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IoT Based Smart Multi Application Surveillance Robot

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***Abstract*—The main goal of this paper is to design and develop a surveillance robot that can reduce the casualties in the war field. The robot acts as surveillance robot to capture the intruders surrounding information before the intruder is attacked by the soldiers. The laser gun equipped on the robot aims to shoot the intruder on sight. The issues related to short-range communication to control the movement of the robot is overcome using an IoT technology. The robot movement can be controlled on an android phone by sitting anywhere from the globe. This project comprises of five phases: controlling the Robot in manual mode using IoT technology or in automated mode via android/PC, Wireless Night vision camera live video streaming with audio communication, PIR and Metal detection sensors, GSM & GPS technology, and a Laser Gun. The execution begins when the Robot halts on the detection of the PIR sensor and Metal detector sensor. The work aims to reduce the loss of life and achieve safety in the war field. The robot can perform multiple application such as if any bombs are placed at public places this robot acts as a bomb detector robot using the metal detector sensor and the location of the bomb detected is tracked using GPS. The robot can be used in natural disaster like earthquake, if any human is trapped under the building can be detected by using a PIR sensor equipped on the robot.**

Keywords—IoT,Solar panel, NodeMCU(ESP8266), GSM, GPS, Laser gun, IP Camera, cayenne software.

I. INTRODUCTION

With the various and fast advancements in the field of Automation and Robotics, Robots are playing a crucial role in the lives of human beings by reducing human errors and human labor. Surveillance is the method of systematic close observation over a person, area of suspicion. The surveillance is mainly required in the area of defense, public, industries, and offices. The main advantage of this robot in the surveillance field is replacing the humans, thus reducing the risk of life. This robot also overcomes the drawback of short-range technologies by using IoT technology for controlling the motion of the robot.

This robot is controlled by vision-based, which is done by using the Wireless Night vision camera which gives the live streaming of the robots surrounding area. The direction of robot wheels is controlled using the Internet of Things via an android/PC from the controller unit of Defense. The issue of power supply has overcome by equipping the solar panel on top of the robot, which stores charge in the battery. PIR sensor and metal detector sensor placed on the robot traces the motion detection and buried landmines. The GSM technology provides the notification to the control unit once the robot stops on the detection of sensors. The GPS receiver is used to track the robot and also to notify the user of the landmine or bomb's exact location.

II. LITERATURE SURVEY

Ahsanul Hoque1 et. al. reported a design of robot with an night vision camera which provides the live stream of the required vicinity and a metal detector is used to detect bombs beneath the robot. The IP camera used in their work do not provide the audio communication[2]. Jignesh Patoliya et. al. designed a robot in which the movement of the robot is controlled using Bluetooth technology by an android application. The limitation of their work was the short range of communication of the robot vehicle [3-4].

Other similar works are reported in the literature where an android application call Cayenne software is used to control the motion of the robot via Internet of things. The cayenne software is used to provide commands to microcontroller via a wireless medium i.e. Wi-Fi module [5].

Shuddha Chowdhury et. al. have reported a design of a robot which was designed to serve during the natural calamities like cyclones, earthquakes, landslides etc.[6] the robot uses an PIR sensor to detect the human being or animals trapped under the collapsed buildings. The major drawback of the proposed robot was to track the real time location of the robot. Various prototypes of landmine detection robot were reported by researchers [7-10]. The robot was equipped with GPS system for navigation purpose and tracking of the robot with and the solar panel for power supply.

Souvik Saha et. al. reported a surveillance based robot which developed on raspberry pi and the software implementation was carried out on Linex operating system and Python language was used for programming [11].

R.Praveen Kumar, Dr.S.Smys reported about the development of Internet of Things, Importance of IoT, and its widely used protocols[12]..

III. DESIGN AND DEVELOPMENT

The Design and development is divided into three domains. The hardware implementation, System Architecture, and Circuit development.

A. Hardware implementation

The Block diagram is shown below in the figure.1 depicts the entire robot system which illustrates the operation of the entire system.

- *Arduino board:* Arduino UNO board consists of ATMega328 microcontroller. Arduino UNO is an open source platform for the users to develop AND DESIGN the prototype using Arduino IDE software.
- *Solar panel*: The solar panel is equipped on the Robot to charge the battery, which supplies the power to the entire system, the renewable resource of energy produces up to 12Volts in bright sunlight. The solar panel is connected to a charging control unit which is further connected to the battery. The charging control unit prevents the extra amount of charge to flow in the battery, the extra flow of charge to the battery may damage the battery.
- *Android phone/PC:* The next block is the controller block. The controller unit comprises of android phone or PC through which the operator has access to the robot.
- *IoT server*: The IoT server is used to place the communication between the robot and the operator. The communication can be carried out using the cayenne software.
- *ESP8266 (NodeMCU):* The ESP8266 is a Wi-Fi module which is used to provide the internet access to the microcontroller. The commands are provided to the microcontroller via cayenne software to control the motion of the robot. Cayenne is an object relational mapping framework. It provides the programmer to work on the object abstracted from databases.
- *IP camera (V380):* IP Camera (V380) is the Wireless Night Vision Camera which is manually controlled using an android application called V380 via internet. The application provides the live streaming video, of the surroundings and also the audio communication feature is available.
- *PIR sensor:* The PIR sensor HC-SR501 is used in the system. This sensor is used for detecting the motion in the vicinity.
- *GSM (SIM900A):* Global system for mobile communication (GSM) is equipped on the robot. The GSM provide Short Message Service (SMS) to the operator on detection of the PIR sensor.
- *Metal detector senor:* The metal detector is used to detect the landmines or bombs underneath the robot. On the detection of the same, the location is tracked via GPS.
- *GPS (NEO-6M):* Global positioning system *(GPS)* is used in the system to track the location of the robot. The coordinates of the location are provided in longitude and latitude values in the android application called bylnk.
- *Motor driver (L293D):* The motor driver are used as an amplifier, to amplify the voltage supply to the motors. The motors operate at 12v but the microcontroller provides only 5v at its output pins.
- *Laser gun:* The laser gun which is equipped on the robot is activated if the human is detected as suspicious.

B. System Architecture

The system architecture shown in the figure 2 and figure 3 provides the design flow of the work and the implementation of the system. The system works in two modes of operation Manual mode and automated mode. In the Manual mode the complete robot is under the control of the operator at the controller unit in the defense sector. In Automated mode, the robot is put into the automatic mode, the robot roves around the provided area by the operator and the robot stops only on the detection of the sensors and provides notification of the same to the user or operator in the controller unit.

1. Communication:

In the system, the operator communicates with the subsystems through wireless communication. The microcontroller is connected to the internet using another microcontroller NodeMCU(ESP8266).The instructions are provided to the microcontroller via an android/PC application called cayenne software based on the Internet of Things(IoT) to control the motion of the robot[5]. The Cayenne software is used to control the directions of the robot-like forward, reverse, right, left, and stop. The wireless night vision camera V380 used to stream the live video of the surrounding is controlled via an android application called V380 by creating a "Wi-Fi smart-link" in the application one can control the movement of the camera. GPS tracker application is used to track the location of the robot.

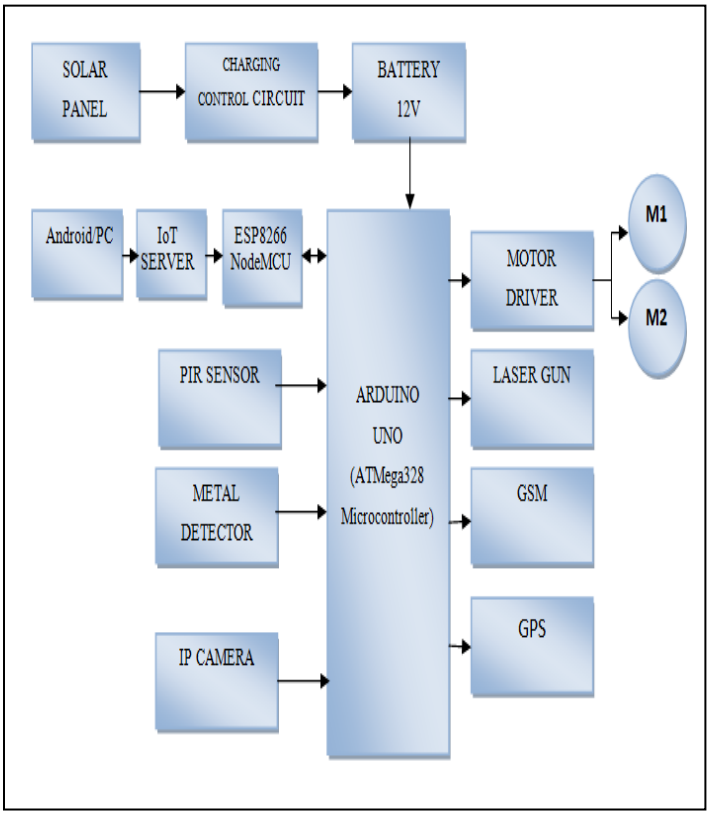

Figure 1 Block diagram of the proposed system

2. Design flow:

The implementation of the design is divided into two modes of operation:

a)Manual Mode:

Motor movement: Using the smart phone /PC the instructions are provided to the Microcontroller which is connected to the internet, on the basis of provided instructions the robot roves around i.e. forward, backward, left, right, and stops if any instructions are not provided[3].

PIR sensor: Whenever the PIR sensor on the robot senses the motion within the approximate range of 10m, the robot stops and notifies the operator using GSM that "Motion detected". The camera is rotated or controlled by the user to check around for the object. The Laser Gun is activated if necessary and if the intruder is suspicious, the intruder can be encountered on site. If moving commands are received, the robot roves.

Metal Detector: When the Metal Detector detects the landmines/bombs buried under soil, the Robot stops and the location is tracked using GPS. The latitude and longitude values are traced and are received by the operator. So that, the Bombs and landmines can be diffused. If moving commands are received, the robot roves.

The complete working of the robot in manual mode is as shown in the below figure.2

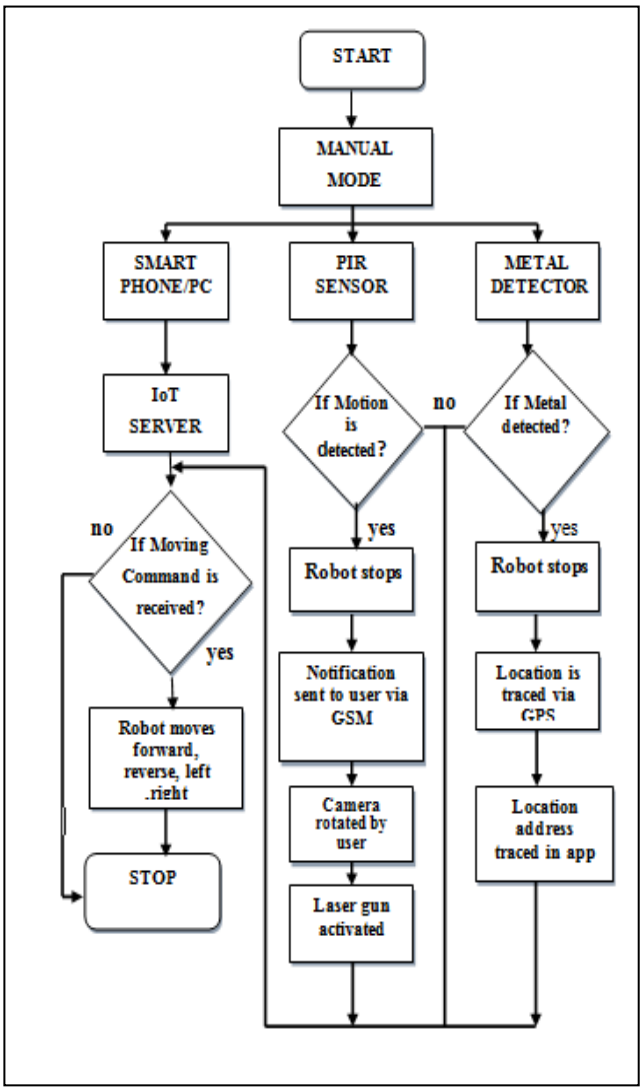

Figure.2 Design flow of the robot working in manual mode

b)Automated mode:

In the automated mode, the robot roves around the provided area and if the PIR sensor detects the motion within the approximate range of 10m, the robot stops. The notification "motion detected" is sent using a global system for mobile communication (GSM) to the operator and the operator can do the tasks such as rotate the camera or activate the laser gun as required. If the moving commands are received to move the motors the robot roves around.

C. Circuit development

The circuit implementation provides the pin mapping of the components such as sensors, actuators, GPS Module(NEO-6M), GSM(SIM900A), and WiFi module(ESP8266) to the Arduino UNO board containing ATMega328. The pin mapping is shown in figure 3 below:

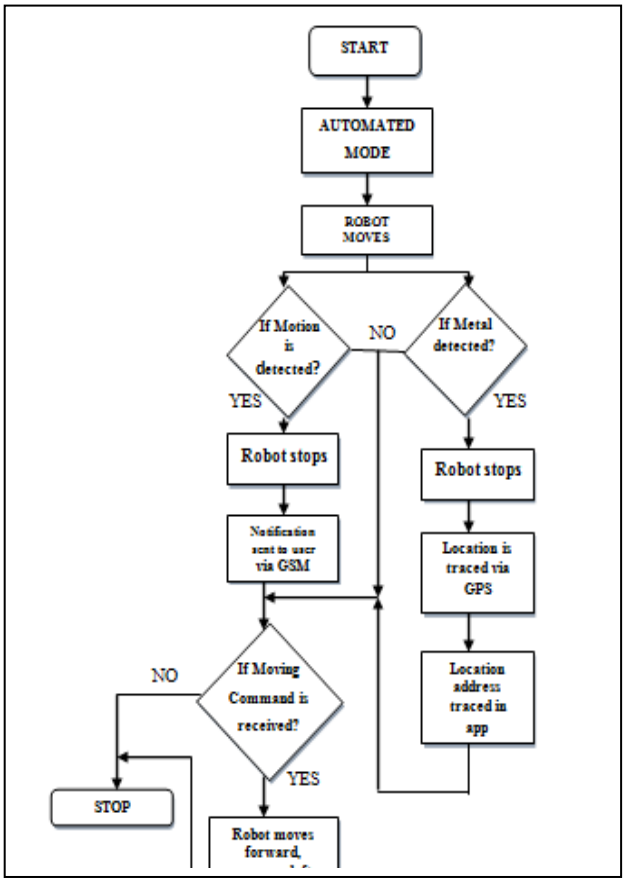

Figure 3. Design flow of the robot working in automated mode

- The IP wireless Night vision camera is connected to the the 5v of power supply and to the ground pin

- The GSM Tx pin is connected to the digital pin D0 of the Arduino Board. The power supply pins gnd and Vcc of GSM is connected to the gnd and 5V OF Arduino board.
- The GPS Tx pin is connected to the digital pin D2 of the arduino and corresponding Vcc and gnd are connected to the 5v and gnd.
- The output of the Metal detector is connected to the digital pin D1 of the Arduino board.
- The output of the PIR sensor is connected to the digital pin D5 of the Arduino board.
- The Wi-Fi module NodeMCU Tx pin is connected to the pin D6 and Rx to the D7.
- The DC motor is connected to the pins D11, D12, A0, and A1 of the Arduino board.
- The Laser gun is connected to the pin D10 of the Arduino board.

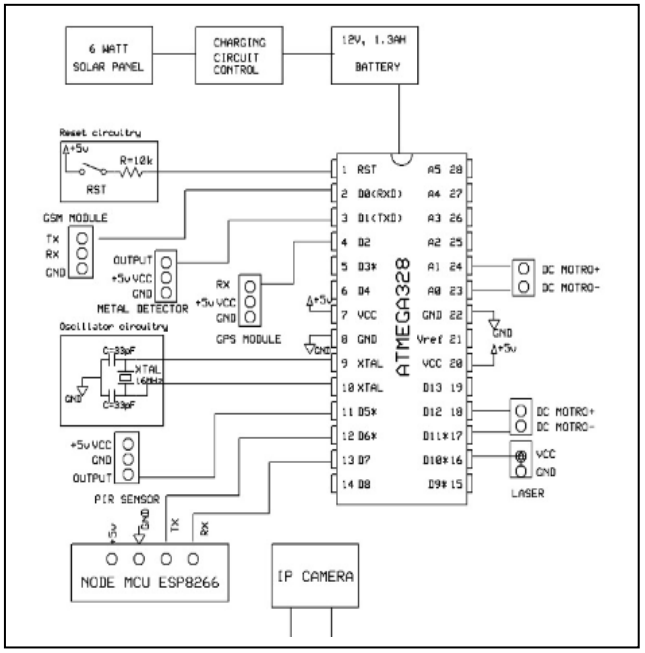

Figure 4. Circuit implementation of the system

IV. RESULTS

In this paper, the movement of the robot is achieved by using the cayenne software as shown in the figure.4 the robot can be put in manual mode or automated as shown in below figure.4. By pressing the corresponding button the robot moves forward, reverse, left, and right [5]. The Robot goes in automated mode once the auto mode button is pressed.

In this work, the live streaming of the surrounding area is obtained by the IP Camera V380 with a resolution of 720 pixels and high picture quality. It also contains features like two-way intercom, voice message, wide angle-view, live video monitoring, and night vision. It consumes low internet data and the camera can be rotated with an angle of 360 degrees. The memory card is supported up to 64GB.The camera provides video of the required area with high quality as shown in figure.5

V. CONCLUSION

The robot model can be reported to build a robot whose motor movement and mode of operation i.e. manual or automated are controlled by using a cayenne software that is used to build IoT based application. The wireless night vision camera is used for video recording and the live stream of the video can be viewed through an android application known as V380. The PIR sensor used on the robot sense the motion in its vicinity and notifies the same to the operator on the android phone or PC by short message service (SMS) through GSM service module equipped on the robot.

The robot proposed can reduce the loss of life of on border areas, and other locations where military surveillance is required. With the help of live video streaming the operator can perform the patrolling duty and recce any unexplored area.

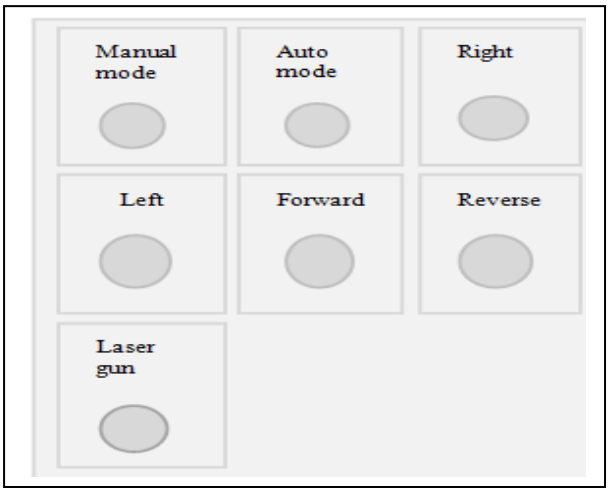

Figure 5. Control buttons to control the motion of the robot

Figure 6. Video recording captured by the wireless camera of the area

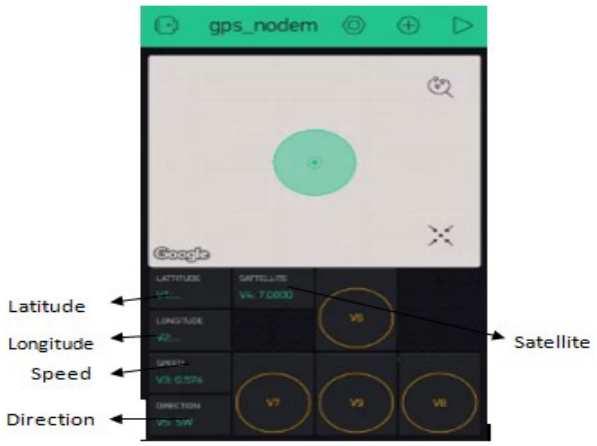

Figure 7. The location traced in the blynk software

The laser gun equipped on the robot can be used to shoot the trespasser if necessary and the metal detector can detect the landmines buried in the ground, the GPS tracker equipped on the robot can provide the coordinates of the landmines.

The further research can be carried out to overcome the limitations of the proposed robot such as the inability of the robot to rove in the rain. The size and weight of the robot can be further minimized by using innovative design and advanced material to build a robot.

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