

# Design And Implementation of a Low-Cost Smart Surveillance Robot for Secured Monitoring System

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## Abstract

Modern surveillance requires a lot of human effort. The international border monitoring also requires human involvement. By using automated robot, distant location monitoring can be easily achieved. An idea is proposed to design a robot for location tracking and for security purpose. It is primarily used for location where human surveillance is not possible. The robot is commanded to reach the destined location then using the wireless camera it transmits the scene. The robot comprises of three steps namely receiving the data, going to the location, and transmitting the surrounding data through the camera. The transmitter section consists of four buttons. When the first button is pressed, the DC motor attached with the robot runs and the robot reaches the destined location. The signal comes from the transmitter reaches the receiver section and the Arduino gives the command to rotate the DC motor. After reaching the location, it starts to transmit the surrounding scene through the wireless camera placed in the robot. Based on the input command the robot reaches the destined location. The wireless transmitting camera can be used for surveillance purpose. A firearm is attached to the robot. Whenever any intruder passes the restricted place, the firearm can be used to stun the intruder. An extra button is provided in the transmitter section for firing the weapon manually. An LCD display is used to see the current location of the robot. All these components are interfaced using Arduino board.

**Keyword:** Surveillance Robot, Zigbee, DC motor, Arduino, Wireless Camera

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## I. INTRODUCTION

In the age of smart technology, to match the pace of the smart cities, need for smart security is of utmost significance. Analysts are of the opinion that the rise in terrorist

activities, growing crime rates, data thefts, remote monitoring, growth of public infrastructure, increasing IT spending, government initiatives and increasing security spending are all boosting markets for surveillance systems in India [1]. Against this landscape, as part of the world's leading portfolio of security and fire safety events, many security providing industries provide an opportunity to learn about the latest technology and industry trends and discover the best solutions to keep their business and clients secure amongst a showcase of products like CCTV & video surveillance, biometrics & RFID, integrated systems, access control, cyber security, integrated systems, physical security, perimeter protection, fire detection systems, intruder alarms and fire alarms on display[2]. The future of the India electronic security market is expected to be favourable on account of rapidly growing urban population, improved residential, commercial, and industrial construction and rising GDP of India. The rising awareness about benefits of the electronic security equipment will encourage the industries to expand their centres across the potential markets in India [3]. The electronic security market in India is projected to grow at a 24.0% during the financial year 2018 - 2021.

## **II. LITERATURE REVIEW**

In the present era of autonomous robotics, unmanned ground vehicles (UGV) and unmanned aerial vehicles (UAV) have emerged as a prime technology for implementing security and surveillance system [1]. The emergence of security robots is a new milestone in the evolution of security systems. Autonomous mobile robots designed for outdoor use can reduce the need for human workers to ensure the safety of large facilities. Security robots can provide the highest level of security at a modest cost that is much lower than the wages of hired employees. Previously security robots were manually controlled. After technological revolution, security robots are becoming automatic. In these robots, the end user profile is updated. Whenever any intruder enters the place, the robot scans the intruder and checks with the uploaded data. Upon mismatching with the reference data, the robot gives an alarm to the user [2]. Aerial monitoring implements unmanned aerial vehicles (UAVs) and these UAVs work on the same principle as that of the robots [3]. The application of these security robots is in military restricted area, residential area, border security and during night.

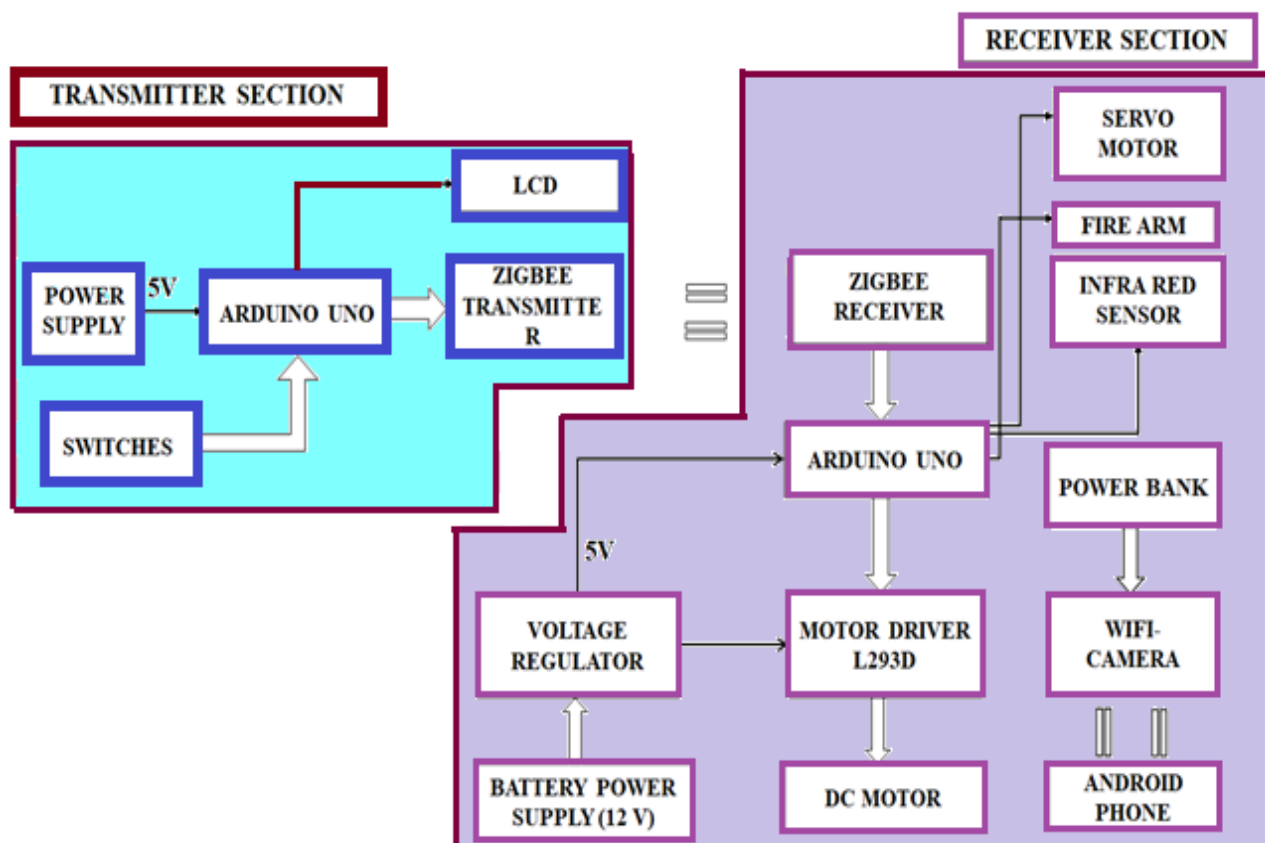
## **III. PROPOSED MODEL OF SURVEILLANCE ROBOT**

The robot is pre-defined with the co-ordinates of the location to be monitored. When the command signal is given, the robot reaches the location based on the pre-defined values. On reaching the first location, it can be instructed to move to the next location. Three different locations can be stored in the robot and by using the wireless camera, the location can be monitored. Every time when an intruder passes, the firearm placed in the robot can be used to stun him.

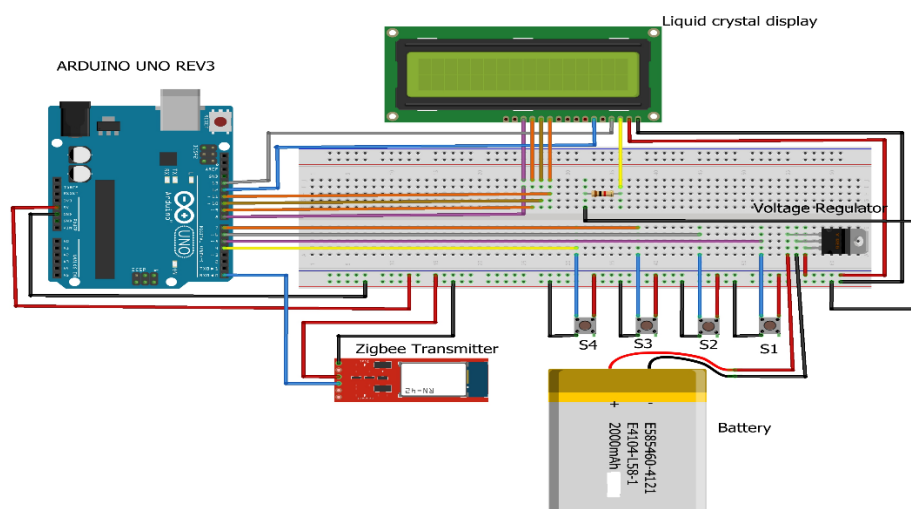
Figure 1 shows the overall block diagram of Surveillance Robot. The entire module comprises of two sections namely Transmitter section and Receiver section. The Transmitter section module includes Arduino UNO, ZigBee transmitter and four push buttons. The first three buttons are used to store the path for the locations and the fourth button for signalling the firearm to shoot [4]. An LCD display is interfaced with the Arduino to see the location of

the robot. Figure 2 shows the wiring diagram of transmitter with ZigBee transmitter and programmed with Arduino which is connected to the battery supply. Figure 3 shows the hardware module for transmission section.

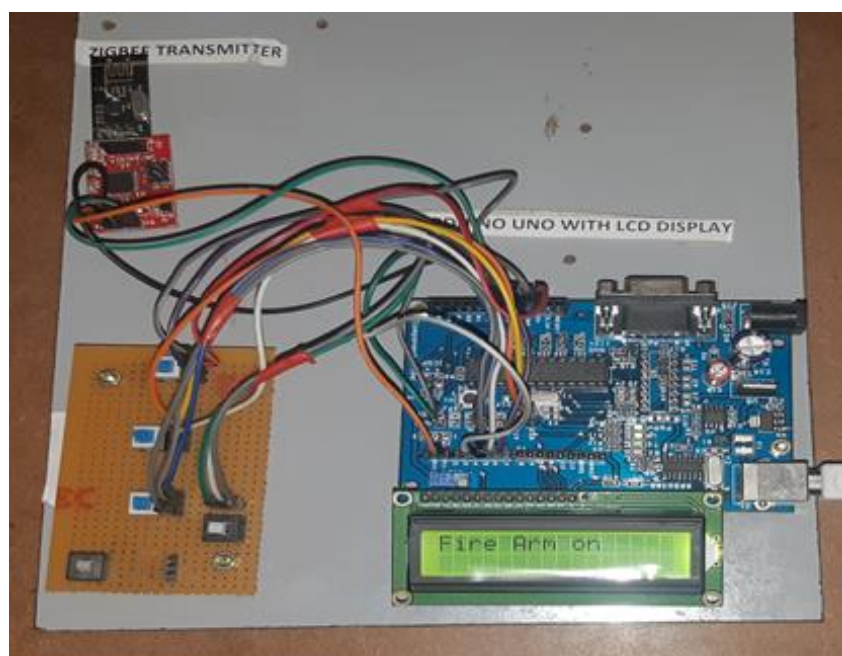
Figure 4 shows the wiring diagram of receiver circuit. The receiver section consists of 12V battery, voltage regulator, ZigBee receiver, Arduino UNO, motor driver circuit, servo motor, DC motor and wireless camera [5-7]. An IR sensor is used to detect any obstacles. The wireless camera is mounted over the servo motor to rotate in 180° for surveillance. Figure 5 shows the Hardware module of Receiver Section.



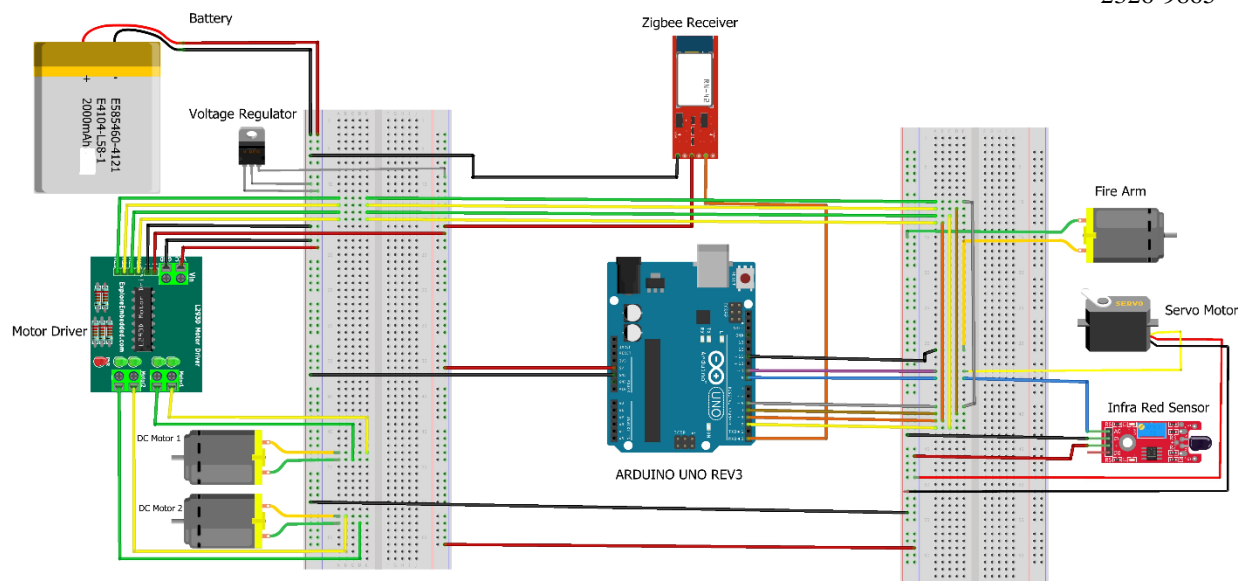
**Figure 1. Block Diagram of Surveillance Robot**



**Figure 2. Wiring Diagram of Transmitter Section**



**Figure3. Hardware module of Transmitter Section**



**Figure 4. Wiring Diagram of Receiver Section**



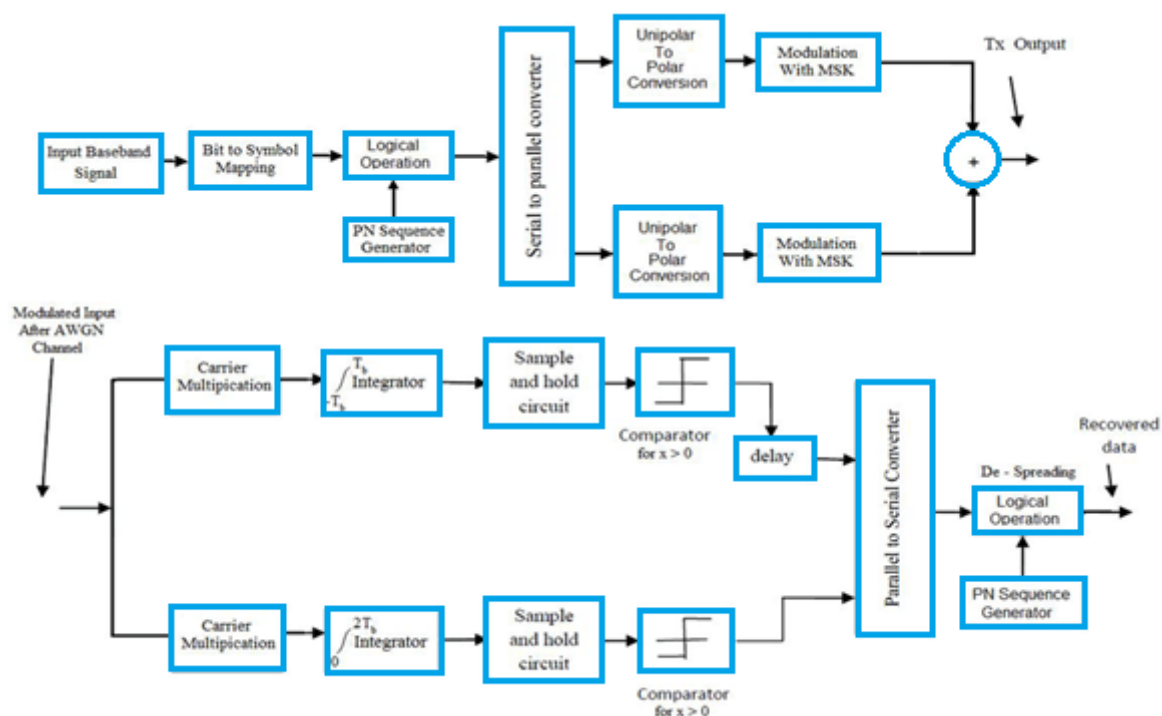
**Figure 5. Hardware module of Receiver Section**

When the first button is pressed, the ASCII value is generated, and it is transmitted through the ZigBee to the other section. The received data is checked for the values uploaded in the receiver section. When the data value matches, it executes the operation. On receiving the command from the user, the Arduino first checks, if there is any reading detected by the IR sensor. If there are no obstacles, the camera mounted over the servo motor records the surrounding and then the motor rotates based on the path to reach the destined location [8].

The motor driver circuit gives the necessary supply current for the motor to rotate and the command with which motor should rotate. The DC motor is used in the place of firearm. When the robot stops due to any obstacles, the fourth button in transmitter section is used to signal the firearm to shoot which means that the DC motor runs. The other two button when pressed does the same operation and reaches the destined location [9].

#### IV. MODULES OF LOW-COST SURVEILLANCE ROBOT

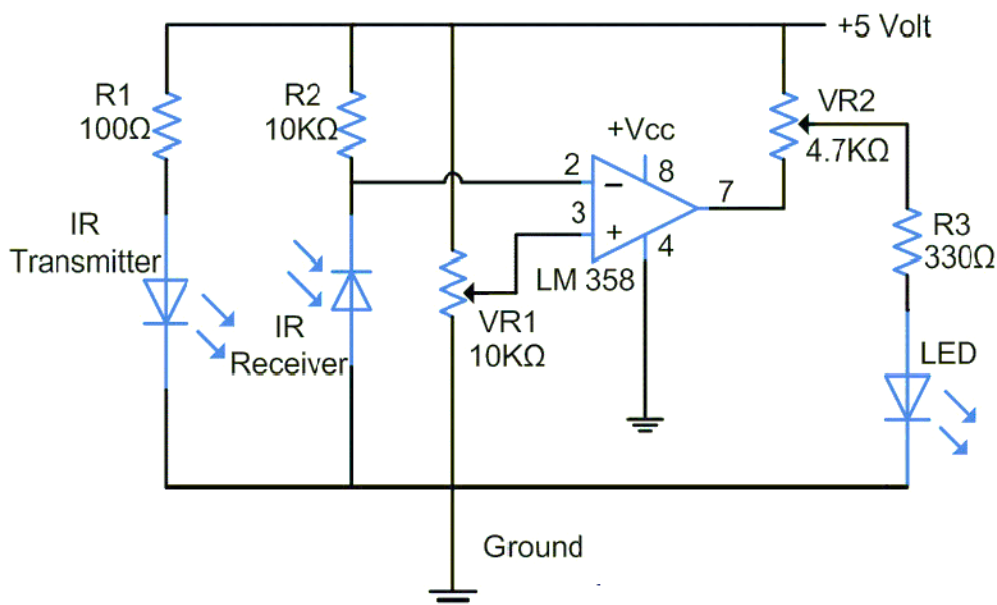
Zigbee is a high-level communication protocol used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection. The specifications of Zigbee module used are 250 kbps, range (10-100m), UART interface, 2.4 GHz frequency and 9600 baud rate. Figure 6 shows the block diagram for working of Zigbee module.



**Figure 6. Block diagram of Zigbee module**

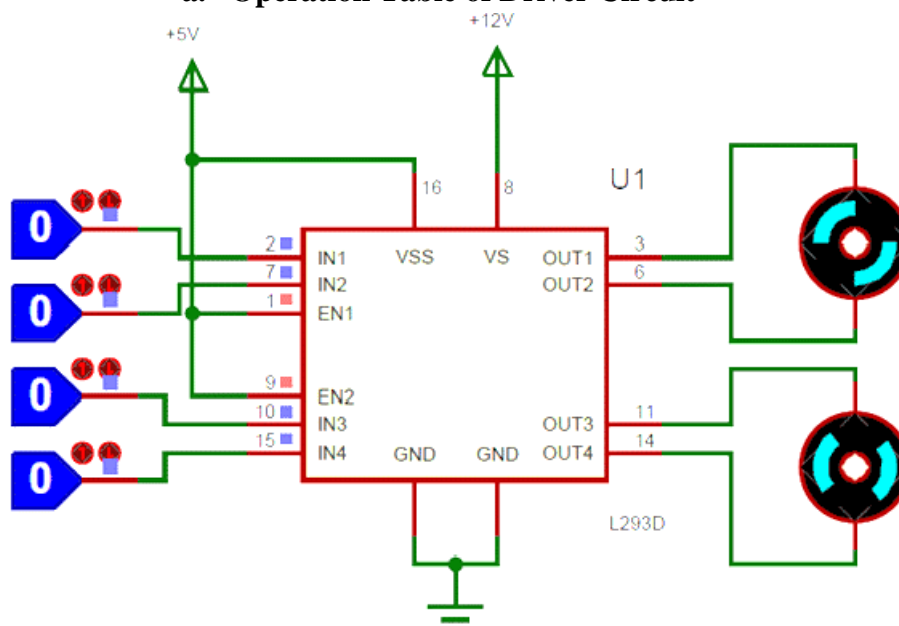
The usage of DC motor tends to keep robot lighter and more energy efficient. The main feature of flexible speed control of DC motor makes it an impeccable choice. Using power electronic controllers, DC motor can be used in different speed and torque conditions which is not possible with AC motor. It has higher starting torque, quick starting, stopping, reversing, variable speeds with voltage input and they are easier and cheaper to control than AC. The specifications for DC motor are 150rpm, 12V, 80 gm and rated torque of 2kg-cm.

An infrared sensor which is shown in Fig.7 is applied to sense a variety of characteristics of the surroundings. It can efficiently sense the heat emitted by an object and motion detection. The low power requirements, simple circuitry and its portable features makes it an efficient choice [10].



**Figure 7. Circuit Diagram of an IR Sensor**

**a. Operation Table of Driver Circuit**



**Figure 8. Circuit Diagram of Motor Driver**

Figure 8 shows the motor driver circuit. The Enable pins (Enable 1,2 and Enable 3,4) are used to Enable Input pins for Motor 1 and Motor 2, respectively. Since in most cases we will be using both the motors both the pins are held high by default by connecting to +5V supply. The input pins Input 1,2 are used to control the motor 1 and Input pins 3,4 are used to control the Motor 2. The input pins are connected to the any Digital circuit or microcontroller to control the speed and direction of the motor. You can toggle the input pins based on the following table to control your motor. Table 1 gives the motion

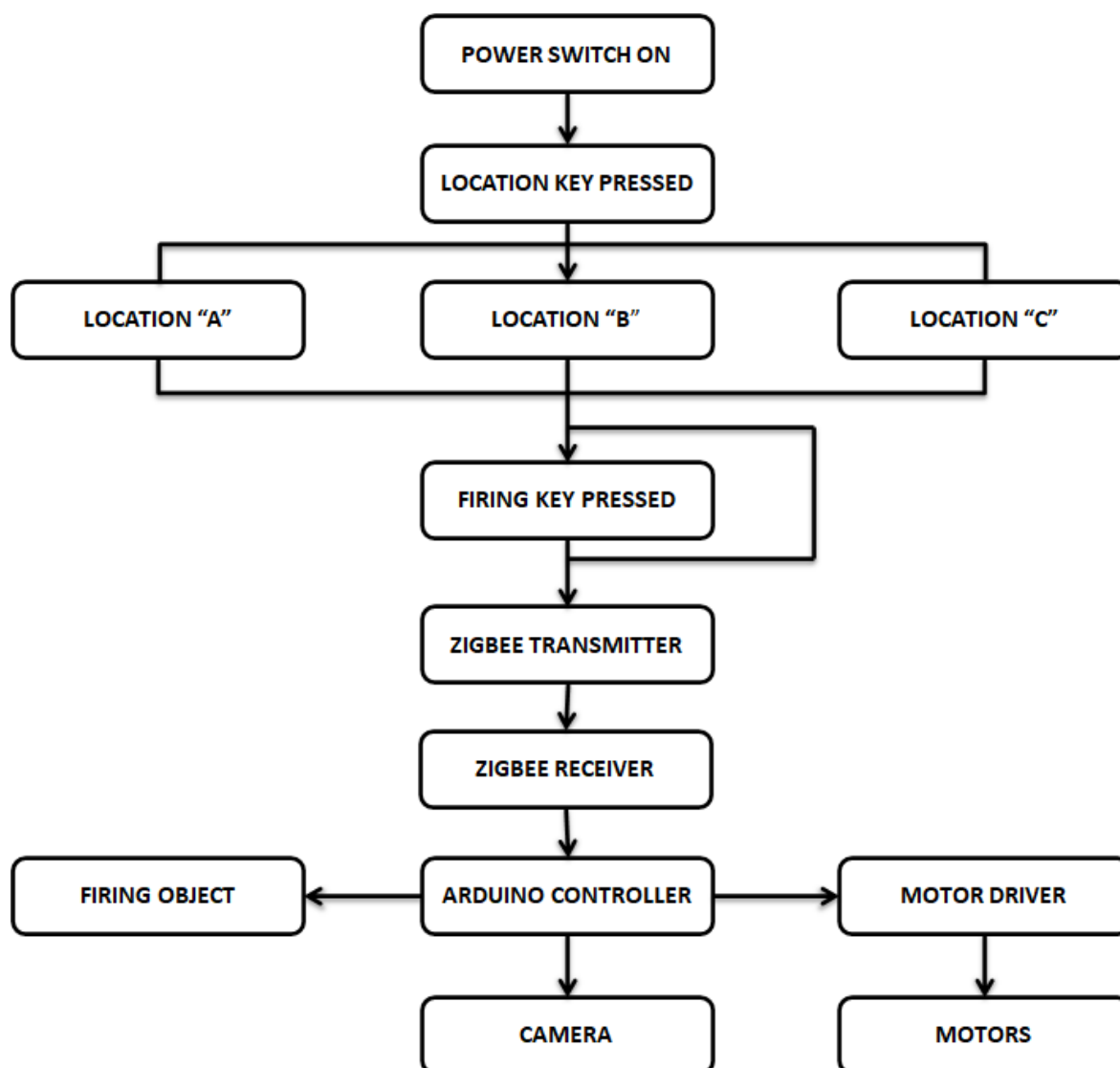
control operation table for motor driver. Figure 9 represents the operational flowchart of surveillance robot.

**TABLE 1. OPERATION TABLE FOR MOTOR DRIVER**

Input 1 = HIGH(5v)	Output 1 = HIGH	Motor 1 rotates in Clockwise Direction
Input 2 = LOW(0v)	Output 2 = LOW	
Input 3 = HIGH(5v)	Output 1 = HIGH	Motor 2 rotates in Clockwise Direction
Input 4 = LOW(0v)	Output 2 = LOW	
Input 1 = LOW(0v)	Output 1 = LOW	Motor 1 rotates in Anti-Clockwise Direction
Input 2 = HIGH(5v)	Output 2 = HIGH	
Input 3 = LOW(0v)	Output 1 = LOW	Motor 2 rotates in Anti - Clockwise Direction
Input 4 = HIGH(5v)	Output 2 = HIGH	
Input 1 = HIGH(5v)	Output 1 = HIGH	Motor 1 stays still
Input 2 = HIGH(5v)	Output 2 = HIGH	
Input 3 = HIGH(5v)	Output 1 = LOW	Motor 2 stays still
Input 4 = HIGH(5v)	Output 2 = HIGH	



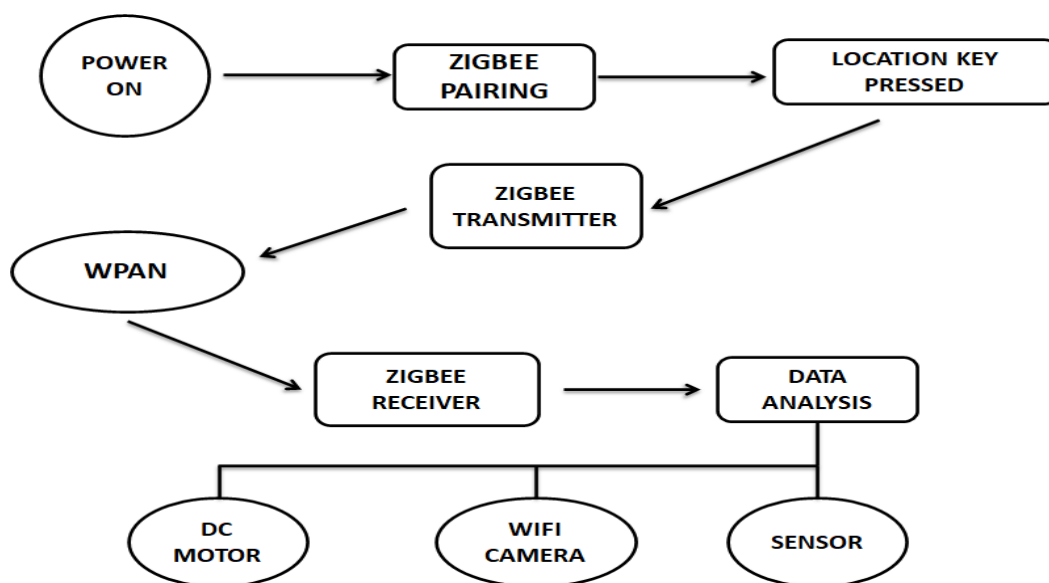
## b. Operational Flowchart



**Figure 9. Flowchart of Operation of Surveillance Robot**

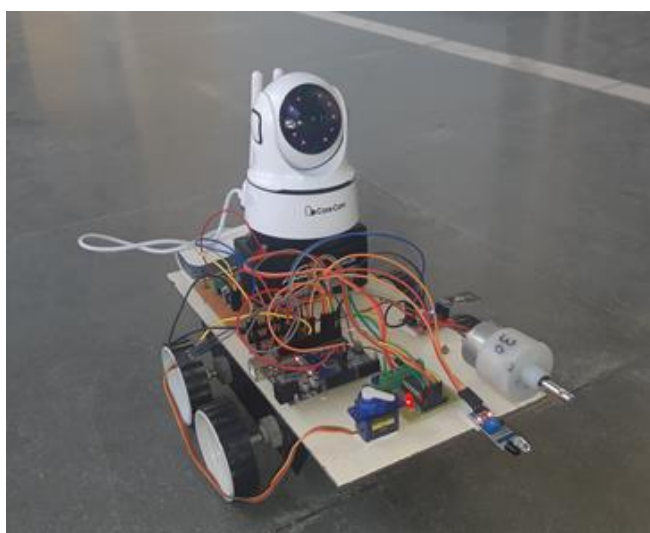
The power supply is switched ON and the location is given as an input. The Arduino in the transmitter decodes the input and sends it to ZigBee for transmission. ZigBee in the receiver obtains the data and the command is given to the motor via Arduino. Robot reaches the destined location, and the surroundings scene is transmitted via camera. Robot monitors the intruder, and a firearm is triggered to mobilize the intruder.

### c. Overall System Process



**Figure 10. Overall System Process**

Overall system process is shown in Fig. 10. The Zigbee is turned ON and both the Zigbee and Arduino is paired. The necessary location key is pressed, and the signal is transmitted to the receiver Zigbee. The receiver Zigbee sends the data to Arduino which analyses the data and gives the input to run the DC motor, Camera, and IR sensor. Figure 11 and 12 shows the prototype of surveillance robot and the image captured from the surveillance robot.



**Figure11. Prototype of Surveillance Robot**



**Figure 12. Captured Image of the location**

## V. CONCLUSION

The automatic location tracking robot was developed indicating the feasibility of the proposed approach. The robot receives the command from the transmitter and responds to it by reaching the destined location. The entire surrounding near the robot is visible to the end user by the help of wireless camera. when we press the other switches in the transmitter, the robot reaches the other location as commanded. Whenever an intruder is detected by robot, it stops and stuns them. The robot designed is applicable to guard a designated area, employed in unmanned locations and in military locations. The design would be more usable if a robotic arm is incorporated, which can manually be controlled by the user to move any objects out of the way. A night vision camera can be added to improve the vision during night.

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