

EXPLOSIVE ORDINANCE DISPOSAL ROBOT

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Abstract - This paper presents the wireless bomb disposal robot which will help to improve defence of our nation from terrorist, suicide bombers and other such activities. Wireless control of robots is becoming popular and so are mobile handsets. In this paper we describe the control of a robot using an Android mobile. We use Bluetooth as the wireless interface between the mobile and the robot. The robot that we have designed is guided by controls that take input from a human and perform certain actions based on these inputs. We have designed it in certain way that it can serve the purpose of an explosive detection kit or device keeping in focus certain constituents that the explosive is made up of. The central idea behind this robot is to provide a line of defence to a bomb disposal squad against the life-threatening risk, faced by them in the event of an explosion. It provides the squad a safe distance to dispose a bomb, which he normally has to do with his bare hands.

Key Words: Android Mobile, Bluetooth module, DC motor, Detection sensors, Android application, Wi-Fi Camera.

1. INTRODUCTION

The word robot was derived from Czech word robata which means "a forced labourer" then later a well-known Russian science fiction writer Isaac Asimov coined the word robotics. From there on various developments are being successfully done till date in the field of robotics in the form of manipulators, humanoids, micro robots etc. as the trend of the industry is moving from the current state of automation to robotization. Thus, the robot technology is advancing rapidly. The robot that we have made is a command control robot which takes the input from the user and performs the required action. We have used sensors that can detect certain constituents of the explosive so that a separate detection device is not required. We have also used a Wi-Fi based wireless camera for visual feedback. Thus, we have designed this robot as an assistant to the bomb disposal squads.

1.1 Goals

The main goal of the project is to provide safety to the bomb disposal squad by providing an extra line of defence.

1.2 Objectives

- Provide a user-friendly android monitoring and controlling application for analysis of a suspicious packet (or bomb).

- Allow the user to manipulate the packet using the robotic arm.
- To provide visual feedback from the site of the packet.
- To provide an on-board detection mechanism.

2. BLOCK DIAGRAM

The fig above shows the block diagram of our system. It consists of a microcontroller AVR ATMEGA 16 which is the brain of our robot, A 12V Battery is used and 7805 IC is used for voltage regulation. A 16x2 LCD display is present on board and we have used L293D motor driver IC for the control of the DC motors of the robotic arm. We have used L2938 module for the control of the DC motors at the base of the robot. Detection sensors based on the detection of two parameters are used for the detection of explosives. A wireless Wi-Fi based camera is used for visual feedback and two android handsets are used out of which one provides video feedback and other has the robot controlling application.

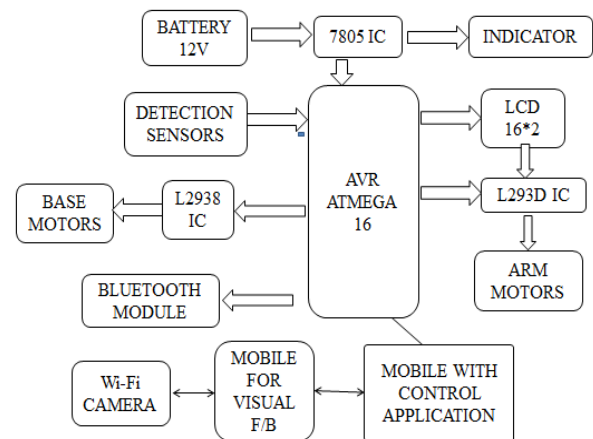


Fig.1. Block Diagram

3. HARDWARE REQUIREMENT

A. ATMEGA 16:



Fig.2. ATMEGA 16 IC

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz. ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively. ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD. ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16

B. HC05 Bluetooth Sensor

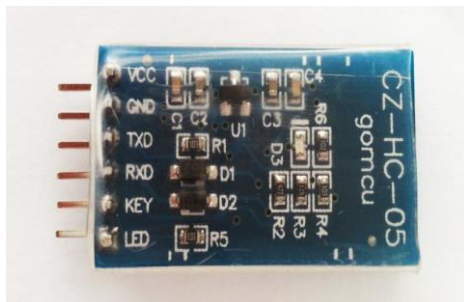


Fig.3. HC05 Bluetooth sensor

HC-05 Bluetooth Module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Its communication is via serial communication which makes an easy way to interface with controller or PC. HC-05 Bluetooth module provides switching mode between master and slave mode which means it able to use neither receiving nor transmitting data.

Specification:

- Model: HC-05
- Input Voltage: DC 5V
- Communication Method: Serial Communication
- Master and slave mode can be switched

It has 5 pins:

- 1) VCC- 5V OR 3.3V.
- 2) GND – Ground.
- 3) TXD- Transmission.
- 4) RXD- Reception.
- 5) KEY- Command/ Data mode.

C. 7805 IC



Fig.4.7805 IC

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink. Its specifications are as follows:

Input voltage range- 7V to 35V

Current Rating-1A

Output Voltage range- V(max)= 5.2V and V (min)= 4.8V

D. L293D IC

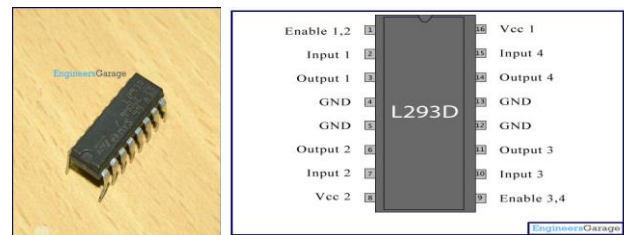


Fig.5. L292D IC with Pin description

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

E. L298 Module



Fig.6. L298 Module

This motor driver module uses the popular L298N integrated circuit, which contains two H-bridges, capable of currents up to 2 A each. This module can be controlled by standard TTL logic and it works with a wide range of input voltages, making it ideal for robots and other high-power projects. This module is capable to drive 2 DC motors independently or a single 4 phase stepper motor. Its features are as follows:

- Motor power supply: 6V to 35V DC
- Output current: up to 2 A each channel
- Control logic: standard TTL logic levels
- Logic supply voltage: 5V to 7V (the module contains a 5V regulator).

F. DC Motors



Fig.7. 12V DC motors

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. We have used 4 DC motors for the Base of the robot which are of 10 rpm each and also, we have used 2 DC motors for the arm of the robot which are of 10 rpm and 300 rpm respectively.

G. LCD Display



Fig.8. LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module. In this paper, 16x2 LCD display is used which is very basic module and is very commonly used in various devices and circuits. LCDs are economical easily programmable and have no limitation of displaying. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting

the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

H. Detection Sensors



Fig.9. MQ2 Gas detection sensors

Gas Detection Sensor: MQ2 Sensor

Sensitive material of MQ-2 gas sensor is SnO₂, which with lower conductivity in clean air. When the target combustible gas exists, the sensor's conductivity is more higher along with the gas concentration rising. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.

Sensing Resistance: 3KΩ-30KΩ (1000ppm iso-butane)

Concentration Slope rate: ≤0.6

Standard Detecting Condition

Temp: 20°C ± 2°C Vc: 5V ± 0.1

Humidity: 65% ± 5% V: 5V ± 0.1

Metal Detection Sensor: Inductive Proximity Sensor

A proximity sensor detects the approach of an object without making a contact. There are three types of proximity sensors: 1) High-frequency oscillation type using electromagnetic induction 2) Magnetic type using magnetism 3) Electrostatic capacity type which senses the changes in the electrostatic capacity between the sensing object and the sensor. Its features are:

- 1) Non-Contact Detection
- 2) Usable in severe environment
- 3) Only metal detection
- 4) High precision
- 5) Short response time
- 6) Long life.

It can detect metals like iron and its alloys, aluminum, steel, brass, copper etc. and the range is 3mm-4.5mm.



Fig.10. Inductive Proximity Sensor

I. Power Supply

We are using a 12V DC battery as the main power supply. However, the components such as the Bluetooth sensor, microcontroller etc. need a 5V supply and the other need 2-3V of supply.

J. Wi-Fi Based Camera



Fig.11. Wi-Fi Smartnet Camera

We have used a Wi-Fi based camera to get the live visual feedback from the site of operation on the android handset also the camera is capable of recording the video which can be of great help in spying purpose too.

4. SOFTWARE REQUIREMET

The soft wares that we have used are as follows:

- AVR Studio Version 4:** AVR Studio 4 is the Integrated Development Environment (IDE) for developing 8-bit AVR applications in Windows NT/2000/XP/Vista/7 environments.

AVR Studio provides you with an integrated Assembler, integrated Simulator. It also integrates with GCC compiler plug-in, adds support for all Atmel tools that support the 8-bit AVR architecture, including the AVR ONE!, JTAGICE mkI, JTAGICE mkII, AVR Dragon, AVRISP, AVR ISPMkII, AVR Butterfly, STK500 and STK600
- Kiel µvision Version 4:** It is a software used to create a Hex File using C language code or Assembly language code.
- Progisp Version 1.72:** It is a software used to load the Hex File created using Kiel µvision onto the target chip.

We are using a Bluetooth Application for controlling the robot which is installed in the android handset the application that we are using is called BlueSPP

5. SYSTEM OVERVIEW

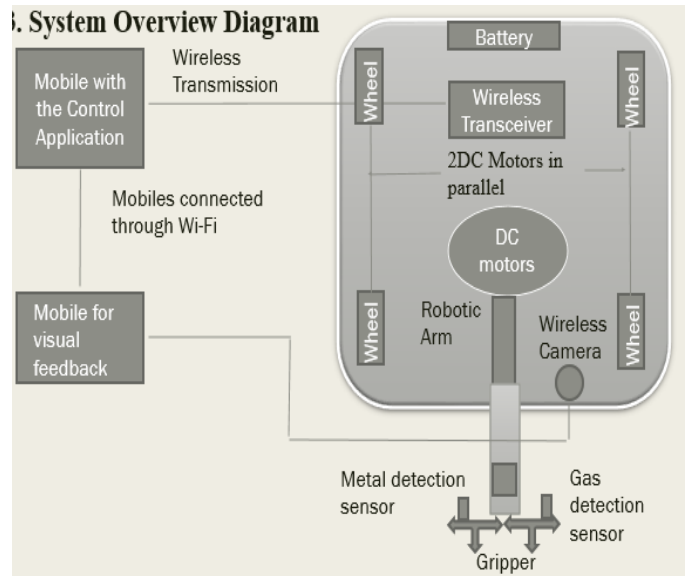


Fig.12. System Overview Diagram

The fig above shows the overview of our system. The base is rectangular and has 4 wheels which have 4DC motors that drive them. The 2 motors on left hand side are connected in parallel and same is done on the right-hand side. These 4 base motors are of 10rpm each. For the arm we have used 2 DC motors of 10 rpm and 300 rpm. The metal and gas detection sensors are attached on the gripper and a Wi-Fi based camera is installed on the base which is powered by a power bank. Wireless transceiver is a Bluetooth sensor HC05 controlled using Android application. The architectural flow diagram of the system is shown in the fig below.

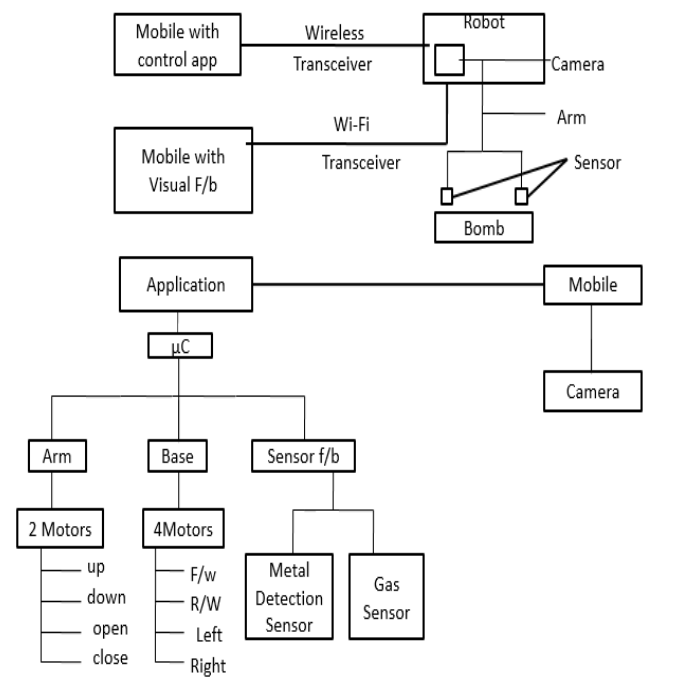


Fig.13. Architectural flow diagram

6. DESIGNING STEPS & WORKING

1. **Designing:** The steps involved in designing the overall system is shown as below:

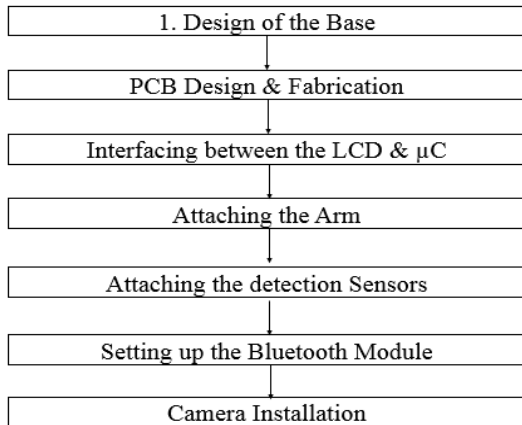


Fig.14. Designing Steps

2. **Working:** When the robot reaches the bomb site it first analyses the suspicious packet. The sensors attached on the gripper of the robotic arm detect whether an explosive is present or not. Whenever an explosive is detected the sensors give signal to the buzzer and it blows. This signal can be viewed through camera and further action towards disposing the explosive can be taken. The working is shown in the fig below.

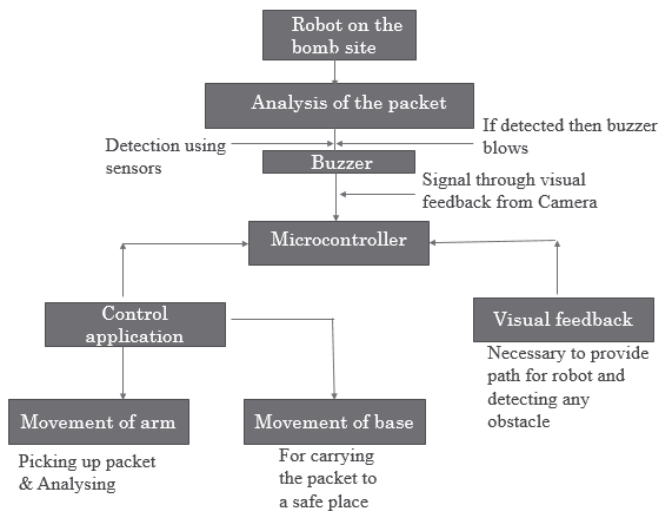


Fig.15. Working

7. RESULT

In this way, we have implemented a robotic bomb disposal system wireless controlled by an android device. We have controlled the various movements of robot as well as bomb disposal system by sending different commands from android device through Bluetooth model. We have used

metal detection and gas detection sensors considering in mind the detection of those explosives that are made up of typical gases or those which give out or release some gases as well as those explosives which use ferrous metals in packaging or are made up of metals such as iron, copper etc. The results can be seen in Fig.



Fig.16. Robotic Arm



Fig.17. Base of the robot

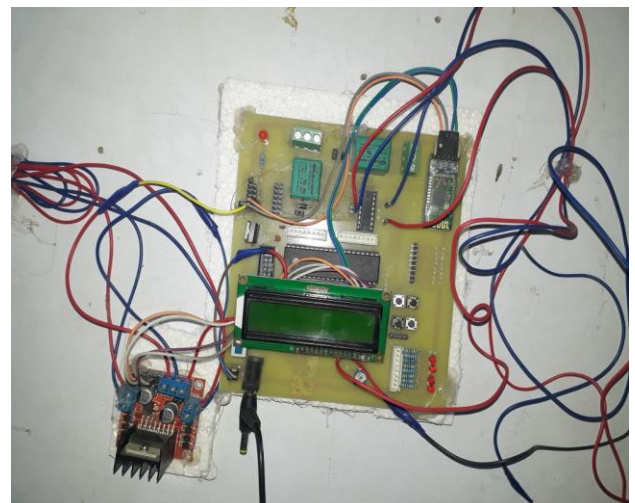


Fig.18. PCB on board



Fig.19. Complete view of the EOD

8. CONCLUSION

The Wireless Bomb Disposal Robot has been designed in such a way that it can cater to the needs of the bomb disposal squad, the military, the police and also for the personnel who handle radioactive materials. It has countless applications and can be used in different environments and scenarios. For instance, at one place it can be used by the bomb disposal squad, while at another instance it can be used for handling mines. While another application is to provide up to date information in a hostage situation. The major advantages of this robot are:

- It can be altered to suit the needs of the user
- It can be controlled remotely.
- It has video feedback.
- It has its own power supply.
- It has a detection mechanism using sensor hence no need of separate detection mechanism.

9. ACKNOWLEDGEMENT

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10. APPLICATIONS

We will design it as an assistant robot to the bomb disposal squad but there are several other applications of this robot. It can be used by:

- Police: In hostage situations
- Military: For reconnaissance missions
- Fire Fighters: To provide video feedback of the site for further analysis.
- Nuclear fighters: For handling hazardous or radioactive materials.

11. FUTURE SCOPE

The system that we have built is a working prototype of a robot, which should be compact, fast and accurate. This prototype may not have the features and reliability of the original design. It is only being developed to ensure that the design is feasible, not impractical and can be implemented on a much larger scale in a more efficient way.

Hence the future enhancements may include a much smaller, faster, and more reliable machine. It may have the ability to handle a much wider range of objects and the ability to manoeuvre them to much safer places. Some of these enhancements are described below.

- Compact Design
- Quick Movement
- Improved Reliability
- Removable Gripper/Multi-Gripper Robotic Arm
- Artificial Intelligence
- Night Vision Camera

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