War Spy Robot using Arduino Uno and HC05 Bluetooth module

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Abstract – **With the sophisticated technological advancement nowadays robotics has become a hot field for research. Robots are now used by military forces for reducing risk of their causalities and to defeat their enemies. The major focus of this project is on the use of robot in war, peace and as well as their impact on society. Here Radio Frequency modules signals are used in wireless remote-control system for transmitting and receiving wireless logic signals to control the motors and actuators of robot control system. Vision monitoring system has been added which will capture and transmit the information surrounding the robot to the operator. With this feature the robot can not only transmit real time videos with vision capabilities but cannot also be identified by the enemies in war zone. A metal detector and flame sensor has also been added which will inform us about any bomb underneath the robot vehicle. In this paper, Remote operated Warfield assistive robot is a small robot designed for assistance, sort range surveillance and inspection purpose.**

Keywords: HC-05, RPI-Camera, Arduino, Flame sensor, Metal detector, Driver ckt

I. Motivation

The Motivation is to build a Low-Cost Wireless Spy Robot all by myself to detect the explosive materials items and should not arm any soldiers or people while detecting bomb.

II. Aim

The project has been designed for developing a wireless surveillance robot for helping the soldiers during their operation, war or other situations where human life is at risk. The robot along with camera can wirelessly transmit real time video with camera controlling capabilities and also using a robotic arm anything can be picked or dropped within its limit. This kind of robot can be very useful for helping purpose in war fields. The project is also designed to search invisible metal stuffs from where people are not capable to reach and it is so designed to work in hostile environment where visible light will not be available. Basic objectives that our robot will be able to perform can be noted as follow:

1) This will capture live videos of surrounding of the robot and will transmit to operator's monitor.
2)The robot will detect hidden any metal right underneath the robot and transmit the signal to the operator's PC.

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III. Introduction

Science has brought out wondering technologies to ease human life. Robotics is one of the branches of it which has made human life easier and lessened the workload. It has also enabled us to reduce the participation of human in risky works. Nowadays robots are being used for various purpose in industries, labs, Space and also in battlefield. People are sending robots to places where man can hardly go like in space, underwater, bomb surrounded areas. Wireless communication system has become one of the essential features for commercial products and a popular research topic within the last ten years. There are now more mobile phone subscriptions than wired-line subscriptions. Lately, one area of commercial interest has been low-cost, low- powe r, and short distance wireless communication used for personal wireless networks. Technology advancements are providing smaller and more cost-effective devices for integrating computational processing, wireless communication, and a host of other functionalities.

This project's main functionality is to deal with tough situations where human beings cannot handle situations like darkness, entering narrow and small places and detecting hidden bombs etc. This system works using an RF signal through which the whole controlling of the system response is done. Using night vision camera attached to robot situations around the system is observed according which the robot is instructed to move or do other functionalities. PC receives a signal which will be obtained if there is any short of bomb or metallic weapons around the robot. well calibrated and has anti Interference ability which gives digital output signal which can be easily decoded by the microcontroller.

DESIGN METHODOLOGY

3.1 Stages

PROPOSED METHODOLOGY

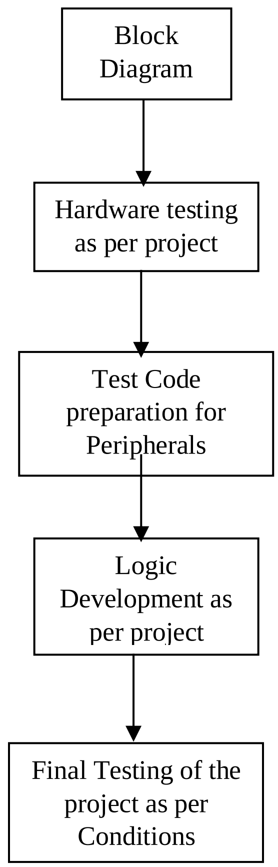

Fig 1. Design and development flow

3.2 Block diagram

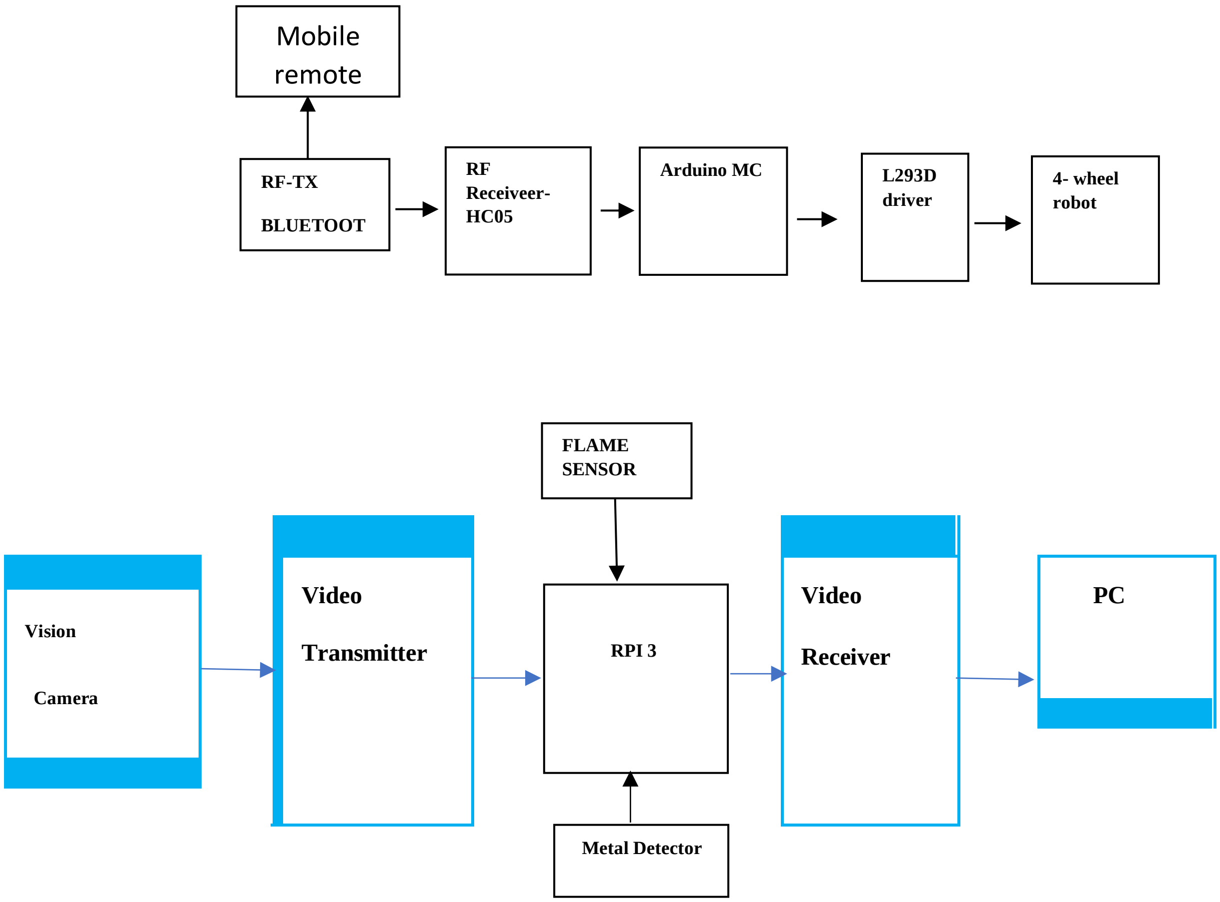

Fig 2. Block diagram of the entire system and subsystem.

Here the block diagram representation of the entire robot system is depicted from where its operating procedure can be described. The remote block represents the operator controlling section from where instructions are encoded and transmitted in form of RF logic signal which is received by the receiver HC05 and it is then decoded and delivered to the brain block of the robot which is the microcontroller module. This microcontroller is then programmed according to the instructor's demand. The microcontroller block is connected to motor drivers block which means the motors and actuators are controlled by the microcontroller commands through motor drivers.

Another subsystem block is the metal detector block and Flame sensor which is connected to RPI 3 module which means when the metal detector and flame sensor gets a signal then it sends it to microcontroller and then to where it sent to the operator's PC.and the last subsystem in the diagram is the wireless video transmitter module which will capture images around the robot and its internal transmitter RPI3 will transmit them to the receiving monitor section.

Hardware Design of the System

1 Arduino UNO R3 Microcontroller

In the project we have used Arduino UNO microcontroller. It can be termed as the brain of our project. The reason for selecting this device is its reliability and availability. In addition to all the features of the previous board, the Uno now uses an ATmega16U2 instead of the 8U2 found on the Uno (or the FTDI found on previous generations). This allows for faster transfer rates and more memory. No drivers needed for Linux or Mac (info file for Windows is needed and included in the Arduino IDE), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc.

1.1 Pin description:

The Arduino Uno [15] is based on the ATmega328 (datasheet) having 14 digital input/output pins (6 of them can be used as PWM out), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The pins which we used are described below,

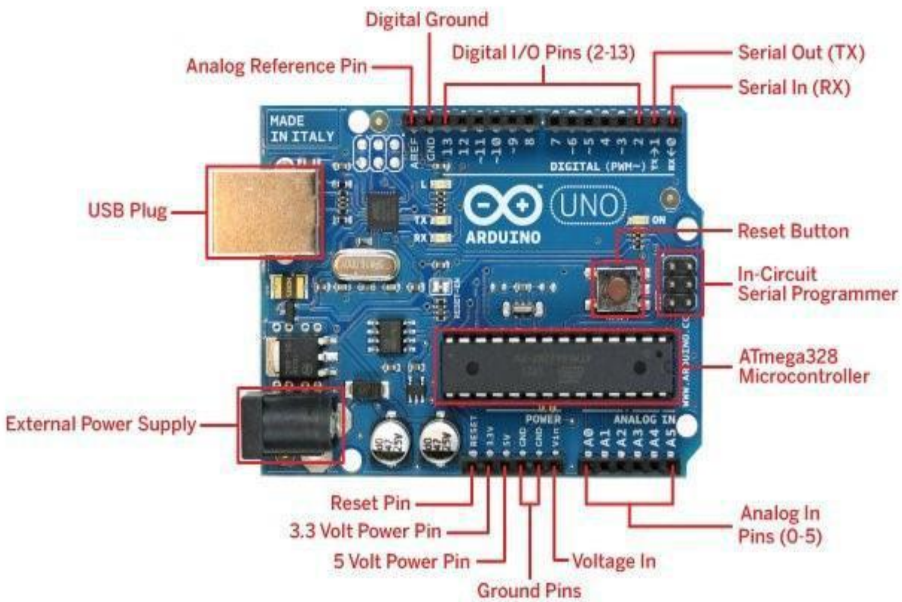

Fig 3. Arduino UNO R3

1.2 Pin connection:

Dgital Pin 4, 5,6,7, are connected to the motor driver of the base controlling motor for controlling the motion of the robot vehicle.
Metal detector is connected to Analog pin A0.
Pin 0 is connected to the TXD pin of the HC05 RXD module.
Pin 1 is connected to the RXD pin of the HC05 TXD module.
Pin 9 is connected to the ENA of l298N.
Pin 10 is connected to a ENB of L298N.

2. Raspberry pi 3

Raspberry Pi 3 with a 1.2 GHz 64-bit quad core processor, on-board 802.11n Wi-Fi, Bluetooth and USB boot capabilities. On Pi Day 2018 the Raspberry Pi 3 Model B+ was launched with a faster 1.4 GHz processor and a three-times faster gigabit Ethernet (throughput limited to ca. 300 Mbit/s by the internal USB 2.0 connection) or 2.4 / 5 GHz dual-band 802.11ac Wi-Fi (100 Mbit/s). Other features are Power over Ethernet (PoE), USB boot and network boot. It is used to live streaming video to operators window. Here in my project I connected Indicators LED and Buzzer to the GPIO pins 7 & 5 respectively. Also two sensors are connected to GPIO pins of 3 &11 respectively.

3 DC Motor

DC Motor is such an electromechanical device where electrical energy (voltage or power source) is converted into mechanical energy (produces rotational motion). They run on direct current. The Dc motor works on the principle of Lorentz force which states that "when a wire carrying current is placed in a region having magnetic field, than the wire experiences a force". This Lorentz force provides a torque to the coil to rotate. In this project we have used DC gear motor. DC gear motor is nothing but an extension of DC motor where DC Motor has a gear assembly attached to it. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. Here geared DC motor is used for some specific reasons which are,

- The gear assembly helps us in increasing the torque and reducing the speed.
- This readymade assembly reduces the complexity and cost of designing.
- Gear motors allow the user of economical low-horsepower motors to provide great motive force at low speed such as in lifts, winches, medical tables, jacks and robotics.

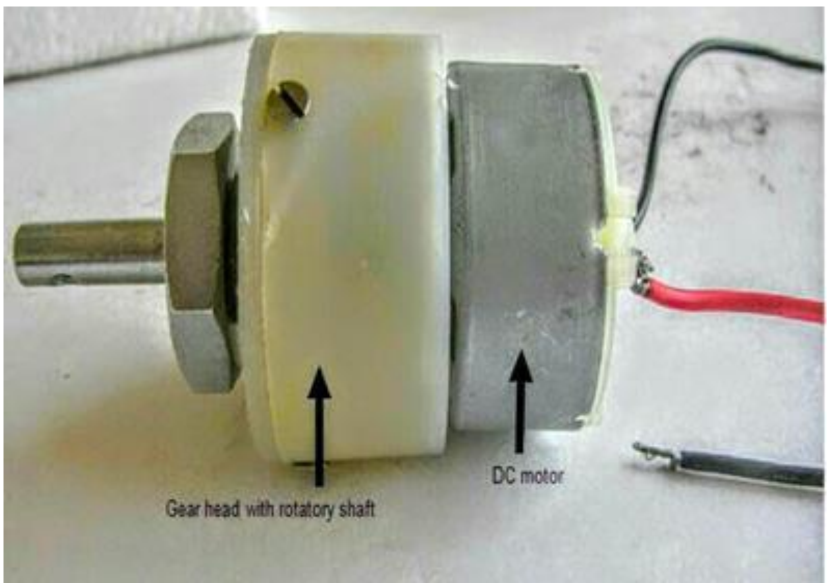

Fig 4. DC motor

4 Flame sensor

A furnace flame sensor works by detecting the presence of a flame within the furnace. The sensor is a short length of thin metallic rod that creates a small current of electricity in order to confirm there is fire burning within the furnaces .It has three pins which are VCC, GND and A0 which are connected to RPI3 3.3V(Pin 1) , GND (Pin 6)

5 Motor Driver (L298N)

Motor Driver IC [19] is a bipolar module which allows DC motor to drive on either direction. Here L298N H-bridge Dual Motor Controller Module is used.

Specifications

- This allows us to control the speed and direction of two DC motors.
- Can control one bipolar stepper motor with ease.
- The module can be used with motors that have a voltage of between 5 and 35V DC.

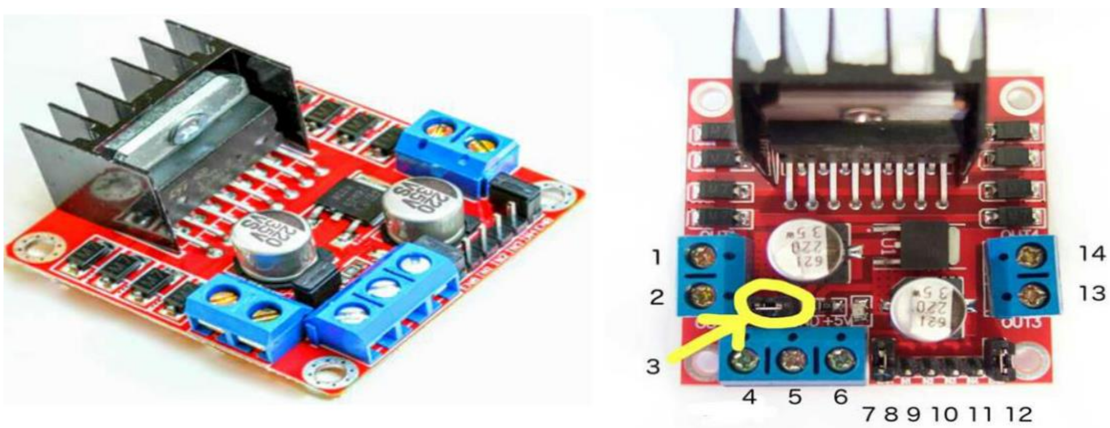

Fig 5. Motor Driver L298N

6 HC-05 Bluetooth module

The robot is controlled by Android smart mobile by using Bluetooth technology. For this purpose we use Bluetooth module HC-05. This module is used for controlling and connect to any electronic circuit to Bluetooth. This module also have Rx,Tx pins for receiving and transmitting data. This Rx,Tx pins are given Tx,Rx of Arduino. For operating this we have to apply +5V DC supply. This supply is taken from Arduino board.

Pin Description

- Pin TXD is connected to Arduino Pin 0.
- Pin RXD in connected to Arduino Pin 1.

7 Metal Detector Module

Metal detector is an electronic instrument which can detect metals nearby. It works by producing electromagnet around itself. The circuit of a metal detector consists of an oscillating circuit which induces an alternating magnetic field around it. It has 3 pins where VCC , GND and D0 where it is connected to RPI3 of GPIO 11, VCC and GND respectively.

8 Camera

The robot is equipped with a wireless camera, which is very effective when the robot will be far from the operator but as the name suggests it has to operate like spy.

9 Android Application

Android is a very familiar word in today's world. Millions of devices are running on Android OS and millions are being developed every day. App Inventor is an application originally provided by Google and now maintained by the Massachusetts Institute of Technology (MIT). It allows anyone to create software applications for the Android Operating System (OS). It uses a graphical interface that allows users to create an application.

The first phase of application design goes through the App Inventor Designer, which is accessible through the web page. The left side of the window consists of ingredients like a screen, buttons, text boxes, images, labels and many more and the right side of the designer allows users to view the screen and components added to the screen.

In this app development, the App Inventor provides a versatile opportunity to develop a customized application that starts with establishing a Bluetooth connection by searching the available Bluetooth devices and make pair with them. For robotic movement, a character is assigned for each operation such as Forward-"F", Backward-"R", Left-"TL", Right-"TR" and to Stop-"n"

Fig 6. Interface of app screen and App building blocks

Software Design of the System

1) I have used Arduino IDE which is Integrated Development Environment provided by the Arduino.cc company itself for developing software and flashed the software directly to the microcontroller board via USB. It also supports open-source libraries and no extra piece of hardware is required for flashing.

Code to control the robot:

```
#include <SoftwareSerial.h>

#define enA 9

#define in1 4

#define in2 5

#define enB 10

#define in3 6

#define in4 7


int turn = 100;

int motorSpeedA = 10;

int motorSpeedB = 10;

int motorSpeed = 150;



void setup() {

 Serial.begin(9600);

 Serial.flush();

 pinMode(enA, OUTPUT);

 pinMode(enB, OUTPUT);

 pinMode(in1, OUTPUT);

 pinMode(in2, OUTPUT);

 pinMode(in3, OUTPUT);

 pinMode(in4, OUTPUT);

}



 void loop() {

  String input = "";

  while (Serial.available()) {

   input += (char)Serial.read();

   delay(5);
```

```
  }

  if (input == "n") {
   stp();
  }
  else if (input == "F") {
   fwd();
  }
  else if (input == "R") {
   rev();
  }
  else if (input.indexOf("TL") > -1) {
   lft();
  }
  else if (input.indexOf("TR") > -1) {
   rght();

  }
  else if (input != "") {
   motorSpeed = input.toInt();
  }
 }
void fwd(){
  analogWrite(enA, motorSpeed);
  analogWrite(enB, motorSpeed);
  // Set Motor A forwarward
  digitalWrite(in1, HIGH);
  digitalWrite(in2, LOW);
  // Set Motor B forward
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  // Convert the declining Y-axis readings for going backward from 470 to 0 into 0 to 255 value for the PWM signal for increasing the
motor speed

 }
 void rev(){
  analogWrite(enA, motorSpeed);
  analogWrite(enB, motorSpeed);
  // Set Motor A backward
  digitalWrite(in1, LOW);
```

```
  digitalWrite(in2, HIGH);

  // Set Motor B backward

  digitalWrite(in3, LOW);

  digitalWrite(in4, HIGH);

  // Convert the declining Y-axis readings for going backward from 470 to 0 into 0 to 255 value for the PWM signal for increasing the motor speed


 }


  void lft(){

  analogWrite(enA, motorSpeed - turn);

  analogWrite(enB, motorSpeed + turn);

  // Set Motor A left

  digitalWrite(in1, LOW);

  digitalWrite(in2, HIGH);

  // Set Motor B left

  digitalWrite(in3, HIGH);

  digitalWrite(in4, LOW);

  }


 void rght() {

  analogWrite(enA, motorSpeed + turn);

  analogWrite(enB, motorSpeed - turn);

  // Set Motor A backward

  digitalWrite(in1, HIGH);

  digitalWrite(in2, LOW);

  // Set Motor B backward

  digitalWrite(in3, LOW);

  digitalWrite(in4, HIGH);

 }

 void stp() {

  analogWrite(enA, 0);

  analogWrite(enB, 0);

  // Set Motor A backward

  digitalWrite(in1, HIGH);

  digitalWrite(in2, HIGH);

  // Set Motor B backward

  digitalWrite(in3, HIGH);

  digitalWrite(in4, HIGH);

 }
```

2) I have used python code for transmitting signals from sensors to operators monitor . I have used inbuild camera function (motion monitor) to use as spy camera.

Code to transmit the sensor signal:

```
import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BOARD)
GPIO.setwarnings(False)

flamesensor=3
gassensor=11
buzzer=5
led=7

GPIO.setup(flamesensor,GPIO.IN)
GPIO.setup(gassensor,GPIO.IN)
GPIO.setup(led,GPIO.OUT)
GPIO.setup(buzzer,GPIO.OUT)
GPIO.setup(flamesensor,GPIO.IN,GPIO.PUD_DOWN)
GPIO.setup(gassensor,GPIO.IN,GPIO.PUD_DOWN)
while 1:
        state=GPIO.input(3)
        states=GPIO.input(11)
        time.sleep(0.1)
        if(state == 1):
                GPIO.output(buzzer,0)
                GPIO.output(led,0)
                time.sleep(0.1)
        elif(state == 0):
            GPIO.output(buzzer,1)
        GPIO.output(led,1)
      print('Fire alert.... Hurry up ')
        #print('calm down no Fire found yet')
        time.sleep(0.1)
        if(states == 1):
      GPIO.output(buzzer,1)
      GPIO.output(led,1)
      print('metal bomb  found.. Hurry up ')
      time.sleep(0.1)
   elif(states == 0):
      GPIO.output(buzzer,0)
      GPIO.output(led,0)
      #print('nuclears or explosive material found...')
      time.sleep(0.1)
```

APPLICATION AND LIMITATIONS

1. Application:

Military usage of remotely controlled vehicles dates back to the first half of 20th century. Soviet red Army used remotely controlled tele tanks during 1930s in the winter war and early stages of world war 2.There were also remotely controlled cutters and experimental remotely controlled planed in the Red Army.

Remote controlled vehicles are used in law enforcement anti-military engagement for some of the same reasons. The exposure of hazards are mitigated to the person who operates the vehicles from a location of relative safety. Remote controlled vehicles are used by many Police Department bomb squads to defuse and detonate explosives.

2. Limitations

1) It works with a limited RF signal range of 8 meter. Testing at distance of 10m our robot stopped.

2) For zigzag wheels DC motor draw more power than ordinary DC motor, so our battery needs maintenance and recharging after a certain time

3) It needs a person to operate the robot every time.

4) RF signal can be jammed by other signals.

3. Future scope

1) Further, we can use single board to optimize the power consumption.

2) Using Actuators we can use it as bomb detachable robot with another Driver circuit

3) Using Water pump we can pour water on fire.

4) Further, we can use more sensors to detect explosive material accurately.

5) Further we can work on improvisation of range to communicate between robot & operators PC.

RESULT AND DISCUSSION

1. Working of the Entire system

In the robot initially it when it is switched on in different sections of the base it awaits for the signal from the transmitter remote section. Initial startup of the robot vehicle energizes up the metal detector's coil which produces a magnetic field around it. When this magnetic field is cut by any metallic conductor then it sends a signal to the microprocessor which then initializes the RPI module. With the help of RPI module and a network system it sends a message to the operator's PC.

According to the instructions received by the receiver the microprocessor initializes farther step which was programmed and uploaded before. When the operator presses any buttons on the base controlling remote it activates the motor driver and hence the two dc motors which controls the motion of the robot vehicle.

By activating the camera and monitoring system live view is seen and according to which the robot vehicle is driven.

2. Result

My project worked perfectly during our experimental operation though sometime it behaves slow error due to wave distortion via different noise signal. I have tested some experiments to determine the working capacity and efficiency of the robot. I have been able to view the things accurately that are currently happening in the surrounding area. My design has not caused any sort of disturbances. The robot worked smoothly according to the command we sent from the remote section unit. I have shown the view of the area around the robot by camera. By keeping the circuit easy and simple, most users will be able to use it easily. Thus we should be able to manipulate its path when necessary, to create the robot safely.

3. Conclusion

A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety tasks. Here I have designed such a multi-tasking robot reducing the drawbacks of the previous works which will provide short distance surveillance to our soldiers in hostage situations.

Conventionally, spy robots are implemented with nominal cameras which wirelessly transmit them to the monitor. Moreover a metal detector and flame sensor are added to which will provide the soldiers information about the dangers and situations in the hostage situation.

Final model and working pictures

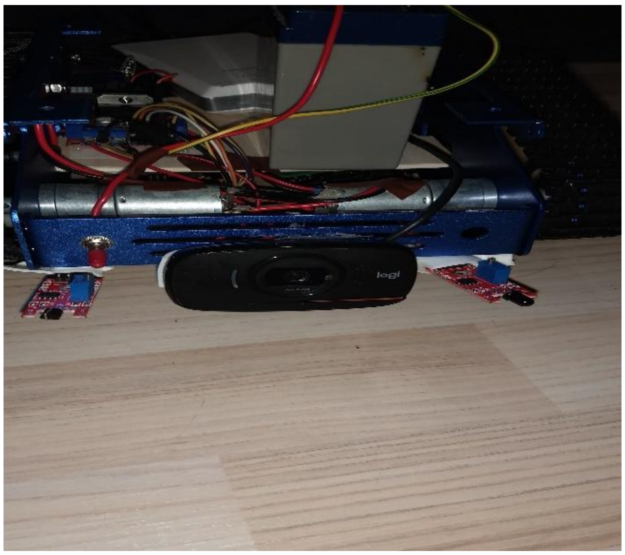

Fig 7. Top view of the project model robot

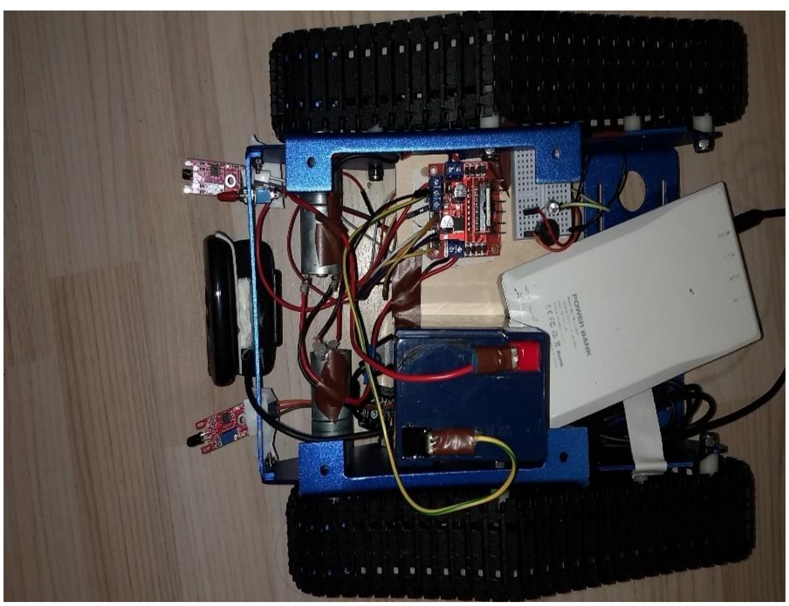

Fig 8. Top view of the project model robot

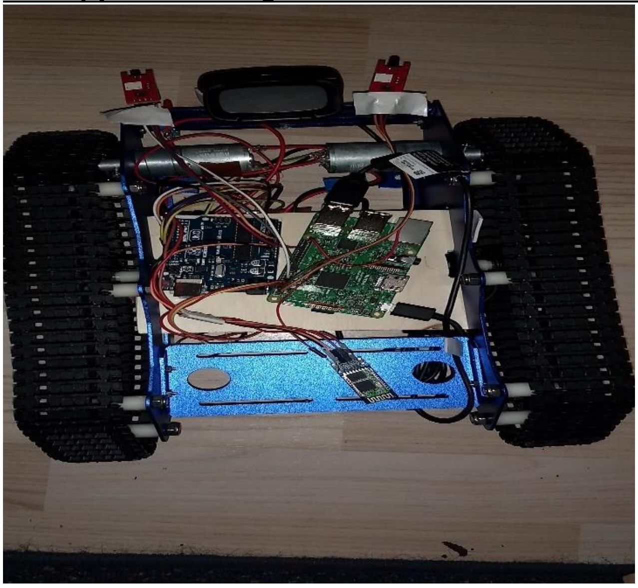

Fig 9. Rear view of the Project model robot

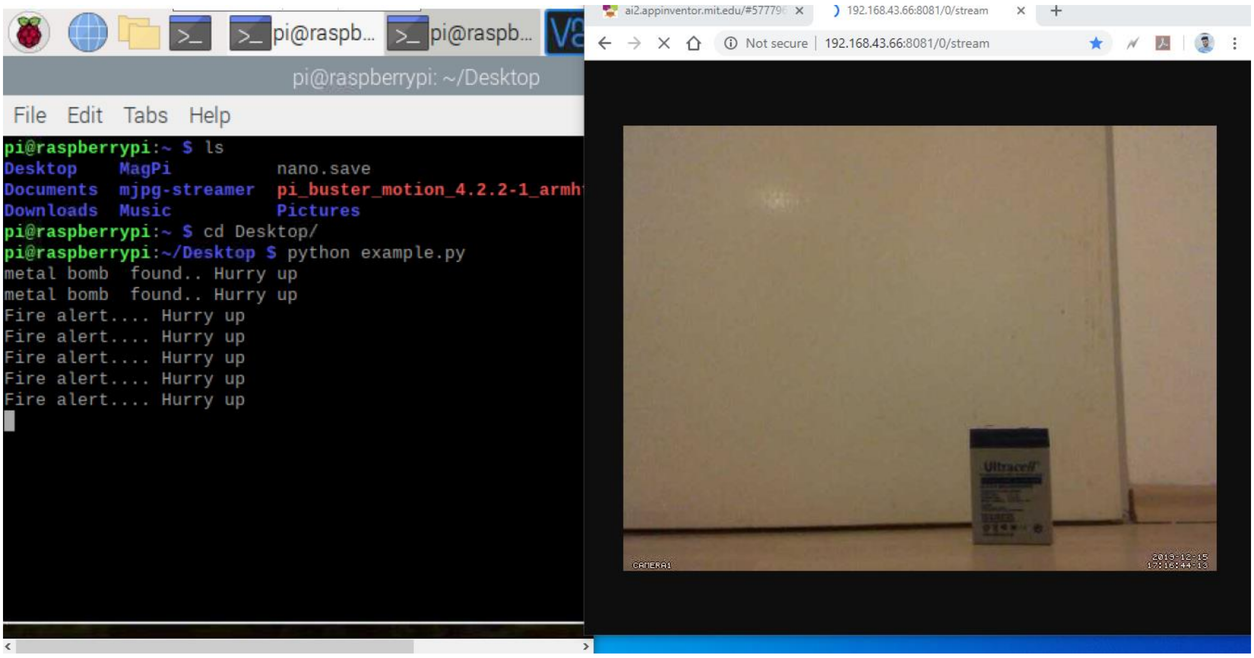

Fig 10. Sensor messages and real time camera monitoring from operator end

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