Android based Robotic Fire Alert System to Save Fire Victims

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Abstract — A Robotic systems that interact among themselves and the environment in which it works. In robotics, end effecters are the devices at the end of a robotic arm, is designed to interact with the environment. Gripper is an end effecter or tool to grasp any object. In this work we are going to build a fire alert system to save fire victims using Arduino microcontroller (Atmega328), which will save the victims in fire accidents. In this work the wireless connectivity is through Bluetooth modem and controlling through android application by particular commands, which then allows the Arduino to determine the position of DC motors. The fire victims are sense through PIR sensor and then information will be passes via bluetooth to android application. The robot would be controlled by the rescue team to save the fire victims. The sensitive information into text as transmitter and receiver will be perform many other functions using certain commands programmed in the arduino (Atmega328). This work can be very useful for industries, defence, surgical purposes and so on so forth.

Keywords— Arduino UNO R3 (Atmega328), Bluetooth, DC Motors. Fire Sensor, KEIL Compiler, L293D, PIR, Robotic Arm, Sensor.

I. INTRODUCTION

Robotics is one of the fastest growing engineering fields of today to work in unreachable environment. With such device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire. The design of a wireless controlled robot which can perform actions intelligently by itself. Mobile robots are used in mining, military, forestry, security, etc. Robot technology can be very efficiently used in such cases to rescue much more fire victims. In this work we have two ends, namely, Transmitter end and Receiver end. On receiver end, there is a vehicle, it has Arduino Atmega328 which is interfaced with input and output devices, used to control vehicle. On the transmitter end, there is an android phone with android application, wireless signals are sent to transmitter side via Bluetooth module by android phone to control vehicle. Mobile robot control is done through mobile OS. The arm is placed on a moving vehicle and through different commands the robot is able to move in all directions. This vehicle uses four servo motors for the operation. It has arm assembly with a jaw. One servo motor allows the robotic arm to grab the object and other one allows the movement in upward and downward direction. The other two servo motors are to be attached with the robotic arm base that gives an advantage to move the base in forward and backward direction. Arduino acts as an interface to the Motors, Bluetooth modem and Android mobile which has a Bluetooth application present in the mobile. This system has 10 independent commands for the gripper to open and close, elbow upward and downward, base clockwise and counters clockwise, base forward and backward directions left, right forward and backward by arduino application.

II. LITERATURE SURVEY

With the invention of such device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire[1]. The design of a wireless controlled robot from a distance or which can perform actions intelligently by itself, which will reduce the risk of this task of fire fighting. Mobile robots are used in mining, military, forestry, security, etc. Robot technology can be very efficiently used in such cases to rescue much more victims [2]. In present fire fighting system, fire fighters have to fight against fire from very closer technical persons had worked on it to improve it. They have used different techniques to implement this. Before deciding our method to implement innovative fire extinguishing vehicle, we have studied many research papers regarding to our topic. This work includes different methods for the purpose of fire fighting [3]. There are sensors connected on each and every side of vehicle to detect flame and according to that the vehicle navigates towards fire to extinguish it. But this method gives delayed output so takes more time to fulfil the task and has less accuracy [4]. The Idea about the Android software “Blue control” and its application in controlling Robotics is described in the Google play store website. From all these we find a different controlling technique using android device and software with a different approach for soft catching arm (electronic pressure sensor) [5]. The robotic vehicle is designed with a soft catching gripper that can be controlled by android OS based smart phone available in the market for remote operation[6]. The android application device transmitter will acts as a remote control while the receiver end Bluetooth device is fed to the microcontroller to drive DC motors via motor driver IC for necessary work. Remote operation is achieved by any Smart phone with Android OS, upon a GUI (Graphical User Interface) based touch screen operation. Users friendly and inexpensive in price are some of the advantages of Bluetooth technology used in controlling the robotic vehicle. Therefore controlling the robotic vehicle by smart phone will come true [7].

III. ROBOTIC SYSTEM DESIGN

The Functional block diagram of proposed system is as shown in Fig.1, the hardware components are Atmega 328 microcontroller, PIR sensor, DC motor, and power supply.

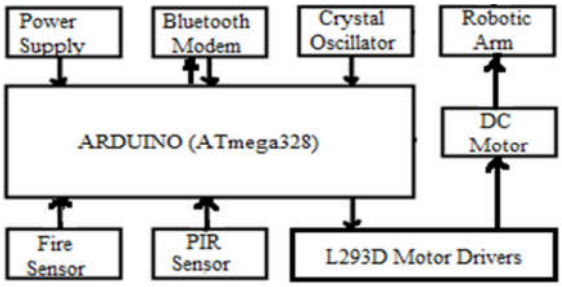

Fig. 1 Functional Block diagram

The main scope of work is to send commands from one android phone to be received by Bluetooth module mounted on the robot. The controller also connected to the Bluetooth module, which sends information to rescue person about the dangerous area where robot is running. It can send the required information in the form of text to the rescue team. The required power is of 13 Ah battery with voltage of 12 V.

A. Bluetooth Modem

Bluetooth serial communication module has two work modes, order-response work mode and automatic connection work mode. And there are three work roles (Master, Slave and Loopback) at the automatic connection work mode. When the module is at the automatic connection work mode, it will follow the default way set lastly to transmit the data automatically as shown in Fig. 2. When the module is at the order-response work mode, user can send the AT command to set the control parameters and send control order, specification is as shown in Table II.

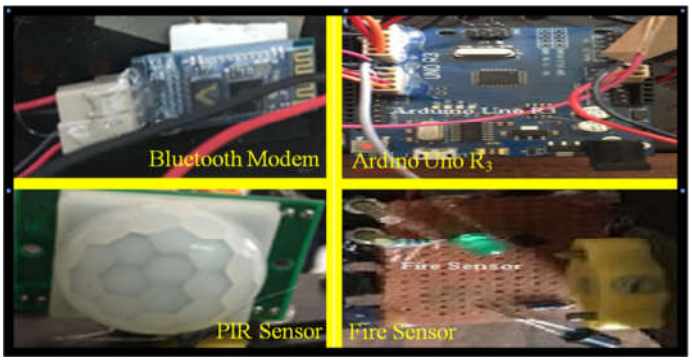

Fig. 2 Bluetooth Modem with Ardino Uno and sensors

B. Arduino UNO R3

The Arduino Uno is a microcontroller board based on the ATmega328. As shown in Fig. 2. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller, As shown in Fig. 3. Simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started, the detail specification is shown in Table II.

C. PIR sensor

The detected radiations are converted into an electrical charge, which is proportional to the detected level of the radiation as shown in Fig 2. Then this charge is further improved by a built in FET and fed to the output pin of the device which becomes applicable to an external circuit for further triggering and amplification of the alarm stages.

D. Fire sensor

A flame sensor module, that consists of a flame sensor (IR receiver), resistor, capacitor, potentiometer, and comparator LM393 as shown in Fig. 2. It can detect infrared light with a wavelength ranging from 700nm to 1000nm.The far-infrared flame probe converts the light detected in the form of infrared light into current changes. Sensitivity is adjusted through the onboard variable resistor with a detection angle of 60^{o} degrees. Working voltage is between 3.3v and 5.2v DC, with a digital output to indicate the presence of a signal. Sensing is conditioned by an LM393 comparator.

E. Wrist and End effectors

It has a spur gear meshing with a worm gear with a 12V stepper motor and two end effectors out of which one is fixed and another is movable, as shown in Fig. 3.

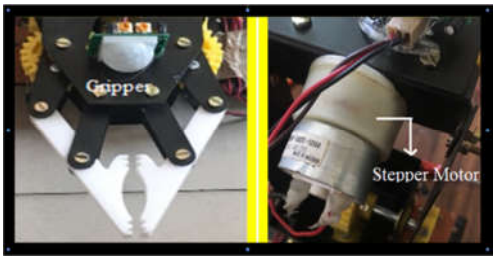

Fig. 3 Wrist and end effectors with Stepper Motor

F. Motors

There are two magnetic fields produced in the motor as shown in Fig.3. One magnetic field is produced by the permanent magnets and the other magnetic field is produced by the electrical current flowing in the motor windings. These two fields result in a torque which tends to rotate the rotor. As the rotor turns, the current in the windings is commutated to produce a continuous

Table II
COMPONENTS SPECIFICATION

Components	Specifications	
Bluetooth	Frequency Modulation Sensitivity Speed Asynchronous Synchronous Power supply Working temperature Dimension	v2.0+EDR 2.4GHz ISM band Less than 4 dBm, Less than to84 dBm 2.1Mbps(Max) 1Mbps/1Mbps +3.3VDC 50mA 20 ~ + 75° Centigrade 26.9mm x 13mm x 2.2 mm
Arduino	Microcontroller Operating Voltage Input Voltage Digital I/O Pins Analog Input Pins DC Current per I/O Pin Flash Memory SRAM EEPROM Clock Speed	ATmega328 5V 7-12V 14 6 40 mA 32 KB of which 0.5 KB 2 KB (ATmega328) 1 KB (ATmega328) 16 MHz
PIR Sensor	Size Output Sensitivity range Power supply	Rectangular 3V up to 20 feet (6m) 110° x 70° range 5V-12V input voltage
Fire Sensor	Wavelength Temperature Voltage	700nm to 1000nm 60 degrees 3.3v and 5.2v
Arm Manipulator	Weight Length	30×2=60 gm for big arm 10×2=20 gm for small arm 25 cm for big arm 5cm for small arm 2.33
Motors	Step angle Speed Voltage Supply current	1.8degrees 100 rpm 9 V 0.5 A DC
Shaft	Diameter of shaft Length of shaft Bearing type	15 cm 28 cm Ball bearing

G. Robotic system of gripper links

The object to be lifted is by Metal Plates and weight of the object is 50-80gm the link has two parts, Part1 and Part2. The Arm manipulator has length as Part1 = 25 cm and Part 2 = 5 cm. Therefore, the ratio of the length of the two links is Link1: Link 2 = 5: 1. Design Length of shaft = 24mm, Torque (T) = 42 N-m and Tangential force on gear = $\frac{2T}{D}$, Where, (D) = Diameter of gear = (2x42)/0.025 = 3360 N, Twisting moment (T) = 47.18 N-m.

Normal load acts on gear teeth is,

$$\frac{Ft}{cos20} = (3360/0.937) = 3585 \text{ N} \qquad (1)$$

Maximum bending moment,

$$(M) = \frac{WL}{4} = (3585x0.025)/4 = 21.51 \text{ N-m} \quad (2)$$

Power and Torque Transmitted,

If Voltage = 220 V, Current = 0.4 A and Speed = 20 rpm, then Power transmitted = VI*P = (220*0.4) = 88 watt

Torque calculations,

$$\text{Torque} = \frac{P60}{2\pi N} = \frac{88*60}{2\pi*20} = 42 \text{ Nm} \quad (3)$$

H. Force calculation of joints

This will provide a fundamental understanding of moment arm calculations for statics and dynamics. Choose these parameters weight of each linkage weight of each joint weight of object to lift length of each linkage. This particular design has just two degree of freedom (DOF) that requires lifting, and the centre of mass of each linkage is assumed to be acting at half of the length.

Torque about Joint 1

$$M_1 = \frac{L1}{2}.W1 + L1.W4 + \left(L1 + \frac{L2}{2}\right)W2 + (L1 + L3)W3 \quad (4)$$

Torque about Joint 2

$$M_2 = \frac{L2}{2}.W2 + L3.W3 \quad (5)$$

For each DOF we add the math, gets more complicated, and the joint weights get heavier. We will also see that shorter arm lengths allow for smaller torque requirements is as shown in Fig.4. Where $W_1 = 0.5$ N, $W_2 = 0.25$ N, $W_3 = 0.25$ N, $W_4 = 0.5$ N. $L_1 = 20$ cm, $L_2 = 10$ cm, $L_3 = 15$ cm and $M_1 = 180^o$, $M_2 = 90^o$

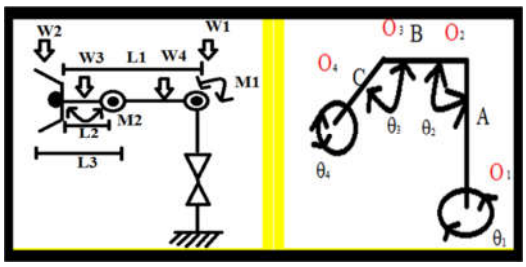

Fig. 4 Load on joints and DOF

Where, as shown in Fig. 4 has $\theta_1 = 360^o$, $\theta_2 = 270^o$, $\theta_3 = 180^o$ and $\theta_4 = 90^o$. Generally arms are described by their degree of freedom (DOF). This number typically refers to the number of single-axis rotational joints in the arm. Higher DOF indicates an increased flexibility. There are mainly 6 degrees of freedom per robotic arm. Six degrees of freedom (6DoF) refers to the freedom of movement of a rigid body in three-dimensional space.

DOF = Number of joints in robotic arm

Robotic arm is designed with two servo motors, so there are two joints in arm, can be called 2 degree of freedom. Here the arm is designed with 2 DOF, which is sufficient for this application. They are up-down, open-close. According to datasheet of servo motor stall torque is 11 kg/cm for 4.8V (operating voltage) and 13.5 kg/cm for 6V. Hence maximum load on both the motors should be 0.51kg approximately.

V. RESULTS

This android robot vehicle is designed by metal plates. The prototype design of vehicle is shown Fig.5.This vehicle is guided by operator with android phone. Wireless signals are, sent from android and are received by HC-05 Bluetooth module to the microcontroller Atmega 328. Vehicle follows commands from android, after it reaches to fire, command of program stops the vehicle and sends information of victims in fire accidents.

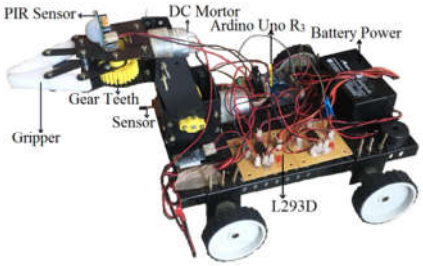

Fig. 5 Prototype Design Setup

This is the dataflow of the system. For this purpose an android application is developed and it is a snapshot of Android application as shown in Fig.11. We have implemented innovative fire alarming system to save victims in fire accidents using android and also android application is designed to control the vehicle remotely with the help of Android application and result of it is shown in Fig. 6. Use of this vehicle can save number of fire victims.

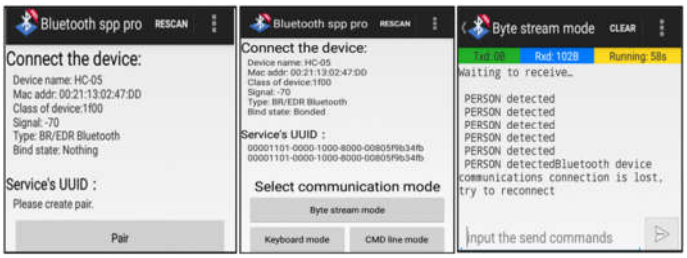

Fig. 6 Robot controlling by Bluetooth operation

This vehicle is based on android phone. But there are many other ways to control it. Other technique is self operated by using sensors, but it may result in delayed output and accuracy is also less. Hence the android control technique is superior.

Table III
ROBOTIC COMMANDS

Sr. No.	Commands	Particulars
1.	Griper Open	Gripper starts opening
2.	Griper Close	Gripper starts closing
3.	Forward	Vehicle starts moving forward
4.	Backward	Vehicle starts moving backward
5.	Left Forward	Vehicle left side wheel starts moving forward
6.	Left Backward	Vehicle left side wheel starts moving backward
7.	Right Forward	Vehicle right side wheel starts moving forward
8.	Right Backward	Vehicle right side wheel starts moving backward
9.	Elbow Upward	Robotic arm elbow starts moving upward
10.	Elbow Downward	Robotic arm elbow starts moving downward.

It starts alarming with the help of IR flame sensor and buzzer which gives alert. Also victims are saved by PIR sensor. Vehicle is controlled by android phone. The relation between input from android phone and corresponding outputs are shown in below table III. conclude that main objective of this work is to develop an embedded system based application to operate the robotic arm. It has been developed by integrating features of all the hardware components used.

VI. CONCLUSIONS

We Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Robot is protected from fire and obstacles by sensors but one can use wireless camera for this purpose.

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