MULTIFUNCTIONAL ROBOT FOR MILITARY APPLICATIONS

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Abstract— With rapid growth in technology every day, scientists and researchers have now come up with the invention of robots. The most important and concern area is the defence areas. The multifunctional robot helps the military to deal with most difficult conditions like war, unknown traps in the border area, etc. This robot monitors different parameters using components such as IR sensor, bomb detector, thermistor, gas sensor. These components are connected to Raspberry Pi, based on the inputs processed the data is sent to the commander. The robot is used to perform the tasks such as missile sensing and diffusion in air, surveillance, bomb detection, harmful gas detection, thereafter the information is sent to the commander section in the form of mail. Arduino Nano microcontroller is configured for controlling the movement of the robot using Bluetooth module and DC motors connected to it. The movement is controlled using Arduino Bluetooth app at the user end. This robot represents a new method for surveillance at remote places which works on Wi-Fi and Bluetooth technology which is used in this project. The mobility of this robot is governed only in manual mode with the help of Bluetooth module so that we can monitor the path with respect to the information obtained, at that instant of time. The robotic vehicle can be substituted in the place of soldier in perilous situations without any danger to human life. This is specially designed for the armed forces to save human life and protect our country from traitors.

keywords— Arduino Nano, Pi camera, Raspberry Pi 3, Missile diffusal system, Sensor modules.

I. INTRODUCTION

This project confers a cutting-edge approach for reconnaissance or supervision at border and far away regions using multifunctional robot which is based on Bluetooth and Wi-Fi technology used for defense purposes. This robot automobile has the capacity to alternate a solider at border areas to provide surveillance and reconnaissance. This robotic vehicle functions manually which is controlled by the user using Bluetooth technology. This robotic vehicle is used to identify an enemy missile and fire automatically. It also detects landmines (explosives), hazardous gases and high temperature at border and far away regions. All the data retrieval operations are controlled by Raspberry pi and mobility is controlled by Arduino Nano. It has the following operation – 1. Missile sensing and defusing in the air using laser, 2. Harmful gas detection and inform to commander, 3. High temperature detection and inform to commander, 4. Bomb detector and inform to commander.

II. CONCEPT

The block diagram for this project implementation is shown below. It consists of Raspberry Pi as core part of the system. All the sensors are interfaced to the Raspberry pi such as gas sensor, thermistor, IR sensor and metal detector. Pi camera is also interfaced to the Raspberry Pi. The other core part of this project is the Arduino Nano board which is interfaced to the Bluetooth module HC-05 to monitor the mobility of the robot. Movement of this robotic vehicle is controlled through the app called Arduino Bluetooth app. The switching operations are controlled by relay boards in which the DC motors are connected to relay board. Finally, all these components are fixed on a four wheel robotic structure and power supply is provided using 12 V battery. Wireless camera is used for live streaming up to 220 feet.

III. BLOCK DIAGRAM
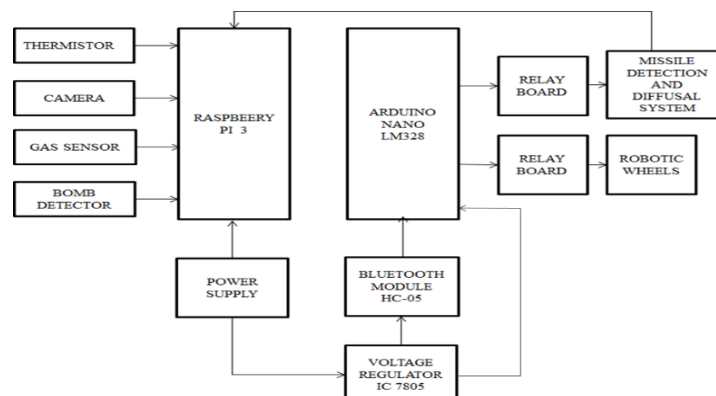
IV. DEFINITIONS:

1. **RASPBERRY PI 3**: Raspberry pi is an on chip computer, which is as small as a credit card and is portable. This project requires the Pi to be installed on the robot for the data retrieval module.

2. **ARDUINO NANO:** Arduino Nano is one of the microcontroller boards that's designed by Arduino.cc. The Arduino Nano uses a IC called Atmega328, which is same as the one as used in Arduino UNO. Arduino Nano is small in size and flexible, it has a wide range of applications.

3. **BLUETOOTH HC-05:** HC - 05 is either used in master or slave configuration, where the Bluetooth device is used for wireless communication. The serial enabled devices communicate with other Bluetooth serial modules using Bluetooth.

4. **IR SENSOR:** It has a pair of IR transmitter and receiver. So, whenever the object blocks the infrared source, it reflects the infrared rays and the receiver receives it. This signal goes through a comparator circuit which is on board. Considering the threshold level, it will produce LOW at the output pin and the green LED will glow, which indicates the presence of the object.

5. **GAS SENSOR**: MQ3 sensor is useful for identifying LPG, Alcohol, CH4, C6H6, C6H14, CO. SnO_2 is the tactful material used in MQ3, which has very low conducting ability in the air. When an alcohol or any other dangerous gas exists, the conductive ability of the sensor becomes high due the concentration of gas rising. This sensing module is very sensitive to Alcohol.

6. **THERMISTOR**: A thermistor is one of the types of resistors, whose resistance value is dependent on temperature. They are mostly used as temperature measuring sensors such as NTC type or as a self-regulating heating device, that is PTC type.

7. **METAL DETECTOR:** Metal detector device is a circuit device used for checking metals or explosives in bags, luggage or person which are mostly used in shopping malls, hotels, cinema halls, which is used to ensure that any man or woman is not indulged in any illegal matters which include weapons, bombs etc. It additionally detects the presence of metals.

8. **PI CAMERA**: The Raspberry Pi Camera Module possess a 5 MP CMOS camera quality that has a fixed focus lens capable of capturing images and also video. Captured Images has a resolution of 2592 x 1944. This camera module is supported in the latest version of Raspbian (Operating system of the Raspberry Pi).

9. **DC MOTOR:** DC motor is a mechanical device that works on Faraday's principle, which works on the conversion of electrical energy into the mechanical energy. The DC motors are connected to by the relay boards which helps in switching operation like rotating the motors in clockwise or anticlockwise direction.

10. **MINI LASER LIGHT MODULE:** Mini laser light module uses 5 V DC supply which operates at the wavelength of 650nm. It works at 3V to 5V. This laser module is compact to other laser light modules.

11. **RASPBIAN :** Raspbian is a Debian-based operating system which is used for Raspberry Pi. Raspbian is based on Linux. There is no need to remember all the commands or that one needs to type: wq to save and exit the text editor. Graphical User Interface (GUI) of Linux is much similar to Windows or Mac OS that has a very few basic commands and shortcuts that makes the user program easily.

12. **ARDUINO IDE:** Arduino supports all types of programming languages and the programs for the board can be written in any type of programming languages such as C, C++, Java, etc. The compiler produces byte code for the target processor. It also supplies a software library which provides many common output and input procedures for wiring project. The user written codes works on only two basic functions, for starting the sketch and the main program loop. The Arduino IDE makes sure that the program is able to convert the code into a text file which is then loaded into the Arduino board.

V. METHODOLOGY

It consists of four wheels robotic structure made up of 4 DC motors fixed on the wooden board. Each of the DC motors in connected to two relays. Then the Bluetooth module HC-05 is interfaced with Arduino Nano which in turn connects and controls the relays. Each of these components will be provided by 5 V supply voltage. Each relay controls the rotation of the motor in clockwise or anticlockwise direction. This is controlled by the user using the app called "Arduino Bluetooth App". This app displays the buttons to users which when pressed controls the movement of the robotic vehicle. The app looks as shows below which consists of many buttons as shown below.
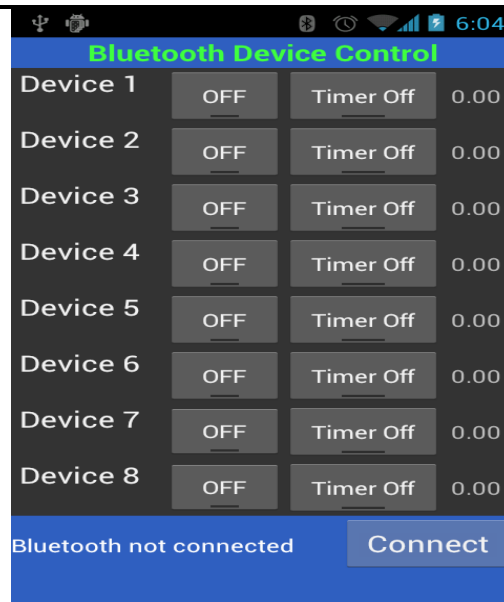
Arduino Bluetooth App

Using this app, it is possible to supervise the mobility of this robotic based vehicle or car. At first, download this app in a smartphone which is readily available in Google Play store. Then switch on the Bluetooth in the smart phone and pair it with Bluetooth module HC-05. By default, the password will be 1234 or 0000. After the devices are paired, it shows the notification in the app saying that it is successfully connected.

When the button is pressed, the Bluetooth module receives the signal and the command is sent to Arduino Nano. This in turn controls the relays which in turn controls the movement of the robot vehicle. The working of relays is to control the robotic vehicle which is explained using the internal block diagram of the relay as show below.
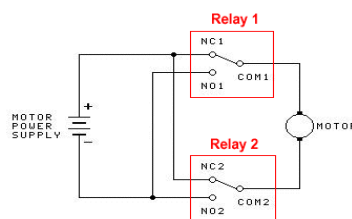
Internal Diagram of Relay

The above figure shows the internal working of the relay. The pin common will be towards the pin normally closed (NC) by default. Whenever a user press any of the button displayed in the app, the Common pin of first relay will be shifted towards the pin normally opened (NO). This supplies the 5V supply to the motor. Whereas the second relay will have normally closed (NC) condition and does not supply the voltage. This makes the motor rotate in one direction. When the second relay is made normally opened condition and first relay is made normally closed condition, the motor rotates in opposite direction with respect to first condition. In the same way, each DC motor will be controlled by two relays. By this way the DC motors can be rotated in desired direction. Therefore the movement of the robotic vehicle can be controlled.

We make use of Raspberry Pi 3 to interface sensor module along with Pi camera as shown in the block diagram. At first, operating system (OS) is installed in the SD card via the Etcher app. To establish the wireless connection with the Raspberry Pi, two text files will be saved in SD card. One text file consists of the information about the Wi-Fi name and password. The other file is saved as empty file with the name "ssh", which enables the Wi-Fi module and in turn connects to the Wi-Fi network. Now open command prompt of the Raspberry Pi using the software tool "PuttyGen". Execute the command to enable the remote desktop connection software in order to connect the PC wirelessly with the Raspberry Pi. For proper functioning of the PC and Raspberry Pi, connect both to the same Wi-Fi network. Power up the raspberry pi and make the wireless connection with the help of Remote Desktop Connection software tool. The OS loads and opens a new file where the code is written and is saved in .py extension.

The hardware connections to Raspberry Pi are made as shown in the block diagram. It consists of sensor module which consists of four different sensors. They are -

1. Thermistor
2. LPG gas sensor
3. Infrared (IR) sensor
4. Metal detector

Thermistor is a type of resistor which depends on temperature. This thermistor is placed on the robotic vehicle. The output of this sensor is connected to the pin GPIO 17 of the Raspberry Pi via a relay. In the same way, we make use of LPG gas sensor MQ-03 to detect harmful gas detection. The output of this sensor is connected to the pin GPIO 4. We also make use of IR sensor to detect obstacles which is connected to GPIO 22. We also use mini laser light module that is connected to IR sensor which automatically diffuses the missiles whenever IR sensor detects the missiles.
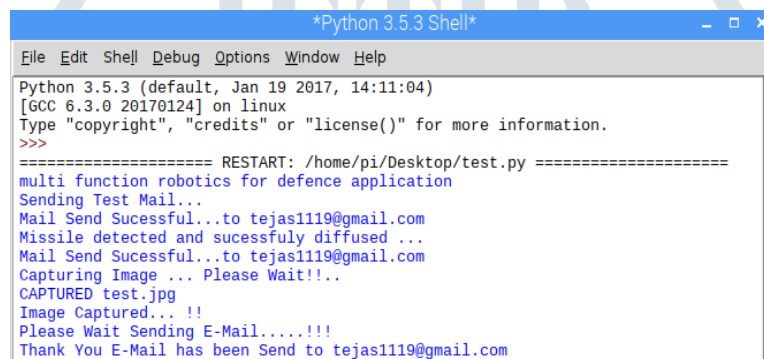
Metal detector circuit is fixed under the robotic vehicle to detect any metals under the ground. The output of this circuit is given to GPIO 27 of the Raspberry Pi. Pi camera is fixed to the camera port of the Raspberry Pi.

It has missile diffusion system which consists of parabolic structure fitted on robotic vehicle. The parabolic structure is further fixed to DC motor which is controlled by Arduino Nano. The Arduino Nano is programmed to rotate the DC motor 180 degree automatically. By this, the parabolic structure will rotate 180 degree whenever the Arduino Nano is powered up. IR sensor is then fixed on the parabolic structure to sense the incoming missiles. Mini laser light module is fixed above the IR sensor to diffuse the missile automatically. This enables the IR sensor to continuously detect the missiles in 180 degree direction and diffuse the missile when it is detected. This mini laser module produces high beam of light of wavelength 650 nm to diffuse the missile.

The camera is mounted on the robotic vehicle which is used for surveillance. The live streaming can be viewed on the device which has a display and Wi-Fi connectivity.

VI. RESULTS AND DISCUSSION

Case I: IR Sensor Output:


```
*Python 3.5.3 Shell*                          _ □ ×
File  Edit  Shell  Debug  Options  Window  Help
Python 3.5.3 (default, Jan 19 2017, 14:11:04)
[GCC 6.3.0 20170124] on linux
Type "copyright", "credits" or "license()" for more information.
>>>
==================== RESTART: /home/pi/Desktop/test.py ====================
multi function robotics for defence application
Sending Test Mail...
Mail Send Sucessful...to tejas1119@gmail.com
Missile detected and sucessfuly diffused ...
Mail Send Sucessful...to tejas1119@gmail.com
Capturing Image ... Please Wait!!..
CAPTURED test.jpg
Image Captured... !!
Please Wait Sending E-Mail.....!!!
Thank You E-Mail has been Send to tejas1119@gmail.com
```
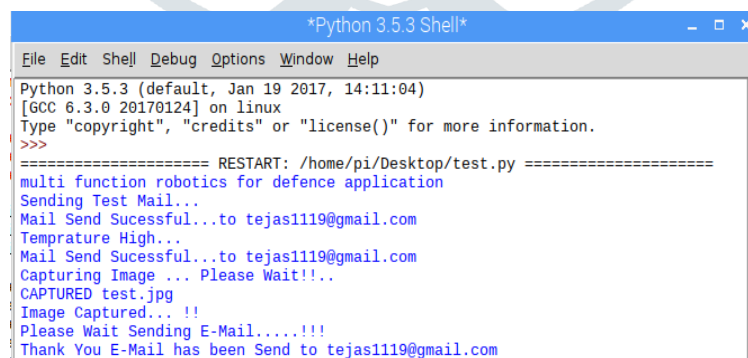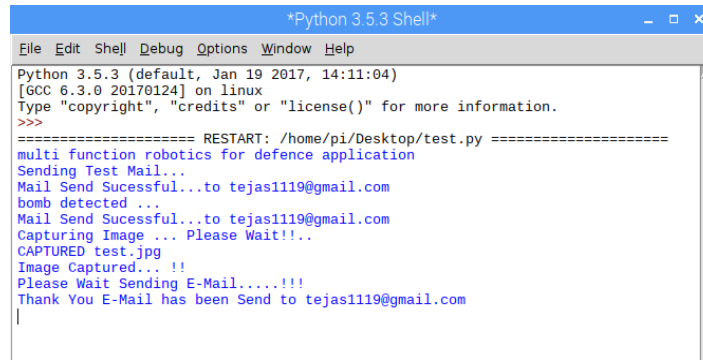
IR Sensor Output

IR sensor is used for detection of missiles. When a missile is detected by the IR sensor then GPIO pin number 22 goes high and simultaneously pi camera takes a picture of the missile and sends it to the commander via email. Along with this, the mini laser module will automatically diffuse the missile.

Case II: Thermistor Output:


```
*Python 3.5.3 Shell*                          _ □ ×
File  Edit  Shell  Debug  Options  Window  Help
Python 3.5.3 (default, Jan 19 2017, 14:11:04)
[GCC 6.3.0 20170124] on linux
Type "copyright", "credits" or "license()" for more information.
>>>
==================== RESTART: /home/pi/Desktop/test.py ====================
multi function robotics for defence application
Sending Test Mail...
Mail Send Sucessful...to tejas1119@gmail.com
Temprature High...
Mail Send Sucessful...to tejas1119@gmail.com
Capturing Image ... Please Wait!!..
CAPTURED test.jpg
Image Captured... !!
Please Wait Sending E-Mail.....!!!
Thank You E-Mail has been Send to tejas1119@gmail.com
```
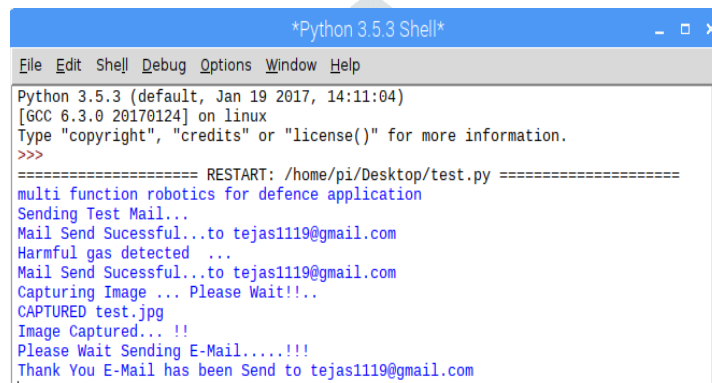
Thermistor Output

A rapid change in the temperature affects the soldiers in the border. So we use a thermistor to check the rapid change in the temperature and inform the commander via email if the temperature goes above 45 degree Celsius. When a temperature above 45 degree Celsius is recorded, then the GPIO pin 17 of the raspberry pi goes high and trigger the camera to take a picture and send it via email to the commander.

Case III: Bomb Detector Output:

Bomb Detector Output

When a bomb or metal is detected the GPIO pin number 27 goes high and this trigger the pi camera to take a picture and informs the commander via email.

Case IV: Gas Sensor Output:

Gas Sensor Output

LPG gas sensor is used to detect harmful gases. Whenever a harmful gas is detected by this sensor, the output of this sensor makes the pin GPIO 4 to high. This enables Raspberry Pi to take picture using the Pi camera. The captured image along with the information is sent to the commander via email.

VII. CONCLUSION

The hardware prototype for implementation of multifunctional robot for military application is successfully implemented. Bluetooth module is interfaced to Arduino Nano to control the movement of robotic vehicle using Arduino Bluetooth app. The camera enables the user for live streaming. The IR sensor detect the incoming missile and diffuse the missile using laser light, along with this the raspberry pi is programmed to capture the image using pi camera and sends via email. Thermistor is interfaced to raspberry pi to inform the commander whenever there is a change in temperature. LPG gas sensor is interfaced with raspberry pi to inform the commander whenever harmful gas is detected. Metal detector is interfaced with raspberry pi to inform the commander whenever a metal or bomb is detected.

VIII. FUTURE SCOPE

1. Normal camera can be replaced with night vision camera.
2. Bluetooth module (HC-05) can be replaced with Blue-Giga for long distance control.
3. GPS tracker can be used to track device's movement and determine its location.
4. Batteries can be replaced by solar panels.

VIII. REFERENCES

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