IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p-ISSN: 2278-8735
PP 01-06
www.iosrjournals.org

Surveillance and Target Engagement using Robots

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Abstract: *This paper presents an approach that can be used for military to avoid bloodshed. Over the years, India has heavily suffered from border encroachment. Soldiers from other nation infiltrate our country through places where human intervention is not possible. Considering this we have designed a robot that is capable of performing surveillance and transmit the live stream of the area continuously without using human help in a tough terrain and attack the unauthorized persons who seek entrance in to our homeland. The robot is designed such that it is capable of working in a hilly area too, and the robot will be equipped with a gun, that is capable of loading and an android mobile with a high definition camera will be used for video streaming. Thus our objective is to make a full featured surveillance and attacking robot using an easily available Android Smartphone that can be easily controlled over the Internet with any complexity and high cost.*

Keywords - *android operated, robotics, surveillance, target identify, wireless.*

I. Introduction

Surveillance is the process in which people, places, or things are monitored usually for the purpose of influencing, managing, directing, or protecting them. Today there is a need for high surveillance especially Country borders, public places, government offices, etc. comes in the category of outdoor surveillance while warehouses, homes, garages fall in the category of indoor surveillance. Both these surveillances can include observation by means of CCTV (Closed Circuit Television) cameras or by sending soldiers or spies near the area which has to be examined. But CCTV and other cameras have their own drawbacks and constraints such as they usually have blind spots and they can be covered with sticking something over the lenses like gum or spray paint, also to cover the entire area many cameras are required to reach every nook and corner increasing the cost. Similarly, human beings also have their own limitations such as obtaining information from inaccessible places is not possible; at the same time human life is precious and getting caught by the enemy is also a risk. Thus humans cannot always be used to acquire information from remote and dangerous places. [1]

Here robots come into the picture. A robot capable of moving in all types of terrains and mounted with camera and other sensors can do the job. It can help in outdoor surveillance by monitoring important places and also it can be made to reach suspicious place for close observations. Similarly, a robot can be used for indoor surveillance and can be made to reach the places of interest for getting the information rather than installing cameras in the whole environment [1]. With the use of the robots many human lives can be saved because an observation can be made without going to the risky places, also even if robot is caught it can be destroyed without risking anything.

Moreover, the enemy may be armed while trespassing our area. In that case human intervention is not possible. By using soldiers, we risk the value of human life and become violent in doing so. In such risky and dangerous situations, a robot could be a great help to defend our area and to attack the attackers [2]. A robot capable of moving in all types of terrain mounted with the camera and sensors can go to the affected area and can provide all the live information to the military, as per the situation the army can act on it.

II. Related Work

Robotics in the field of surveillance and rescue is very popular. A lot of research has been done for transmitting live video, wireless control system of robots to establish long range and reliable communication. The most common method is to use a wireless camera along with costly sensors and mount them on the robot to get the live video and other environment parameter details. The robot is controlled either with Bluetooth or Zig-Bee [1].

Surveillance Robot Using Arduino Microcontroller, Android APIs and the Internet, that is capable of transmitting video relay to a local host was designed. [2]

Our concept is rather unique in the sense that it provides a low cost solution that offers unlimited range, video feedback. The robot is able to avoid obstacles. It is provided with temperature, humidity, smoke and gas sensors to measure various environment parameters. The robot has autonomous navigation facility. The use of Smartphone allows the user to get live audio data from the environment. The use of Android allows the use of many applications that can be helpful in surveillance and rescue operations. The robotic arm facilitates picking up of objects such as radioactive and other harmful objects. Acceleration and GPS data are received from inbuilt sensors in Smartphone. It can also detect humans if present in the vicinity. The robot can be controlled from a Laptop, a Tablet solving the problem of portability of controlling system.

III. Proposed System

Our system includes a two-wheel robot with an Android Smartphone stacked on it as shown in **Fig 1.** The robot is embedded with Ultrasonic sensor, Passive Infrared, Temperature, Humidity, Smoke and Gas sensors. A Laptop or Tablet is used to control the robot remotely over the Internet. **Fig. 2** represents the top view of the arrangement with Robot at centre. The robot connects to the Smartphone to the Internet via Wi-Fi module. The robot is provided with a battery, Sensors and the Smartphone.

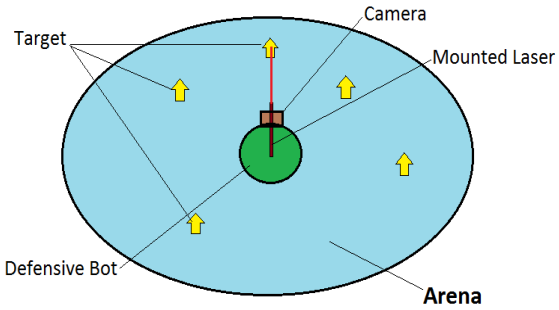

Fig. 1. Shows an overview of the proposed system.

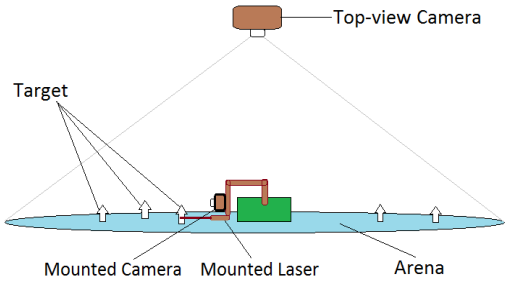

Fig. 2. Shows the side view of proposed system.

IV. Working

The working process of robot will be given by the following set of algorithms defined by us. The following diagram given by **Fig.3** shows the steps the robot will follow.

4.1. Scouting the arena for a target:

The robot will continuously monitor the area for any intruders. It will scan the entire area for any movement. After it scans it totally it then turns a small angle and does it again. [4],[5]

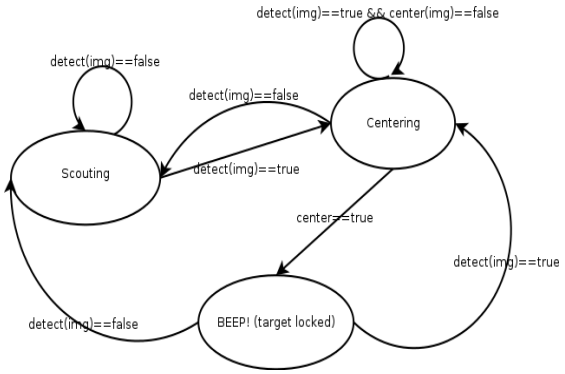

Fig. 3. The working of Robot

4.2. Identification of the target:
If an object is moving the robot will capture the image. The image is first run through an image recognition algorithm, suspected object is identified and when it surpasses a minimum size it is recognized as the target.

4.3. Centring the camera:
The camera is centred on the centre of the object by sending the signals appropriate based on the logic.

4.4. Firing the laser:
The firing of the laser is accomplished by rigging the laser to servo motor 3 and activated when needed to fired.

V. Hardware Requirements

5.1. Fire Bird V ATMEGA2560:

The Fire Bird V robot is the 5th in the Fire Bird series of robots. First two versions of the robots were designed for the Embedded Real-Time Systems Lab, Department of Computer Science and Engineering, IIT Bombay. These platforms were made commercially available from the version 3 onwards. All the Fire Bird V series robots share the same main board and other accessories adapter board. [6]

Fig.4 shows the top view of the robot that is going to perform the surveillance and attacking. The robot is made such that it has two MCU's inside it. One will act as master while the remaining one will act as slave. The robot has inbuilt communication devices both wireless and wired supported.

Fig. 4. Depicting the top view of Firebird-V

5.2.Buzzer:

Robot has 3 KHz piezo buzzer. It can be used for debugging purpose or as attention seeker for a Particular event. The buzzer is connected to PC3 pin of the microcontroller. Also the same buzzer is used in battery monitoring circuit to alert the battery low indication.

5.3.SPI expansion port on the main board:
Main board has SPI connector for adding accessories such as robotic arm, colour sensor etc.

5.4.Serial Communication:

Robot has 9pin female DB9 connector for serial communication. Out of these 9 pins only Tx (pin 3) Rx (pin 2) and ground (pin 5) are connected to the microcontroller via MAX202 RS232 to serial TTL / CMOS logic converter. Figure 3.53 shows location of the serial on main board.

5.5.USB communication:

Fire Bird V's main board has USB port socket. Microcontroller accesses USB port via main board socket. All its pins are connected to the microcontroller adapter board via main board's socket connector.

5.6.Wireless communication adaptor:

It supports XBee and XBee Pro series 1 and series 2 ZigBee wireless modules from Digi international, RN-XV Wi-Fi to serial module and Bluetooth module. Table 3.20 shows the functions of the status indicator LEDs for the XBee wireless modules.

5.7.Sensors*:*

1. Three white line sensors (extendable to 7)
2. Five Sharp GP2Y0A02YK IR range sensor (One in default configuration)
3. Eight analog IR proximity sensors
4. Two position encoders (extendable to four)
5. Battery voltage sensing
6. Current Sensing (Optional)
7. Five MaxBotix Ultrasonic Range Sensors (Optional)

5.8.Android mobile:

An android mobile having the minimum requirement of 2.0 MP front camera and 5.0 MP rear camera with an operating system of V4.4+.

VI. Software Requirements

6.1. IP Webcam:

It turns phone into a network camera with multiple viewing options. Camera can be visited on any platform with VLC player or web browser. Stream video inside Wi-Fi network without internet access. Ivideon cloud broadcasting is supported for instant global access.

Fig. 5 shows the homepage of IP webcam which is an alternate way of displaying video and make screen grabs.

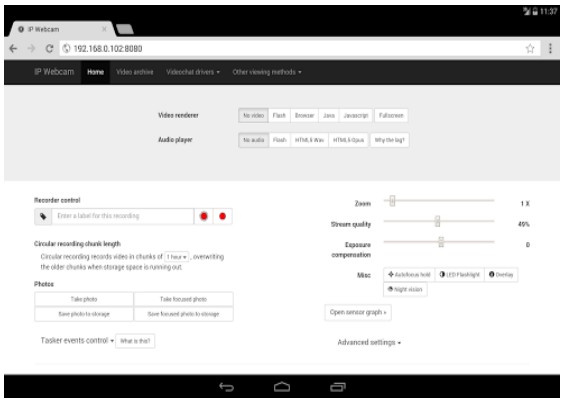

Fig 5. The home page of IP webcam

6.2. VLC media player:

It is a popular open source software that is capable of playing multiple extensions over any platform.

6.3.Matlab:

It is propriety software that is used for signal processing and image processing.

VII. Security Features

A military operation requires a very high security, especially in the case of border line defence. Every mission requires confidentiality while implementing it. Moreover, the data must be maintained such that only the authorised persons may access it. While transmitting a video we must make sure proper authentication

process takes place. The IP webcam provides authentication facility too, by providing a user name and password.

The password can be assigned by using the video interface option present in the application. By default, the network will be open to all, by configuring an authentication process only the authorized person will gain access to the video relay. Moreover, the application is based on static IP, which means the IP can't change the address and remain same. So security becomes an essential feature.

Fig 6 shows the log in window of the application that is featured on the vlc media player. By entering the user name and password, the video transmission between end user and mobile will takes place.

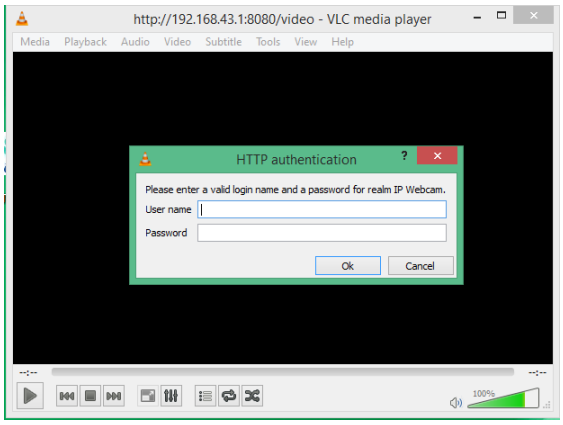

Fig 6. Depicting the authentication process.

VIII. Target Engagement

Once detected we need to go for the next phase which is enemy engagement. The robot will align itself towards the direction of the enemy by using the servo motors. The maximum accurate range it can cover will be about 5m in open space. The model gun will be placed on top of the robot using mount and two servo motors will be available for rotating. The servo motors were placed such that one placed above another. In case one got failed the remaining one can be used.

Fig 7. Shows the hardware arrangement of robot which features a gun mounted on the top of the robot, which rotate in all direction.

Fig 7. depicting the assembly setting of robot for attacking

The gun will automatically target the intruder and attack with the dart placed with in the gun. After attacking it will take a sample snapshot as a proof and will transmit to the base station.

IX. Scope For Future Work

This project offers a lot of scope for adding newer features. Since all image processing is done remotely, there are no resource constraints apart from the bandwidth of the network. We can program the robot such that it can detect objects and reach them on its own. Thus, we can make it completely autonomous. Also, with the presence of GPS navigation and mapping software, the robot has the capability of finding the best route possible to reach a certain location. Also, by making it sturdier and giving it extra protection, we can make it an

all-terrain robot, which would make it ideal for a surveillance robot. There is also the option of adding sound processing to the remote computer, thus giving it greater surveillance capabilities.

X. Conclusion

A comparative study of surveillance and target engaging robot is carried out and a framework for building a cost effective robot is proposed. The system has all the required sensors and accessories useful in any situation. The use of Smartphone solves the problem of limited controlling range, provides easy and portable Internet connectivity and also provides the audio data facility. The robot can run in all types of terrains. It can detect alive humans and can move autonomously avoiding obstacles. It can also perform military surveillance like spying enemy base, exploring unknown enemy territory, explosive disposal, and as a mobile communication device during war, natural disasters.

Acknowledgements

Authors would like to express their sincere gratitude towards Mr. CT. Vijay Nagaraj for being a source of help and encouragement to put forth this project. Authors would like to acknowledge Dr.S. Robinson for his continuous support in fulfilling this research. Authors would also like to thank their Institute Mount Zion College of Engineering and Technology for providing the necessary facilities for carrying out research work.

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