fire and housebreaking in family. A robot centring on network topology structure is presented and realized. All of the sensor nodes information in the network will be sent to the robot node, so the robot node usually undertakes the task to collect sensor data information, conserve the information, process the information, and also as the interface of the network with the other users. This monitoring system has strong anti-jamming ability and can work well with the robot' self-moving and monitoring.

The RoboGuard is a mobile security device which is tightly integrated into the existing surveillance framework developed in [7] and marketed by Quadrox, a Belgian SME. RoboGuards are semi-autonomous mobile robots providing video streams via wireless Intranets to existing watch guard systems, supplemented by various basic and optional behaviours. RoboGuards fill several market-niches. Especially, they are a serious alternative to the standard approach of using Closed Circuit Television (CCTV) for surveillance. The robot is controlled from the PC in Zigbee communication using application software[8]. Forward, right move, left move and backward direction commands from the application software will drive the robot in any desired direction also will run with the application software. Smoke Sensor is used to detect any fire/Bomb threat and indicating to control room. Robot used to detect live human beings, who need help is discussed in [8].

To detect the Live humans, those who are affected by natural disasters like Earth quakes and need help can be identified by using this robot which can also serves as a Fire Identification ROBOT. Bore well rescue robot [10] designed to rescue a trapped baby from bore well. This is a human controlled robot that gives an insight view of rescuing the baby safely and steps taken to achieve this. The robot also used for Picking and Placing of objects based on arm design. This robot has a high power LED which acts as a light source when light intensity inside the pipe is low. Wireless robot will enable us to control the robot with the help of internet and it will be able to detect the living bodies [11] with the help of PIR sensor. It will help in rescue operation and user can access the video transmitted from the remote area such as the sensitive areas or areas which are beyond our reach. The camera mounted on the robot is able to move horizontally around its vertical axis and vertically along its vertical axis. Camera movement is controlled through webpage at the user interface, thus, providing user with enhanced view of the surroundings. Human casualties can be minimized in terrorist attack by using robot [12]. The combat robot has been designed to tackle cruel terror attacks. This robot is radio operated, self- powered, and has all the controls like a normal car. A wireless camera has been installed on it, so that it can monitor enemy remotely when required. It can silently enter into enemy area and send us all the information through its tiny Camera eyes. This spy robot can be used in star hotels, shopping malls, jewellery show rooms, etc where there can be threat from intruders or terrorists. Since human life is always precious, these robots are the replacement of fighters against terrorist in war areas.

III. HARDWARE DESCRIPTION OF THE PROPOSED SYSTEM

The proposed robot is easy to design and implement both in hardware and software aspects. It uses low cost microcontroller, high sensitivity gas and temperature sensors, wireless camera,TV tuner card and zigbee to support reliable and robust wireless communication network. The PIC16F877A microcontroller is embedded with Embedded C program which processes the received sensor data and provides safety and security alarm through zigbee communication [1]. The mobile robot is a battery powered and controlled remotely through zigbee. At the local system, the front end is designed using VISUAL STUDIO EXPRESS which is simple coding and easy to understand. Receiver microcontroller receives the data and performs the necessary movement of the robot using DC motors [8].

This system provides live video streaming [6]. The robot integrates both safety and security functions and is useful in variety of applications like industries, resorts, and government and non-government organizations. This intelligent robot is mainly useful in rescue operations, which detects the alive human in disaster situations and in war fields, and also used in intelligent security purposes .Given the command to the receiving unit the microcontroller process the received message and gives respective signal pulse to the relay driver which makes the motors move according to the given message.

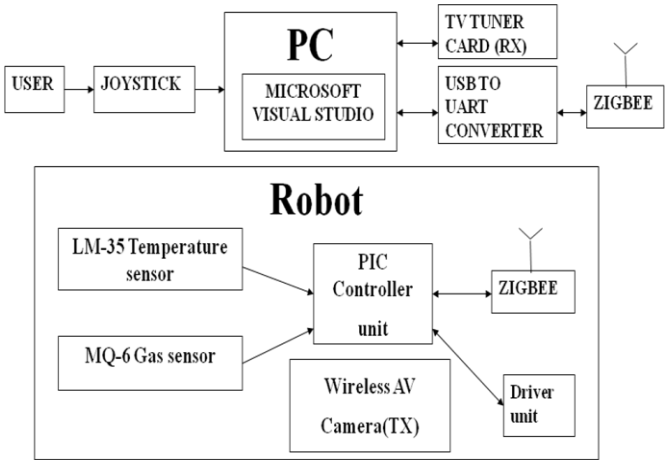

Fig.1 Overall Block Diagram of the Proposed System

III. HARDWARE SPECIFICATION

A. Dc Servo Motor

The heart of a servo is a small direct current (DC) motor. Fig 1 and Fig 2 shows the hardware details.These motors run on electricity from a battery and spin at high RPM (rotations per minute) but put out very low torque. An arrangement of gears takes the high speed of the motor and slows it down while at the same time increasing the torque. The gear design inside the servo case converts the output to a much slower rotation speed but with more torque. Gears in an inexpensive servo motor are generally made of plastic to keep it lighter and less costly. Servo provides more torque for heavier work, the gears are made of metal and are harder to damage.

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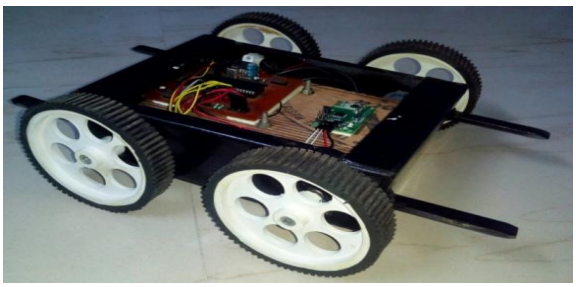

Fig. 2 Rover Robot

B .Robot Section

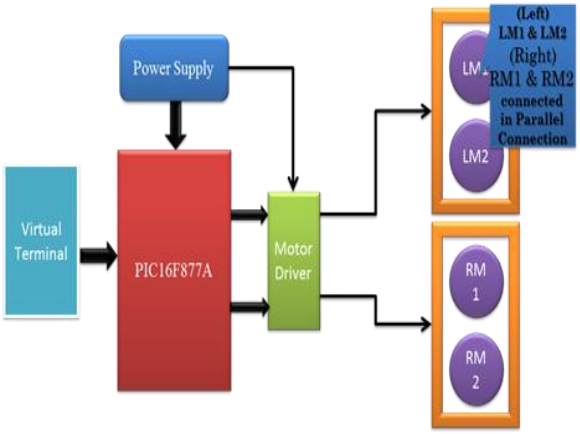

Fig.3 Block Diagram of Controller Section

C. Driver Unit

The circuit has four switches A, B, C and D. Turning these switches ON and OFF can drive a motor in different ways. Fig 3,4 shows the controlling section and the H bridge.

1. Turning on Switches A and D makes the motor rotate clockwise(Forward)
2. Turning on Switches B and C makes the motor rotate anti-clockwise(Reverse)
3. Turning on Switches A and B will stop the motor (Brakes)
4. Turning off all the switches gives the motor a free wheel drive
5. Turning on A & C at the same time or B & D at the same time shorts your entire circuit.

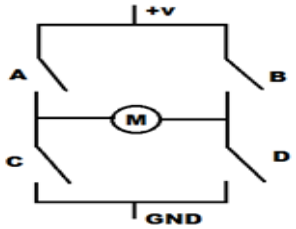

Fig.4. H Bridge

D. Joystick

A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling. It often has supplementary switches to control various aspects of the aircraft's flight. Joysticks are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer. A popular variation of the joystick used on modern video game consoles is the analog stick. Joysticks are also used for controlling machines such as cranes, trucks, underwater unmanned vehicles, wheelchairs, surveillance cameras, and zero turning radius lawn mowers. Miniature finger-operated joysticks have been adopted as input devices for smaller electronic equipment such as mobile phones.

E. Zigbee

ZigBee USB Interfacing Board used to interface ZigBee wireless Module with Desktop or Laptop computer systems. User can use this Interfacing board to connect raw module of ZigBee to make communication between PC to PC, PC to Mechanical Assembly, PC to embedded and microcontroller based Circuits. User can also use this board to configure ZigBee according to application. As ZigBee communicates through Serial Communication so other end of USB which is connected to PC, treated as COM port for Serial Communication. User can use any type of ZigBee module almost. It is provided with indication LEDs for ease. Table 1 shows the USB pin details.
The features are of the Zigbee modules are

- Linear separate pin-out for Transmit data pin (TxD) and Receive data pin (RxD).
- On board USB type-B port.
- Helps to interface USB device with module supporting UART.
- Six LEDs showing status of TXD, RXD, SUSPEND, RSSI, ASSOC and Power LED.

Table No.1 Technical Specification

Technical Specification	*Range of Values*
Power supply	5V DC (only from USB).
Dimension	66mm x 40mm x 12mm (l x b x h).
Temperature Range	0°C to +70 °C.

F. USB

USB (Universal Serial Bus) designed to connect peripherals such as joysticks, mice, keyboards, scanners, digital cameras, printers, hard disks, and networking components to PC. It has become the standard connection method for wide variety of devices. Universal Serial Bus (USB) is a specification to establish communication between devices and a host controller (usually personal computer). Nowadays USB has replaced a variety of earlier PC interfaces (such as RS-232 serial or parallel port). Due to the ability to supply power to the peripheral devices USB is often used as a power charger for portable devices.

Table No.2 USB Pin out Details

Pin	*Name*	*Cable color*	*Description*
1	VCC	Red	+5 VDC
2	D-	White	Data -
3	D+	Green	Data +
4	GND	Black	Ground

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G. MQ 6 SENSOR

SnO2 is the sensing material of MQ 6 gas sensor, which has lower conductivity in clean air. If the combustible gas exist, the conductivity along with the gas concentration increase. MQ 6 gas sensor has high sensitivity to propane, Butane and LPG.

Table No.3 Technical Data

Sensor Type	Semiconductor
Standard Encapsulation	Bakelite (Black Bakelite)
Detection Gas	Isobutane, Butane, LPG
Concentration	300-10000ppm

H. LM 35 Temperature Sensor

Features:

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±1⁄4°C typical
- Low impedance output, 0.1 □□for 1 mA load

I. TV Tuner Card

TV tuner card connected to the PC. It receives audio and video from the wireless AV camera transmitter which is present in the Robot and provide it in the PC.

IV. SOFTWARE SPECIFICATION

A. *Microsoft Visual Studio*

It used to create library code for joy pad interface to UART. It creates graphical user interface.Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silver light. It can produce both native code and managed code. It is used to create front end applications. It generates C# code for the application.

B. Procedure to Create A Front Panel

To create a Windows Forms Application project the following steps are used

Step 1: On the menu bar, choose File, New, Project.

Step 2: Choose Visual C#

Step 3: In the templates list, choose the Windows Forms Application icon. Name the new form Picture Viewer, and then choose the OK button. Visual Studio creates a solution for the program. A solution acts as a container for all of the Projects and files needed by the program. Write the Program.

Step 4: On the menu bar, choose File, Save All.

C. Steps to create and use a Joystick class library in Visual Studio

Step 1: Start Microsoft Visual Studio

Step 2: On the Menu Bar, click File -> New Project...

Step 3: In the left list, click Windows under Visual C#.

Step 4: In the right list, click Class Library

Step 5: Change the Name to SampleLibrary and click OK

Step 6: Click OK.When click OK, C# will create a Namespace with the name have given.

Step 7: Change the class name and create any methods under project template file opened.

Step 8: Build the Library.

- On the main menu, click Build -> Build Project Name
- In the Solution Explorer, right-click the name of the project and click Build.
- In the Class View, right-click the name of the project and click Build.

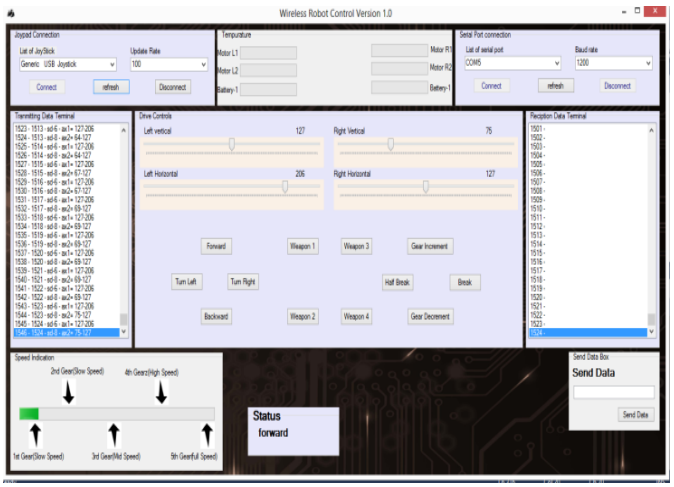
Step 9: Create an ASP.NET Windows Form Application Project: On the Menu bar, click Project -> Add Reference or In the Solution Explorer, right-click References and click Add Reference. Click the Browse tab, locate the folder where the library resides and select it.

Step 10: Call the Library class methods in the application. After selecting the library, click OK.

Step 11: Build and run the project.

VI. RESULTS AND DISCUSSIONS

The implementation of the moving Robot that could move in a controlled manner using joystick was successfully designed using the Application software developed. The robot provides live audio and video monitoring, gas and temperature detection accurately. The working was also verified with number of trials. The robot can be used in war field, mines, power station, military operations, industries and indoor applications. The robot can also be used wherever it is not accessible for the human to monitor due to the hazardous environment. The Robotic movement is controlled remotely through the local system. The robot is developed to detect dangerous gas, temperature and also human presence by using sensors.



. Fig.5 Application Software For Robot Control

VII. CONCLUSION

Today, military ground robots & unmanned vehicles are used worldwide. However, the significant growth of the current military robots comes as the nature of combat changes in every region while the globally integrated enterprise replaces nationalistic dominance. It can be said that military robot

automation of the defense process is the next wave of military evolution. This proposed system gives an exposure to design a simple robot that can be used to do multifunction in industries and defense. Manual control is also employed to control the robot from the control room which is located far away from the border area. The system uses noncommercial Zigbee standard for wireless communication since this provides access to the as-yet unpublished specifications and permission to create products for market using the specifications. Our system is aimed towards the Zigbee technology up to 30 meters distance. In future we can increase the distance up to 100m .In future, the angular movement can be used to provide a proper coverage where more than one mobile bots are used to cover an area .It can also be designed to move up and down in harsh terrain like the mines, areas of emergencies like earthquake etc where casualties have to be detected under the debris.

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