



Design and Fabrication of all Terrine Multipurpose Spy Robot

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Abstract: The man always in search of new devices to carry out the tasks both in civilian and defense domain. This paper discusses the design and development of multitasking robot which can be employed for defense applications. These are the part of integrated system that employs camera, sensor, gripper, screen etc. The use of technology to control the remotely are increasingly used in defense for spying purpose. The control of the robot for capturing pictures, bomb disposal and material handling in war field are main tasks considered. The unique features of this robot is that it is capable of maneuvering in all terrine. The rocker mechanism used has effectively proved that the robot can be used in uneven surfaces viz war fields, mountains, forests and deserts. The developed robot is equipped with camera and bomb disposal system which is working effectively to capture the images and also material handling was performed with satisfactory maneuvering the in uneven surfaces.

Index Terms – Robot, Spy. Rocker mechanism, Pick and place.

I. INTRODUCTION

Defense is the primary requirements of each nation to have security and its development. The technology has spread its wings in all the sectors with defense as no exception to it. The technology has made all the work of human being as effective and as simple as possible like material handling, high precision output, methodological interaction with machines and humans. The defense sector has been the main focus for most of the technology developed. The robotics is the domain considered as the replacement for human efforts and tasks. When it comes to the war fields the most of the lives can be saved if we replace the difficult task performed by the solders with the robots. The challenges to be overcome in performing these tasks are accuracy, intelligence, movement in all types of environments, bomb disposal, capturing enemy environment etc. The robots are substitutes for specific tasks listed above. The advantages of using the robot includes cost, ease of work, remotely controlled and reliable.

The Robots used in military is not completely autonomous, mostly it is controlled by human. This control can be done remotely through RF or IR or Bluetooth or GSM communication. Here a spying robot is built which is embedded with a wireless camera that is used to take pictures at night time and transmit these images to a TV. Here the whole operation and movement of the robot are controlled by the signals from a GUI based application on an Android operated smartphone. Additional feature for the robot employed is smooth travelling of the complete spying system in all terrine. For this purpose it is proposed to use rocker mechanism with wheels and links.

II. DESIGN OF ROBOT PARTS

Degree of freedom of a pair is defined as the number of independent relative motion, both translation and rotational a pair can have. Degree of freedom depends on the type of contact Joint and motion the mechanism possesses. Mobility of mechanism defines the number of degrees of freedom.

To find the number of degrees of freedom for a mechanism we have an equation known as Grubler's equation and is given by

$$F = 3(n-1) - 2j_1 - j_2 \quad (1)$$

Where: F = Mobility or number of degrees of freedom. N = Number of links including frame.

j_1 = Joint with single (one) degree of freedom.

The calculated degrees of Freedom as per above formula is obtained and Table 2.1 shows the degrees of freedom considered for the development of the robot for various joints and links.

Table 2.1 Degrees of freedom for our robot is as shown below

Elements	Type of joint	Nature of Motion	Degrees of freedom
Primary Robotic Arm	Hinge, Rolling	Pure Rolling	5
Secondary Robotic Arm	Hinge, Rolling	Pure Rolling	3
Robot Wheels	Rolling & Sliding contact	Rolling & Sliding	2

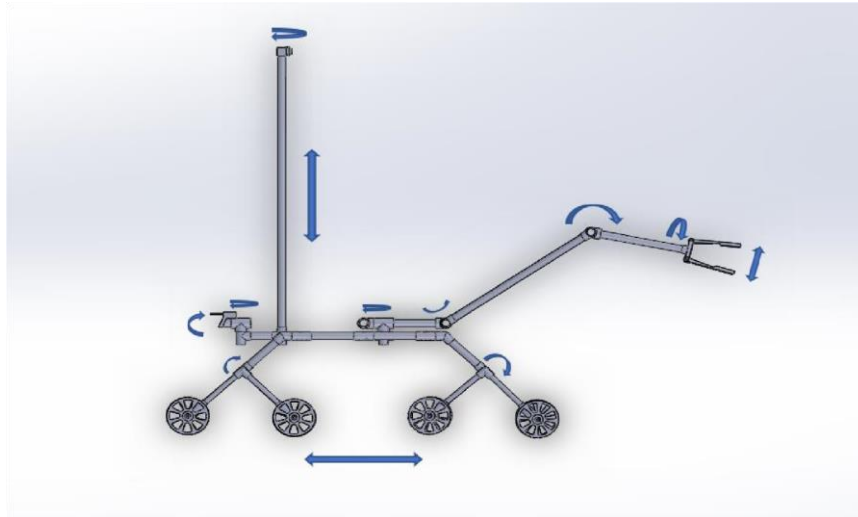


Fig 2.1 Three-D model of Robot and Degrees of freedom of various joints and links

The methodology employed for the development of the spy robot is shown in the fig 2.2 below.

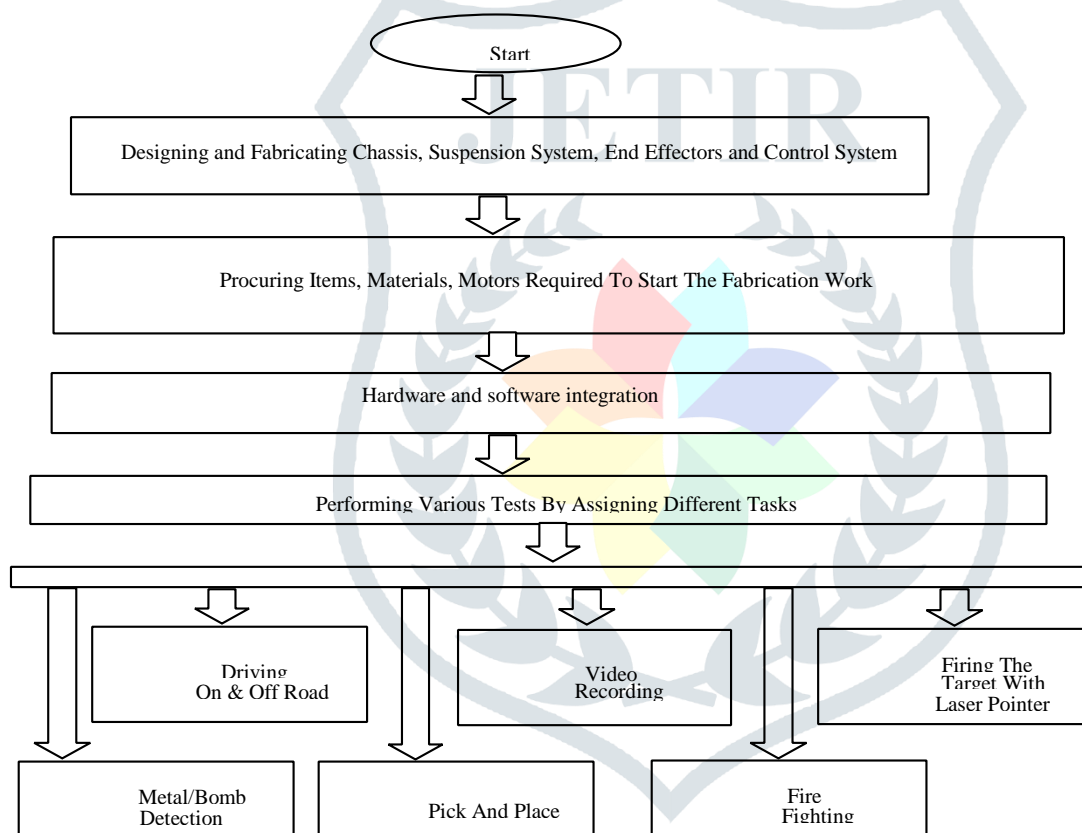


Fig 2.2 Methodology adopted for the development of the Robot

III. ROBOT CONFIGURATION

The mini robot called MINI BOT is an assistance robot for the main system. The robot dimension is very small when compared to the main system. It is fabricated using 200 mm aluminum angle and two BO motors were used to separately drive 2 wheels. The motors were mounted to the aluminum angle with the help of bolts and nuts. The bot is controlled using wireless RF trans-receiver. The bot can be used as an extra assistance for the defense forces. Main robot provides surveillance in the open areas but for spying the rooms, buildings or houses which are suspicious. The mini bot can be thrown into the windows of the suspicious rooms and required footage can be obtained. The camera is placed to front of the aluminum angle using which we can record the video and take the pictures. The model is shown in fig 3.1.

The primary purpose of the paper is to offer protection to the bomb disposal squad via use of robots to detect and pick and disposal of the Bomb. And additionally, to reduce the cost of inspection. The configuration of the robot and 2-D diagram is shown in fig 3.2. Other purpose include

- Serve as remote tracking and controlling tool to test any suspicious war field systems
- To permit the military to govern the suspicious packet by the use of the robot arms.
- To supply captured picture of the area of the battle fields hiding things.
- To make the moment of robot to access the unreachable areas.

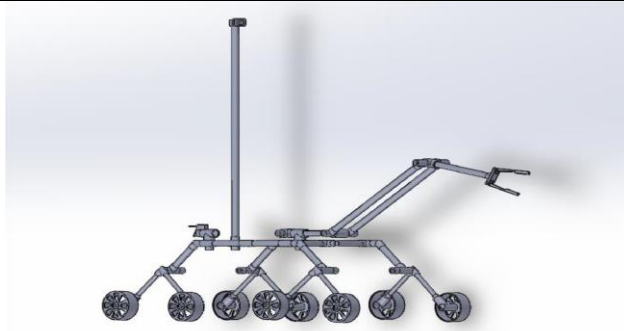


Fig 3.1 Three-D model of Robot and Parts of Robot:

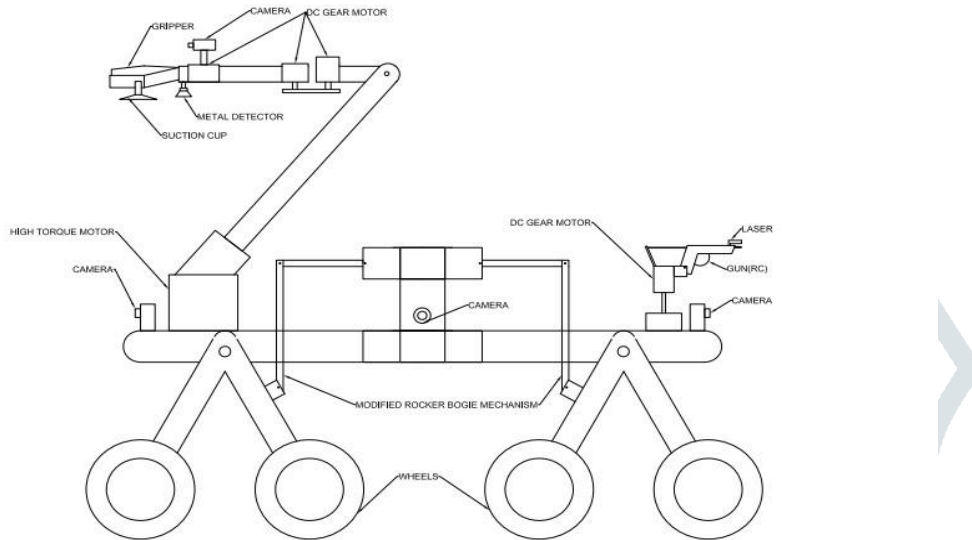


Fig 3.2 Two -D Diagram of Robotic Model with all the Parts

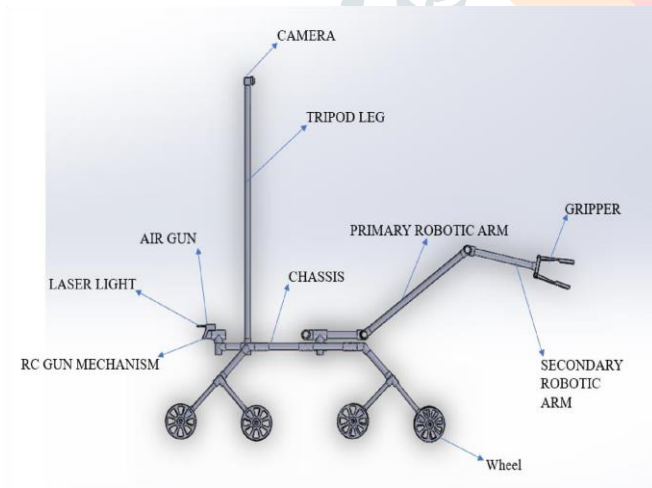


Fig 3.3 Three-D model of Robot parts

The term “work volume” refers to the distance inside which the robotic can operate. Working radius: The running radius of our Robot is about 800mm as proven within side the determined above. The configuration of the robot and work area is shown in fig 3.4.

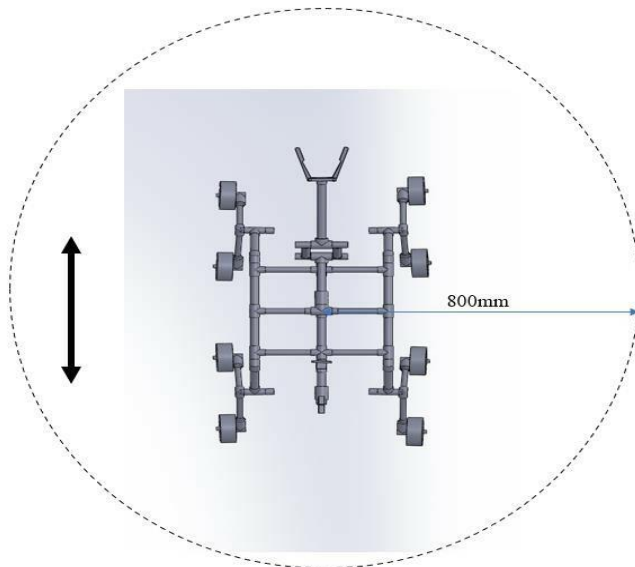
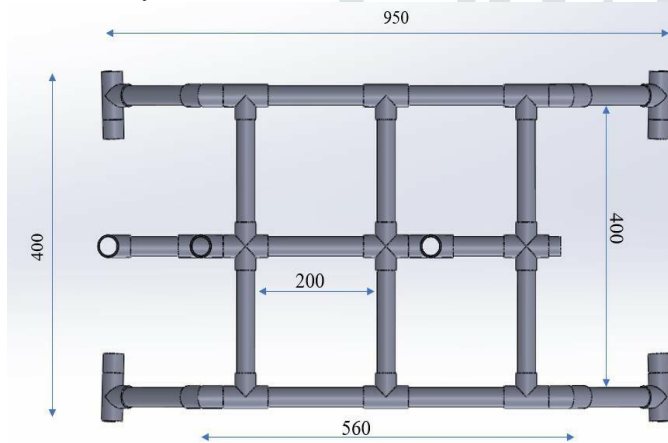


Fig 3.4 Work volume of the robot

IV. FABRICATION OF THE ROBOT

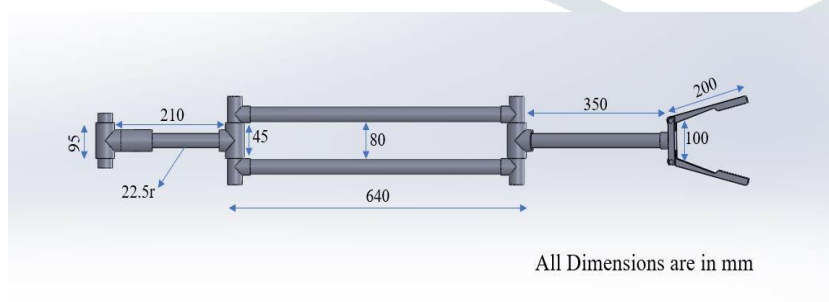
The fabrication of the robot was carried out with the light weight materials for the easy moments of the complete system. The wheels used has 1600 mm diameter and made of plastic material with strong base.

The top view of the robot frame gives the dimensions of the links and arms used. The frame is made of PVC pipes for strength and the durability.



All Dimensions are in mm

Fig 4.1 Top view of the robot with dimensions of the chassis



All Dimensions are in mm

Fig 4.2 Three-D Model of main arm with dimensions of the link

The base is fabricated using 1-inch CPVC pipe and pipe fitting as shown in fig 4.1. The various pipe fitting was arranged according to the initial drawings and the required shape was obtained. Aluminum channel was used to give more stiffness, strength and rigidity. By using CPVC pipes we were able to reduce the weight and fabrication process was also less and manufacturing cost was reduced.

The chassis without wheels and on the top of aluminum angles hard fiber 3mm plate is fixed to place the batteries, receiver module and wiring system. High torque motor to actuate the entire main arm is mounted to the center of chassis frame to balance the center of gravity. The vacuum generator is also mounted to the frame.

Four sub assembly wheels mounted to the chassis forming the modified rocker bogie mechanism with eight wheels. Also the supporting arm is mounted to the high torque motor shaft with cast iron rod. The supporting arm is mounted with two high torque motors and the motors are fixed with aluminum angle to connect the main arm. Figure 4.1 to 4.3 shows the arm, wheel and chassis fabrication.

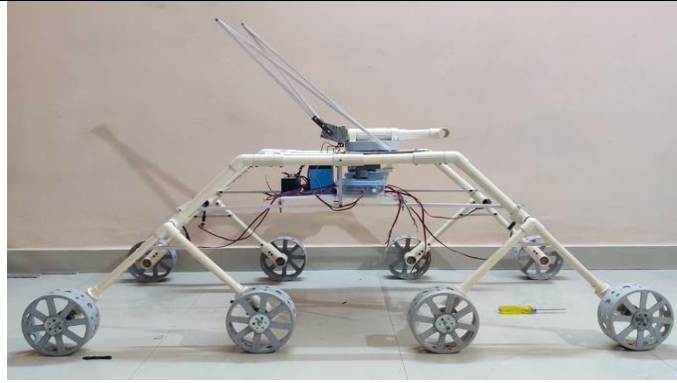


Fig 4.3 Fabricated model of the robot with Primary arm and wheel assembly.

The primary arm mounted to the supporting arm. The primary arm is also fixed with high torque to control the secondary arm. The aluminum angles are also connected to the primary arm. The secondary arm is mounted to the primary and the high torque motor is connected to the secondary arm mounted on the primary arm. The secondary arm is mounted with gripper and 3.5 rpm dc gear motor fixed to the secondary arm controls the vertical tilting action of gripper. The rare arm is also mounted to the chassis and also the concentric camera arm is mounted to the chassis frame, the primary arm mounted to the supporting arm and supporting arm mounted to the 160cm PVC end cap, also the high torque is visible.

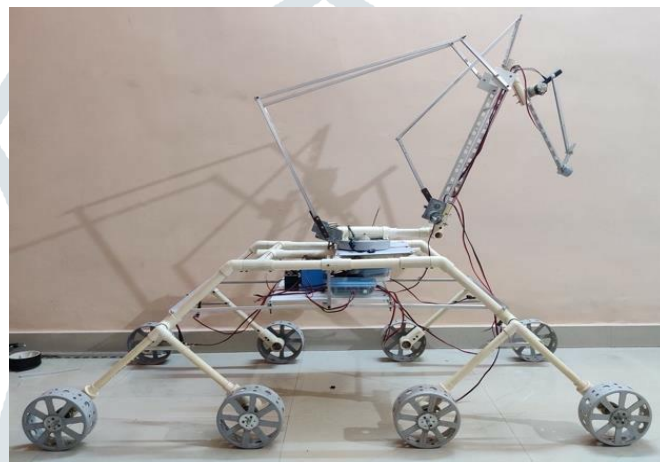


Fig 4.4 Fabricated model of the robot with Secondary arm and wheel assembly.

Secondary arm setup the gear motor mounted to the aluminum angle and the motor is linked the gripper holder. The secondary arm mounted to the primary arm and connected to the high torque motor with the help of aluminum angle. The figure shows the gripper mounted to gripper holder of secondary arm and also gripper is mounted with suction cups.

The tripod leg was used to fabricate the concentric camera arm. It has 3times height adjustment and when fully raised, about 5 feet height was achieved. And is mounted to the based and controlled by 3.5 rpm gear motor for 360 degrees' rotation. The architecture of the robot has also been designed keeping the modular approach in mind.

The Johnson gear DC is a 12 Volt DC motor that is connected to the 160mm diameter handmade wheels. Torque from the DC gear motor is transferred to the robot wheels as shown if fig 4.4.

Main robotic arm: The arm is divided into two parts primary arm and secondary arm, the primary arm is connected to the supporting arm with rotating joint and the supporting arm is connected to chassis to rotate along vertical axis and it is driven by high torque motor with 3.5 rpm and will support the 360 degrees sweeping movement of the entire front arm. Primary arm is actuated by two high torque motors with 3.5 rpm providing 120 degrees of vertical rotation joint. Secondary arm is connected to primary arm in a rotating joint and actuated by high torque motor with 3.5 rpm providing 180 degrees of vertical rotation. And the end effector i.e special mechanical gripper is connected to the secondary arm providing rotating joint with 180 degrees and actuated by 3.5 rpm gear motor for adjusting the gripper. Also, another twisting movement of gripper along the horizontal axis can be provided to the arm.

Rare robotic arm: It consists of toy gun with laser light for aim and shooting the target.

The gun is actuated by three 3.5 rpm gear motors, one motor for the 360-degree rotation of gun setup, second motor for tilting the gun 90 degrees along vertical axis, third motor for triggering the gun to shoot the target.

Robot wheels: The robot is 8wheel driven and actuated by 40 rpm Johnson gear motor. For forward path all wheels rotate in the clockwise direction. For backward path all wheels rotate in the counter clockwise direction and for turning, the turning side wheels are at rest (power supply cutoff). The opposite side wheels will rotate in order to steer the Robot left or right direction.

Suspension system: The modified rocker bogie suspension system is provided to the robot chassis as in figure 4.5. It is a spring less suspension system and with 8wheels driven provides best wheels contact and balance. **Metal detector:** Metal detector coil is placed below the gripper of the robot arm in order to detect metals or bombs. When robot comes in contact with metal or bomb, the buzzer present in the metal detector circuit gives alarm.



Fig 4.5 Fabricated model with concentric arm and camera and gripper is mounted with suction cups

Tripod leg with three times adjustable height is connected to the chassis. The arm if fully extended raises about 5feet and actuated by 3.5 rpm gear motor to rotate the arm 360 degrees along vertical axis. 5mp PI camera is connected to BO motor and the motor is placed on the top of concentric arm to provide 7 feet raised height. The camera tilts along vertical axis and is actuated by BO motor. 1000 rpm dc motor is coupled to a vacuum pump to generate vacuum and the pressure is supplied through a thin hose pipe to suction cups. The vacuum cups used in old tv display system are used as suction cups. There are two cups and mounted to the gripper to hold the and leave the objects with flat surfaces when the pressure is applied or cutoff.

V. HARDWARE AND SOFTWARE CONFIGURATIONS

The IR far flung manage is used to manipulate different gadgets or circuits up to eight gadgets as shown in fig 5.1. The manage codes are dispatched in RC5 layout modulated to approximately 38 kHz provider frequency. The IR transmitter powered via way of means of the CR2016 that's a 3V button Cells Battery CR2016.To amplify the existence of the battery that is executed via way of means of setting the CPU into SLEEP mode for maximum of the time and wake-up best whilst a secret is pressed. This IR far flung manage that you may use to manipulate different gadgets or circuits up to eight gadgets. The manage codes are dispatched in RC5 layout modulated to approximately 38 kHz provider frequency. The IR transmitter powered via way of means of the CR2016 that's a 3V button Cells Battery CR2016.To amplify the existence of the battery that is executed via way of means of setting the CPU into SLEEP mode for maximum of the time and wake-up best whilst a secret is pressed.

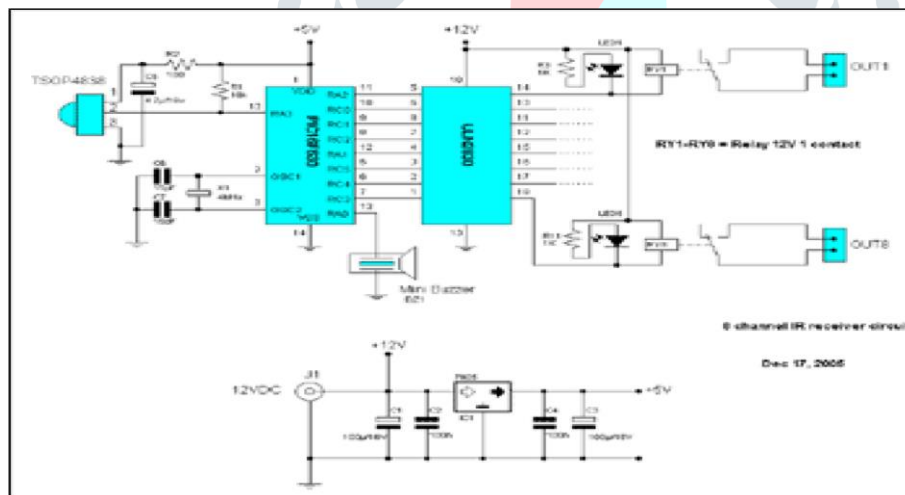


Fig 5.1 IR transmitter circuit

When Channel IR Chip is used to give drive to the wheel motors, from the above figure a set of gear motors visible from left side is connected parallel to each other, and gear motors visible in the right side also connected in parallel to each other, each set of gear motors are connected independently to each other. Figure 5.2 shows the wheel driving circuit.

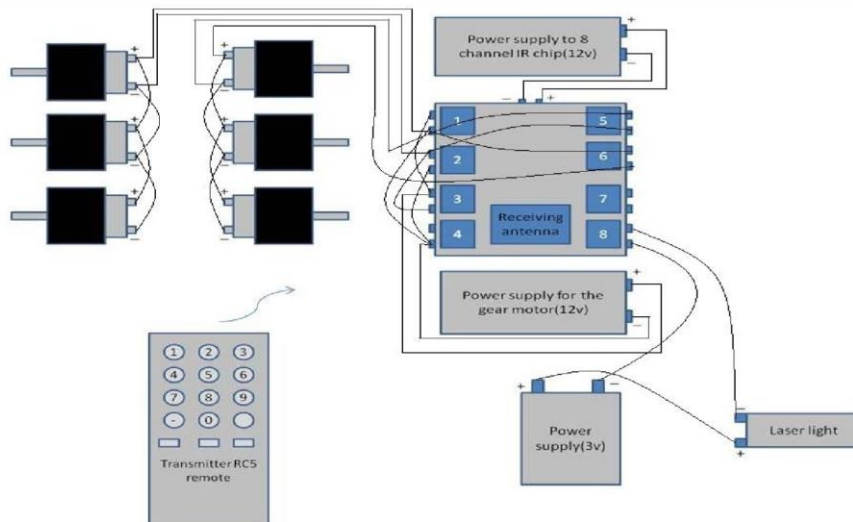


Fig 5.2 Wheel driving circuit diagram with motor and switch control.

VI. TESTING AND SIMULATION

The term Multi terrain means movement of our robot in different land conditions.

Due to eight-wheel drive motion helps in giving more torque to the robot to move on the irregular surfaces, peak slope etc. can be driven in war fields.

Robot can be driven on the wet surface also. Due to higher wheel width, Skidding is less and gives good balance to the robot. This Robot can be driven on the staircase also, it is the most advantage property given to the robot, which can help in detecting explosive material in building also. This can be shown in below fig 6.1 to 6.3



Fig 6.1 Simulation of the Robot maneuvering on a Flat Surface

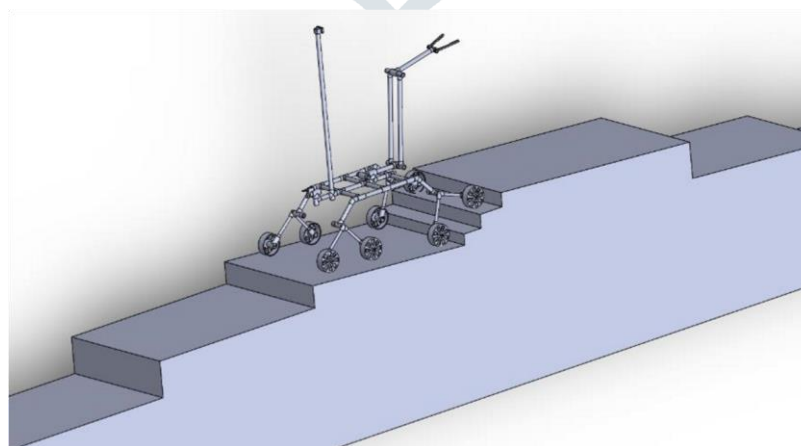


Fig 6.2 Simulation of the Robot climbing the steps and maneuvering on a Flat Surface

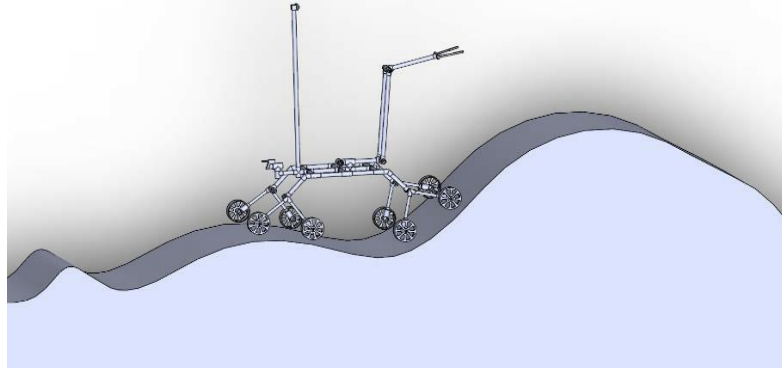


Fig 6.3 Simulation of the Robot maneuvering on a uneven terrine (off road)

VII. RESULTS AND DISCUSSION

The Robot has been designed considering all the objective and the constraints of the previous developers. The simulation and actual working of the developed robot are in agreement as per design. The robot can be driven on the irregular surfaces.

- Can be driven in moist areas.
- It can climb the staircase.
- This robot can be operated in the absence of light.
- Since robot is operated by remote, so no human losses.
- The presence of two robotic arms helps in performing the job without any interference.
- Portable in size.
- Constructional cost is less.

VIII. CONCLUSION

By Literature survey through research papers, and discussing the research gap we arrive at conclusion that this work on the surveillance and spy robot would be designed in such a way that it will be capable of detecting bombs, and with the help of its six degrees, six feet height robotic arm the spying task is much effective and easily performed. It also has 4 cameras in the base, so that complete 360-degree view and continuous video streaming could be done. The key component is Mini-Bot, through which we can perform even more difficult tasks and missions, and also fire the required target and also has the firefighting setup.

The wireless bomb disposal robot has been designed in such a way that it can cater to the needs of the bomb disposal squads, the military, the police and also for the personal use. It has many applications and can be used in different environments. It is economical to the users. We can use this robot in so many areas and in so many situations. By connecting bomb detector to the robot, we can send it to anywhere i.e., (battle field, forests, coal mines, to anyplace) by using our personal computer and we can able to detect the bomb at field, here sensor detects the bomb and gives information to micro controller and it gives the information to transceiver and it sends the information to the personal computer. By using this robot, we can save the life of many living organisms. We can eliminate using bomb detecting dogs to detect bombs.

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