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# DESIGN & IMPLEMENTATION OF AN UNMANNED GROUND VEHICLE (UGV) SURVEILLANCE ROBOT

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## ABSTRACT

This project describes the design, simulation and manufacturing procedure of an Unmanned Ground Vehicle (UGV) surveillance robot which can be operated with a remote manually within a range of 600 meter in open space. The wireless controller is based on Radio Frequency. It has been designed following the design of a tank robot but it is not exactly like the traditional tank robot. It can rotate 360 degree and can tilt 180 degree and after that it can still work normally. This robot can monitor condition of the place like temperature and presence of natural gas. A camera is attached with this robot with which it can observe the condition of the site through internet. It also contain a coil gun with which it can attack enemy within a range of 10 fit and has also obstacle detector to protect itself.

**KEYWORDS:** Unmanned Ground Vehicle, Radio Frequency, Sensor, Coil Gun, Camera

## INTRODUCTION

An unmanned ground vehicle (UGV) is being developed day by day in different applications like military and civilian operations, surveillance, border patrolling, law enforcement, hostage situation, and police for some specific mission to detecting and diffusing bombs. It has the ability to detect obstacle [1],[2].UGVs are also effective to monitor environmental extremes like heat, cold, contamination of chemical, biological and nuclear[3].UGV can be controlled by an operator from remote site. Using sensors of UGV operator can obtain critical information of the areas where human being presence is impossible or risky.

In this paper the proposed UGV can perform remote operation and some autonomous operation. This UGV robot can survive and monitor the place, collect and send information to the operator and also can operate some primary missions by remote control. By smart sensing of angle the robot can detect whether it tilting more than 45 degree. If it tilt more than 45 degree then will go backward automatically. If any how the robot tilted 180 degree then it will adjust its logic automatically with the remote command as it was doing previously.

## METHODOLOGY

The below block diagram state the operation of the robot. Every operation is controlled by the Arduino nano. When the “Rx” get any signal, it send it to the Arduino. Then the Arduino process the signal and match it with the programmed conditions. The Arduino contain four sensors which are tilt, gas, obstacle and temperature sensor. It also

attached with a light, motor driver and Bluetooth device. Coil gun also attached with the Arduino.

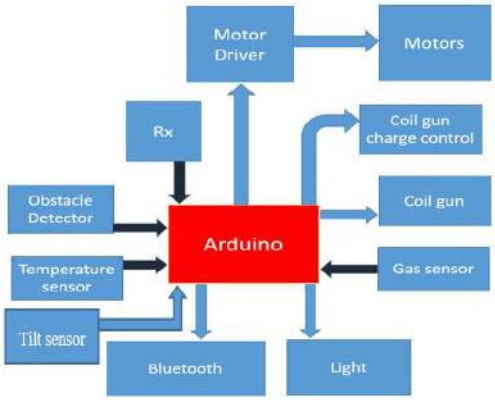


**Figure 1: Process Block Diagram of the Project**

In the joystick the voltage level is divided from 0 to 512 for resolution which is mapped in Arduino from 0 to180 degree so that the robot can rotate up to 180 degree.

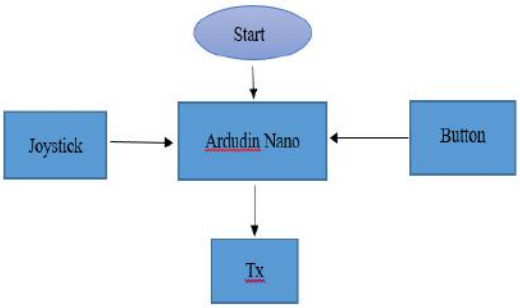


**Figure 2: Data Transmitting System**

There are four buttons for light, sensor data reading, coil gun charge control and coil gun shoot. The joystick and buttons are the input of the Arduino and Arduino is processing and transmitting the data to the transmitter.

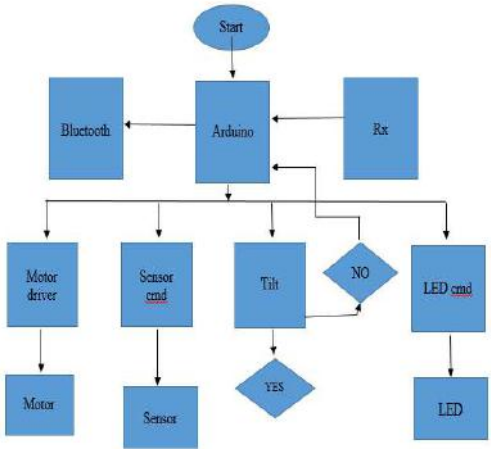


**Figure 3: Data Transmitting System**

## SIMULATION AND RESULTS

The simulation is done for the UGV robot movement. There are four movement of the robot:

- Forward shift
- Right shift
- Backward shift
- Left shift

In this simulation the light, sensor data reading, coil gun charge control and coil gun shoot are also shown. In the simulation one microcontroller has been used. There are four switches for four different output along with resistors R1, R2, R3 and R4. Also two variable resister has been used for motor as well as the robot direction.

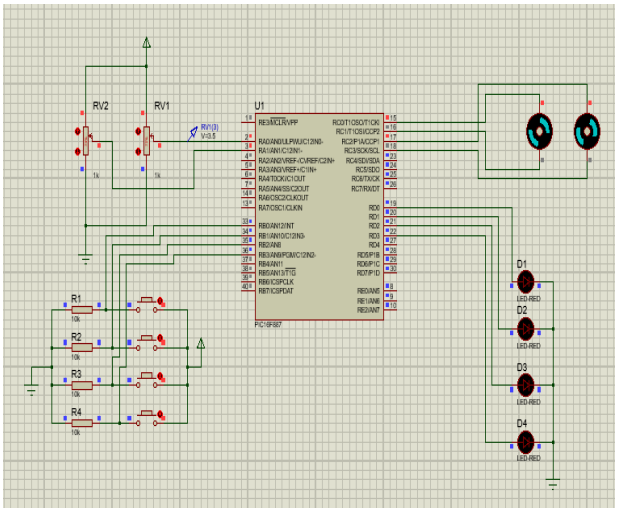


**Figure 4: Simulation Scenario for Forward Shift**

When the first potentiometer RV2 is high the forward shift is activated. And the other potentiometer RV1 is in neutral position. For the activation of forward shift all motors are in forward direction (Figure 4). Here RV1 and RV2 both are low. And the motors are in backward direction as well as the robot is going backward (Figure 5).

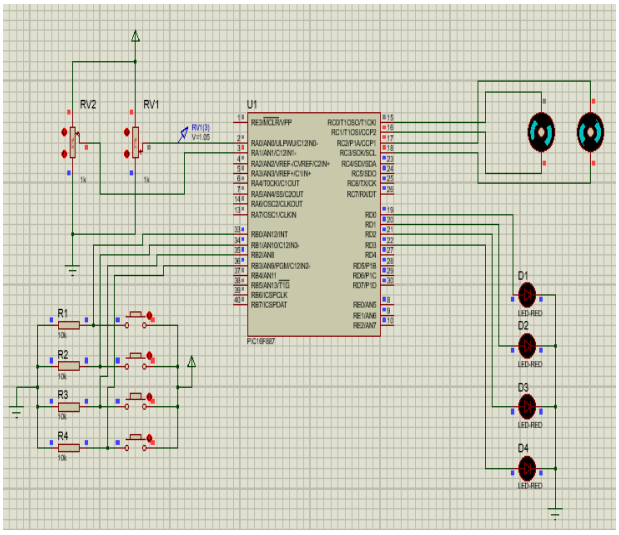


**Figure 5: Simulation Scenario for Backward Shift**

As shown in Figure 6. four button has been introduced in the remote for maintaining the operations which are

light, sensor data reading, coil gun charge control and coil gun shoot. In the simulation four LEDs are using instead of four operation which are corresponding with for button.

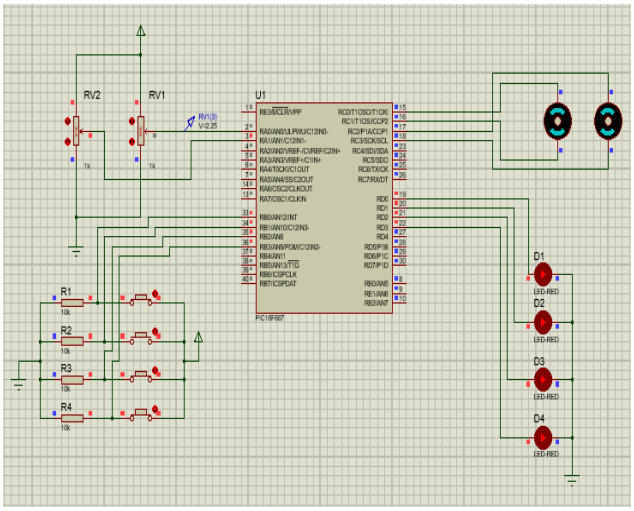


**Figure 6: Simulation Scenario for Button Output**

## IMPLEMENTATION

This section provides a brief description of implementation of the project.

### Mechanical Structure of the Robot

The body of the robot has been made with aluminum. Ten wheels are used in the robot which are made by plastic with rubber tire. Upper cover is made with highly dense plastic board. Ten gear motors attached with the robot body by 20 nut & bolt.

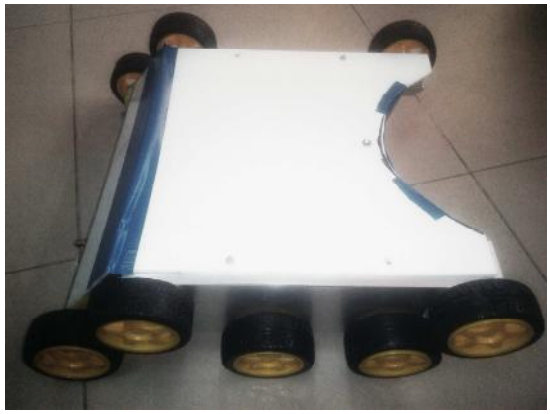

**Figure 7: Mechanical Structure**

### Implementation of Control Circuit

The control circuit is place in the mechanical structure of the robot. The Arduino Nano was programmed to get desired input and output. Then the sensors (temperature, gas, tilt, obstacle), motors, coil gun, Bluetooth device were connected according to the design. Here the RF module used for receiving the transmitted signal from the transmitter. An ARM cortex processor controlled board has been used for video transmission from the robot.

**Figure 8: Total Set Up with Control Circuit**

**Sensor Response System**

Four sensor has been used in the robot.

- **Tilt sensor:** The tilt sensor has two function to work here. 1st it will try to prevent to tilt the motor over 45 degree. And the 2nd one is, if the robot tilted over 180 degree it will maintain the same working configuration synchronizing with the remote controller.
- **Temperature sensor:** LM35 temperature sensor has been used. It will sense the temperature of the area and will send to the microcontroller.
- **Gas sensor:** MQ05 gas sensor has been used in the robot. It will sense if there is any unusual gas present or not. If it detect any gas than will send the data to the microcontroller.
- **Obstacle detector:** An obstacle detector sensor implemented to the robot to prevent any damage to the body of the robot. If it found any obstacle very near to the body of the robot, it will prevent the forward movement of the robot.

**Controlling the Robot Using Joystick**

The remote controller of the robot contain 1 joystick and four button for different operation. Joystick is to control the speed and movement of the robot. Four button is used for four operation as

- Get sensor value
- Light
- Coil gun charge control
- Coil gun shoot

The remote contain a nrf24L01 RF communication module to transmit the data.

**Figure 9: Joystick**

**Work of Coil Gun**

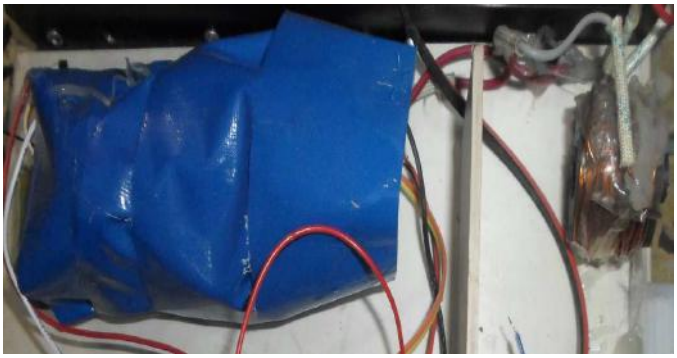

**Figure 10: Coil Gun Circuit**

The coil gun contain two part.

- **Charge control part:** To shoot through the coil gun high voltage need to boost the coil. To supply high energy two 400v 220uf capacitor has been used. To charge the capacitor a high frequency inverter has been used.
- **Coil:** To shoot through the coil gun an electro magnet need to produce. 20ft long insulated wire used to make the coil to produce the elector magnet.

The coil gun able to shoot any object with in the range of 10 feet.

**Image Processing**

To increase the security and for detecting object the robot is connected with Matlab for doing image processing. The taken photo of the robot send to the connected computer and the linked matlab do the image processing work for detecting objet to increase the security.

Below some sample process of image processing system has been given.

1st the device will select a image to process. This taken as sample picture.

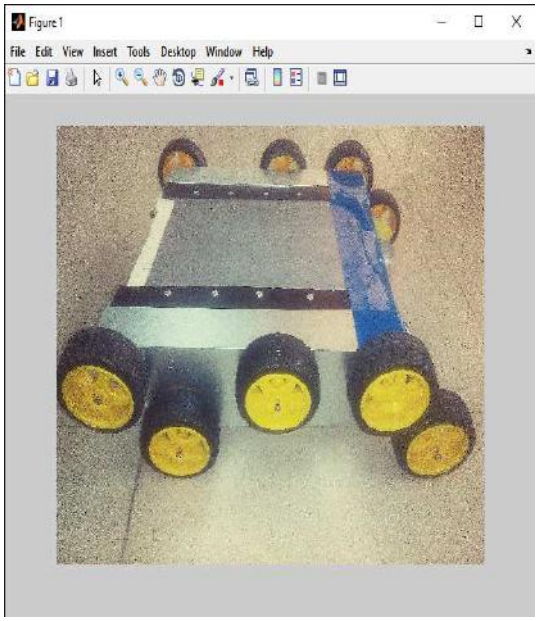


**Figure 11: Sample Image**

Then for detecting area the picture need to convert in gray mood. As shown in the bellow Figure 12 the sample image of Figure 11 has been converted into gray.

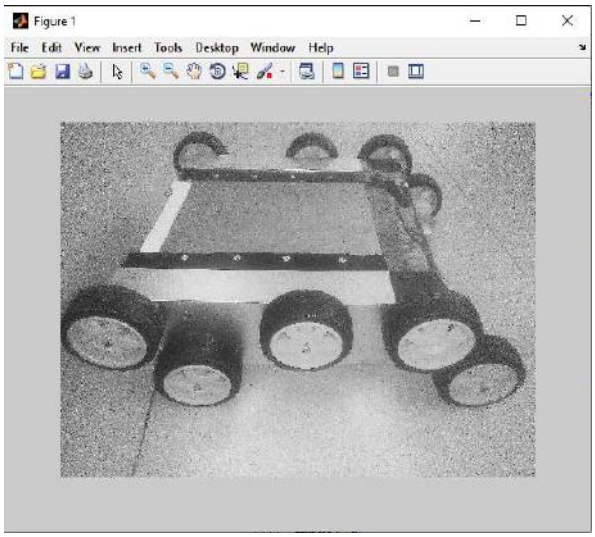


**Figure 12: Gray Conversion**

As machine does not know nothing more then 1 and 0 so the image need to convert into black and white.

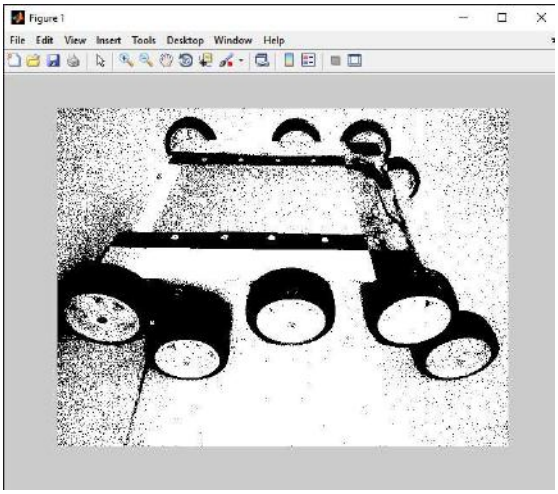


**Figure 13: Binary Conversion**

The robot car able to detect moving object. In case to detect any traffic situation or to detect any person the object moving option can be used. More options like number plat detection or alphabet detection can be developed.

## DISCUSSIONS AND CONCLUSIONS

In this project a UGV surveillance robot is designed and implement which can be used in military operation, disaster site or any other area where human being cannot reach and take data and information of the site. The mechanical structure of the robot is made by following the construction of a tank robot. Successfully I came to a discussion that this robot can monitor the condition of the site like monitoring temperature, monitoring presence of natural gas and also give a view of the site to the user through a camera within a range of 600m. It has obstacle detector to protect itself and also a coil gun to attack enemies within a range of 10 feet. The robot can rotate up to 360 degree and it can tilt itself to 180 degree.

### Limitation of the Study

- The robot is not waterproof
- The coil gun cannot hit an obstacle outside 10 feet
- The torque of the motor should be increased to get a better movement of the robot
- The robot cannot send data without internet connection
- The robot is inactive for above 600 meter.

  The robot is active for open space only

### Application Area

There are huge application area of the UGV surveillance robot. Some of them are:

- The UGV robot can be used in military operation
- The robot can monitor disaster place.

- Can send audio, video and sensor data from any place where people cannot reach can be used for bomb disposal

**Future Development**

This project can be improved in various way. Some of them are:

- The torque of the motor can be improved to get a better movement of the robot
- The robot can be made waterproof
- The UAV (Unmanned Ground Vehicle) can be added in this project in future.
- More sensors can be added to get different types of information
- A hand gesture can be added to control the robot

**Suggestion for Future Work**

Although lots of project is already done based on UGV robot, in this project we tried to make a system which is easy to use, reliable and cheap. There are lots of scopes to build more reliable and better project based on this work. Future project can introduce new devices and technologies. In future similar project can be made such as:

- A UGV can be designed which can send data without internet using specific frequency
- A UGV can be designed which can take any decision depending on the situation without human interface
- A UGV can be designed which can survive using digital map

## ACKNOWLEDGEMENTS

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