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Border Security Intrusion Detection Using IoT and Embedded Systems

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Abstract

Borders are highly prone to intrusion. It is difficult for the soldiers to monitor the border areas consistently and tirelessly. Hence it is essential to build a system which will reduce the effort of a soldier. Life of a soldier is precious and fragile and should be treated as such. This proposed system aims at reducing the workload of armed forces. The proposed portable model consists of Passive InfraRed sensor (PIR) sensor, cameras that will detect motion of the intruder and notifies the control station and the buzzer that self-activates to warn the intruder being in a restricted area. The whole networks of sensors are connected through Internet of Things (IOT) in the border site. The live streaming and face detection feature using Raspberry Pi allows the admin to categorize authorized and unauthorized personnel and make decision precisely. The system also incorporates an electric fence and a gun and can be operated manually to take action against intruder. The set-up will work alongside the human soldiers acting as a helping hand hence assuring protection of the borders.

Keywords: *Internet of Things, Passive InfraRed Sensor, Raspberry Pi.*

1. Introduction

Securing the boundaries from intrusion of illegal man or an unauthorized human across borders using minimal human resource at an affordable cost is the need of the hour. The borders have to be continuously monitored for suspicious actions which can be tiring task for a soldier. Also the climatic and geographic conditions may not be favorable all the time for a human.

The existing system uses Bluetooth enabled communication which may limit the range. A 180-degree controllable motor to scan area which does not provide a complete view of the area. There is a warning facility which is controlled by monitoring centre which may not be reliable all the time. The existing model is not movable.

The proposed robot has wheels making it mobile. Our system consists of a 360-degree rotating camera that will detect any motion and notify the control center. It also employs PIR sensor; data from the sensor is sent to the control station through internet. A self-activating buzzer makes noise, warning the intruder about being in the restricted area. The robot also has live streaming feature which provides continuous media delivering to the controller site via internet. There is face detection feature that is employed which helps in categorizing a person as authorized or unauthorized. There is a motor controlled gun which is manually controlled from the control station. An electric fence is incorporated and is activated on receiving orders from control station.

2. Literature Survey

Border security intrusion detection was intensively studied.

Most of the proposed works are based on PIR sensors and Raspberry Pi. The survey on wireless sensors network for border surveillance as well as intruder detection aims to devise the multi-sensing system. It is developed by combining various techniques for surveillance such as, movement on flat surface or movement on water-body. Distinct sensors are used for human intruder detection with infrared, geophone, hydrophone and surveillance cameras [1].

Bhadwal proposed a model for detecting intrusion at border site using a surveillance camera, infrared sensor

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and PIR sensor [2]. It provides video surveillance for operating site. The angle of surveillance is achieved using multiple motors connected to RaspberryPi. On detection of intruder, the image of border site is sent to controller system screen. The system consists of a warning system and an auto-combat system for achieving security at border and military base stations. The drawback of this system is that it is a stationary model, which reduces the working area of model.

[3] Proposes a trespasser detection system that has a PIR sensor and video surveillance. It uses two mobile phones for operating the system. Two DC motor will be used for positioning the laser gun and providing movement to the model. Bluetooth model sends essential information to control site which is present in microcontroller. Information obtained is used for taking further decision and firing at the intruder if necessary by control room.

The robot system uses PIR sensor for identifying trespasser and sends alert to the security personal through sms using GSM Module [4]. The current model didn't have any module for streaming video continuously and it is a static module. Raspberry pi and ESP8266 based architecture sends notification and establishes communication [5]. It has two sites, namely border site and control site. The window has multiple control operations to control machine gun, turn on and off electricity, controlling the movement by manipulating horizontal and vertical motors. The drawback of this system is that a continuous streaming of border site video is not efficient enough to detect the intruder. More advanced system is required for analyzing even minor motion at the site.

The reprogrammable robot with multiple sensors for detecting metal and bombs, smoke sensor for detection of smoke, and various other sensors for detection of electromagnetic field and fire [6]. A camera is mounted on the robot for streaming video. The robot has the ability to carry weight and RF transmitters and are used at predefined frequency. An applied image processing technique for implementing a home security system to detect signboards and faces is proposed in [7]. The robot is controlled by Raspberry pi and Arduino with various different sensors connected wirelessly. The major drawback of this system is that the area of coverage is low and it detects the objects without recognizing.

The intrusion detection developed using the Crossbows TelosB motes which is used for smart Detect [8]. The system features include self-organization, reliable message delivery, sleep-wake scheduling and network security. Main drawback of this system is the inability to locate the exact position of the intruder. This mainly works on a network which uses routing algorithm. So the programmers can easily hack the system. RADAR system for detection of malicious traffic detect the suspicious moment around the safe location [9]. It is similar to Border Gateway Protocol (BGP). A hybrid scalable network is developed to match an enterprise network. The diversion of suspicious traffic is demonstrated with Cisco and Linux routers to examine network testbed.

Many of the intrusion detection system make use of set of data for intrusion detection [10]. The main aim of the project is to simplify the designing and component used. The effectiveness of the intrusion detection is done using CASIA V1.0 data and an algorithm namely Decision tree Construction which is based on Rough set under Characteristic Relation (DTCRSCR). The system operates on iris detection. As a result if an authorized person has any eye infection it becomes difficult for the model to detect. Other drawback is lens duplication can be done by the intruder.

Security is important in borders. Today, the electronic components and micro-processor cost has reduced [11]. As a result this project uses electronic fence and live streaming to monitor the border area. The drawback of the system is it cannot detect the climatic changes and monitoring should be done 24*7 by the authorized person.

The challenging task of harbor protection is to monitor the vast sea base and the port which used for transportation of goods and passenger [12]. The system consists three-axis accelerometer sensors to monitor the wide surface area of sea and this sensors are mounted on top of the ships and submarines. A buried fiber-optic sensor can detect the human moment, moment of vehicle and drilling of ground [13]. This sensors can be buried under the ground and can detect the motion upto 40km area. Sensor is buried 4 to 5 feet deep down inside the clay soil. The drawback of the system is the length of sensor is limited.

Few papers defines the intrusion detection can be done using computer besides the study of climatic condition across the border can be done [14]. Along the detection of the intruder the system also displays the video-coverage of the border. Firing at the intruder can be done automatically by the personnel sitting in control room. Thus, reduces the work of hundreds of personnel. Drawback of this system is failure to differentiate the authorized and unauthorized person. As it is automated firing gun it should be handled carefully.

It is clear that most of the existing system has several drawback mainly with respect to the low coverage, inability to locate the exact position of intruder. Any stationary model can reduce the visibility and iris detection models suffer lens duplication issues.

Our objective is to design a robot system which provides protection to the country with efficient communication and control operation. It alarms the intruder and if the intruder ignores the alarm an electric fence will be activated. Image of the intruder as well as border side will be transmitted to controller side through IOT. The system can be control using mobile application.

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3. Problem Definition

Our objective is to design a robot system which provides protection to the country with efficient communication and control operation. It alarms the intruder and if the intruder ignores the alarm an electric fence will be activated. Image of the intruder as well as border side will be transmitted to controller side through IOT. The system can be control using mobile application.

4. Proposed System

The Proposed system consists of a 180-degree controllable motor to scan area with two degrees of freedom - horizontal and vertical. Integration of cameras that facilitate monitoring even during fog, dark and humid environments. Night camera also helps in aiming the laser pistol in telescope mode. A warning facility, controlled by the monitoring centre to alert the infiltration. A laser pistol, controlled by monitoring centre intended to prevent hackers and to avoid direct docking with infiltrators. Controlled electric shock in the border fence to block the intruder movement.

5. System Design

The proposed robot has wheels making it mobile and robust. This robot can be of great help in such situations. Our system consists of a 360-degree rotating camera that will detect any motion and notify the control center. It also employs PIR sensor [2]; data from the sensor is sent to the control station through internet. A self-activating buzzer makes noise, warning the intruder about being in the restricted area. The robot also has live streaming feature which provides continuous media delivering to the controller site via internet .This in turn helps in surveillance of the area for security.

There is face detection feature [7] that is employed which helps in categorizing a person as authorized or unauthorized. In case the person is unauthorized, the control station can instruct the robot for the actions to be taken. There is a motor controlled gun which is manually controlled from the control station. This 360-degree rotatable gun which is mounted on the robot helps in shooting the target in extreme situation. An electric fence is incorporated and is activated on receiving orders from control station. Sound sensor can help identifying the location of the intruder.

The whole design steps are divided into two, the first section is in the border area while the second section in controller site. Both the camera and motor controlled by raspberry pi. A communication link between the border area and the control station is established though internet. Network of sensors in border sites are connected through IoT as in the block diagram fig 1.The flow diagram of the software routine at the border site and the controller site is shown in fig2 and fig 3.

When the PIR sensor detects movements, it alarms the intruder and if the intruder still ignores the alarm, a buzzer is activated to warn the intruders about being in a restricted area. The instructions from controller site are received, the laser gun and electric fence can be controlled by control center.

The robot system consists of sound sensors and camera which gives us the exact position of the intruder and is controlled manually through BLYNK app. Live streaming is also provided to monitor the region. Using raspberry Pi face detection is also done which allows only authorized person to have access.

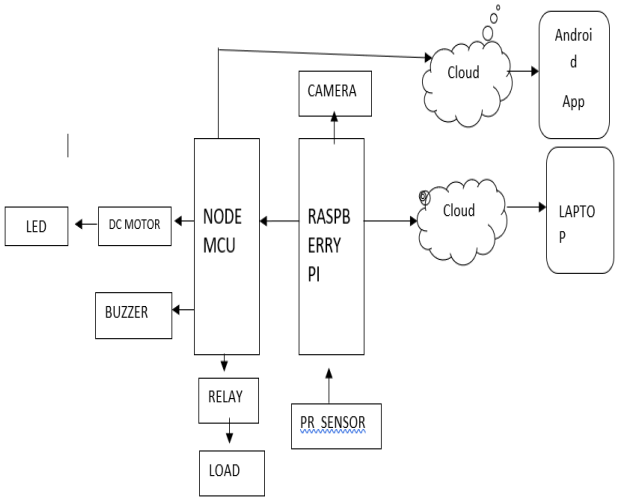

Figure 1: Block Diagram of the System in the Border area

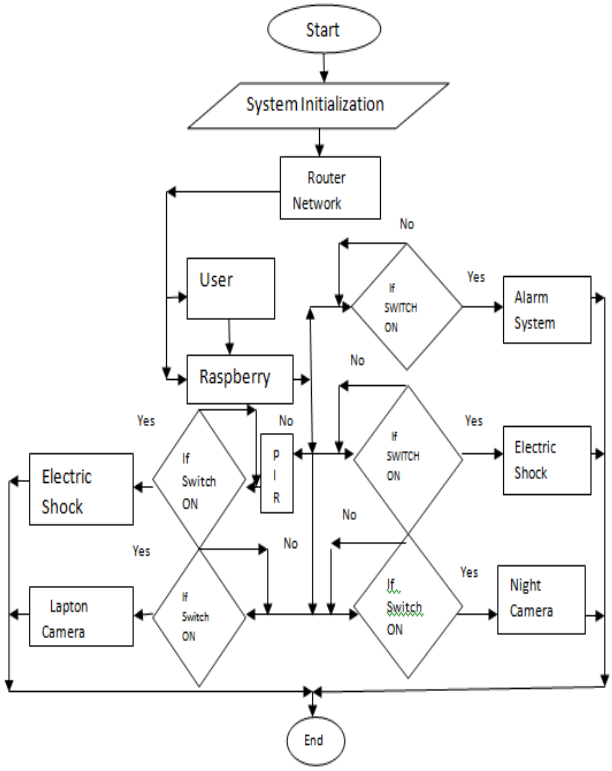

Figure 2: Flow Chart of the software routine at the border site

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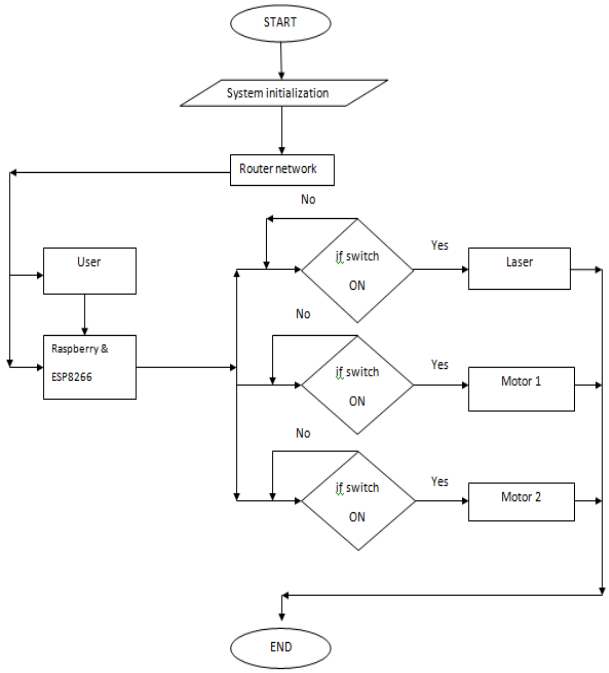

Figure 3: Flow chart of the software routine at the controller site

6. Results

Raspberry Pi and ESP8266 communication happens through Machine Queuing Telemetry Transport protocol (MQTT)- which is an Internet-of-Things protocol. This is a light weight publish/subscribe messaging transport technique and useful for connections over Internet Protocol link. Publish and subscribe to the topic is done by the MQTT node of Node-red. The ESP12E publishes the topic "servoV", "ServoH". In Raspberry Pi, nodered's MQTT node is used to subscribe to the topic "servoV" and "servoH". Thus the messages corresponding to the subscribed topics will be received by the corresponding MQTT nodes.

7. Conclusion

The developed model avails in elevating the security at border. Onsite presence of a soldier for surveillance can be replaced by this robot system which live streams the border area. It also provides the effective transmission and communication. In Case of violent intrusion, the laser gun is activated and hence reducing the death rate. Face detection helps identifying the intruder and the appropriate order can be given from the control site itself. This development allows the defense force to distinguish intruder and an authorized person cost effectively.

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