

# “Spy Robot for Patrolling LOC” (Semi-automatic Unmanned Ground Vehicle)

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**Abstract-** The project is designed to control a robotic vehicle by using RF technology for remote operation. A low power laser light is interfaced for demonstrating the possibilities of using a weapon instead of laser unit. A microcontroller is used for the transmission control, reception and execution operations. At the transmitting end using a keypad, commands are sent to the receiver to control the movement of the robot. At the receiving end two motors are interfaced to the microcontroller where they are used for the movement of the vehicle through traction wheel belt drive. A stepper motor driven 'arm' is also designed. The robot is also enabled with 'Audio-Video' (AV) transmission module externally so that the driver may get the sight of the robot's vision. Further, a metal detector is also implemented at the front end of the robot to demonstrate how a metal buried at a shallow depth can be found (Analogy to that of the mines). Thus all the purposes of patrolling are satisfied and the driver can safely do so from a remote distance inside four walls, thus securing his life.

**Keywords:** - articulated geometry, laser firing arm, traction belt drive, AV module, Amplitude shift keying (ASK).

## I. INTRODUCTION:

The life of soldiers fighting on the border is becoming difficult day by day and is further worsened by the infiltration of the enemies, violating the cease-fire. This robot is designed keeping in mind all the possibilities that a soldier might have to face at the Line of Control (LOC).

Existing systems: The 'Ikhana Predator' and similar Unmanned Aviation Vehicles (UAVs) are currently being used in the defence systems of Russia, USA and France. But this technology is very advanced and consequently costly. Getting inspiration from these UAVs, this robot is developed on similar lines but for the ground patrolling purpose. The 'Ikhana Predator' is completely automatic and used for air surveillance, whereas, the one made in this project robot is manually controlled and serves the same application on the ground. Thus this robot is much more cost effective. Other examples are 'Mirage', 'ANSER' (Airport Night Surveillance Expert Robot), 'Stayer' etc. These types of UGVs are not yet used in Indian defence systems however the drone planes are being imported to India from USA and France.

Limitations in the existing systems:

- i. There are spy robots like 'Daksha', Zigbee controlled robots, Bluetooth controlled etc. but they are bigger in size.
- ii. The cost of these robots is usually more hence making them cost effective is important.
- iii. The 'swarm-robot' developed with attacking ability have simpler arm geometry, constraining their work-space.
- iv. Alarm facilities were not included.

Now, the robot made in this project is introduced further. It has rear wheel drive with the traction belts to propel the torque to the front wheels. The arm can rotate 360° in the horizontal plane, while the elbow joint rotates in the vertical plane; both 30° above and below the line parallel to the ground along the length of the robot. This allows the robot to survey in all the directions as the camera will be mounted on the tip of the 'arm'. It is a 'CMOS' type wireless camera. A LASER will also be included at the end of the arm to demonstrate 'firing'. The robot arm is of 'Articulated geometry' (2R type of joints). Also a metal detector at the front end of the robot will allow it to trace mines (i.e. metal in this case).

This device can be controlled with help of a screen/monitor and a Remote Control (RC) keypad. As already mentioned, RF link made of 433 MHz carrier is used onto which the control signal is modulated. The alarm for metal detector's positive output is visualized on the screen itself, as the LED used for this purpose is placed right next to the CMOS camera on the robot's arm. Thus extra arrangement for feedback and its programming is avoided. Thus the primary objective of securing the life of a soldier on the border is accomplished and additionally if situation gets tight, the robot can answer to it very well.

## II. SYSTEM SPECIFICATIONS:

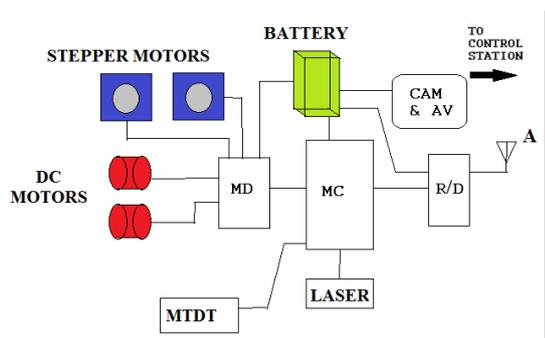
The 'Degree Of freedom' (DOF) for this robot is four and is explained in detail in section III of this paper. The alarm used in metal detector is a visual type of indicator, directly displayed onto the screen. This robot is programmed to accept one command at a time. If

multiple input keys are pressed, then controller is instructed to execute no command and wait for next key. All keys are ‘active high’ (robot works only when key is pressed, and stops executing if key is released). Various parameters of the system were decided as shown in Table 1, and also matched approximately when the project was completed:

**Table 1: System specifications.**

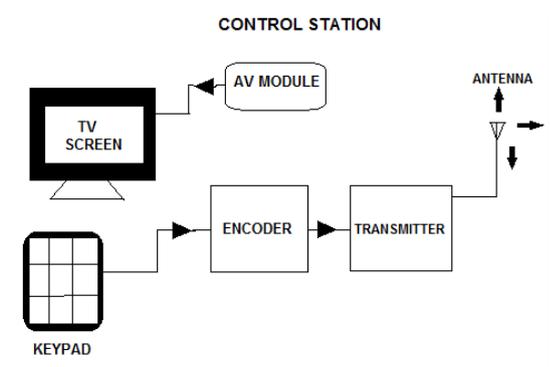
|     |                        |   |
|-----|------------------------|---|
| 1.  | Dimensions             | 250 x 150 x 100 mm. With max ‘Arm’ extension of 200 mm. |
| 2.  | Payload                | 4 kg (max)  |
| 3.  | Operating time         | 1 hr 30 min.  |
| 4.  | Mobility               | 4 wheeled traction belt drive                           |
| 5.  | Communication type     | Wireless type (RF)                                      |
| 6.  | Type of image sensor   | CMOS/CCD  |
| 7.  | Range of communication | 100 meters  |
| 8.  | Actuator type          | Electric (Robotic arm)                                  |
| 9.  | Drive Empowerment      | DC and Stepper motors                                   |
| 10. | Supply                 | 10/12 V Battery   |

**III. SYSTEM ARCHITECTURE:**



**Fig.: 1: Block diagram of receiver.**

The long forms of the abbreviations in the figure 1 are: Cam & AV: Camera and Audio-Video unit, R/D: Receiver and decoder unit, MC: Microcontroller, MD: Motor driver, MTDT: Metal detector.



**Fig.: 2: Block diagram of transmitter.**

Receiver- The signal is received with a telescopic antenna and then decoded in the RF receiver module. Then this control signal goes to the controller, where it executes the respective functions accordingly, as per the programming.

Output power of controller is not enough to drive the motors; hence we interface a motor driver in between the microcontroller and the motors. The output to the LASER is pulled up with help of a transistor so that it has the required power to switch ON. The video transmission is done with an external module and its technique is not into the scope of this project. The metal detector is built using the ‘Colpitt’s Oscillator’ where the further transistors are used for just amplifying the changes in the signal from the preceding oscillator circuit.

Transmitter- A keypad is interfaced to the microcontroller which will serve as a medium for inputs to the robot. These inputs are converted into hexadecimal form and then sent to the transmitter module after suitable framing. These ‘control signals’ are modulated with a carrier of 433 MHz using ASK technique. The framing itself takes care of security, by using ‘Short cyclic random’ sequence padded to the control bits. It also helps in addressing the receiver. Controlling this robot is as simple as playing a video game, by just looking at the screen which shows the actual condition of the robot’s surroundings (in first person). Only care has to be taken that the wire for the arm’s motor do not get twisted around itself due to multiple rotations, else a mechanical stopper can be added on the arm.

Auto stop interrupt for alarm ‘high’:

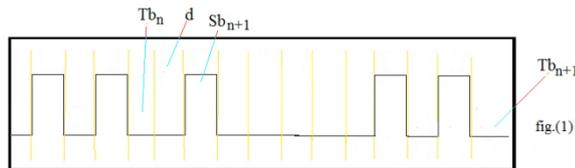
When the output of the metal detector goes high, a programmed interrupt to the controller makes the robot stop instantaneously. The output has to be made ‘low’ manually to resume control over robot. While in active interrupt condition, no commands are accepted by the robot and it comes to a stand-still with alarm high.

Transmission security:

A random sequence of 4 bits is pre-padded with the control signal. There is a set of 8 such ‘4 bits’ which get pre-padded with the control signal in a cyclic manner. The receiving end is in synchronization with this cyclic sequence and acknowledges every successful transmission. Two keys pressed at the same time do not result in any transmission. Thus even though, 433 MHz module is a common RF frequency, care is taken to ensure authenticity of the transmission.

Major components list- Microcontroller: ATXmega8e5 with built in oscillator clock, Wireless Communication: RF (Both AV and control), Motor drivers: LM293D, Standard 4x3 keypad matrix, DC Motor: Geared low rpm (Max. Torque 2 kgm), bipolar Stepper Motor with step angle programmed to 1°, LASER: Low Power 3V,





**Fig.: 5**

Transmission of bits ‘0101’ is shown in fig. 4 and 5 for two conditions: at full allowable baud rate and at half the baud rate respectively. The waveform in fig.:4 shows erroneous reception at 2400 bps, while waveform in fig. 5 shows reception at 1200 bps.

Modules were designed in three steps:

- 1) Software simulation- theoretical correctness.
- 2) Breadboard testing – To overcome the practical problems. (Only metal detector)
- 3) PCB fabrication – Final circuit for the module.

All the modules were integrated at the end. Before getting the PCBs fabricated, DRC report was checked to ensure that the design rules are obeyed. Such previous robot (fig.:6) and the one made in this project (fig.:7) can be distinguished as shown in the following images.



Fig.: 6: The UGV swarm robot with 1R arm geometry of the arm fixed with a gun.

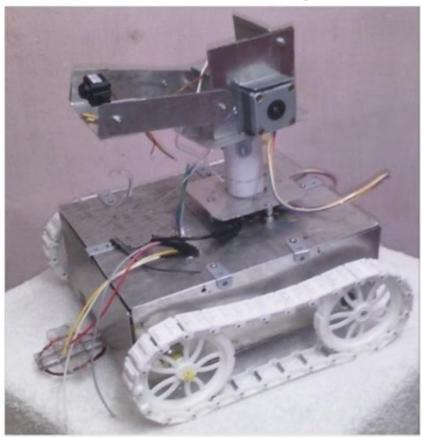


Fig.: 7: UGV with 2R arm geometry and metal detector.



‘Spy Robot’ with 2R arm geometry can be seen in Fig.: 7. As a result, an additional axis is added to the work space making it almost hemispherical.

## VI. CONCLUSION:

In the above described manner, the primary requirements of surveillance were fulfilled in this project and the robot is controlled by wireless communication. A Laser firing mechanism is also included.

Also the prototype Spy robot is provided with a metal detector and AV module.

These spy robots can be made multi-functional and even powerful transmitters can be used to increase the range. Further the load carrying capacity can be increased by using higher torque capacity DC motors. Infrared cameras may be used to enable night vision for the robots.

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