International Journal For Recent Developments in Science & Technology
2581-4575
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INTELLIGENT BORDER SECURITY INTRUSION DETECTION USING IOT AND EMBEDDEDSYSTEMS

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ABSTRACT

Borders are particularly vulnerable to unauthorized crossings, making consistent surveillance a significant challenge for military personnel. To address this issue, it is crucial to develop a system that alleviates the burden on soldiers, whose safety is of utmost importance. This proposed system aims to reduce the workload on armed forces by introducing a portable model equipped with Passive Infrared (PIR) sensors and cameras that detect intruder movement. When motion is sensed, the system alerts the control station and activates a buzzer to warn intruders of their presence in a restricted area. The entire network of sensors is integrated through the Internet of Things (IoT) at the border site. With live streaming and facial recognition capabilities powered by Raspberry Pi, the system enables administrators to differentiate between authorized and unauthorized individuals, facilitating informed decision-making. Additionally, the setup includes an electric fence and a firearm, which can be manually activated to respond to intrusions. This system is designed to work in tandem with human soldiers, enhancing border security and providing essential support.

Keywords :Internet of Things, Passive Infrared Sensor, Raspberry Pi.

I.INTRODUCTION

Ensuring the security of borders against unauthorized crossings with minimal human resources and cost efficiency is increasingly vital. Continuous surveillance for suspicious activities can be a demanding task for soldiers, particularly given that environmental conditions may not always be conducive for human monitoring. Current systems often rely on Bluetooth communication, which can limit operational range. They also utilize a 180-degree controllable

motor for scanning, which does not offer comprehensive area coverage. Additionally, the warning systems operated by monitoring centers may not always be reliable, and existing models lack mobility. In contrast, the proposed robotic system is designed for mobility with wheels, allowing it to navigate effectively. It features a 360-degree rotating camera to detect motion and alert the control center accordingly. Equipped with a Passive Infrared (PIR) sensor, the system transmits data to the control station via the internet. A self-activating buzzer serves to warn intruders of their presence in a restricted area. The robot also supports live streaming, providing continuous media feeds to the control site over the internet. Moreover, a facial recognition feature enables the

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categorization of individuals as authorized or unauthorized. Additionally, the system includes a motor-controlled gun that can be operated manually from the control station, along with an electric fence that can be activated upon receiving commands from the control center.

II.LITERATURE SURVEY

The topic of border security and intrusion detection has been the focus of extensive research. Many proposed solutions leverage Passive Infrared (PIR) sensors and Raspberry Pi technology. A survey of wireless sensor networks aimed at border surveillance highlights the development of multi-sensing systems that integrate various detection techniques for monitoring both land and water movement. These systems typically employ a combination of sensors, including infrared, geophones, hydrophones, and surveillance cameras for effective human intruder detection.

Bhadwal introduced a model that utilizes surveillance cameras alongside infrared and PIR sensors to monitor border areas. This system provides video surveillance and achieves a wide surveillance angle through multiple motors connected to a Raspberry Pi. Upon detecting an intruder, images are relayed to the control system. While this model includes a warning and auto-combat system, its stationary nature limits its operational range.

Another proposed system features a PIR sensor and video surveillance, utilizing two mobile phones for operation. This setup employs DC motors to position a laser gun and facilitate movement. Information is transmitted to the control site via Bluetooth, enabling security personnel to make decisions regarding potential threats. However, this model lacks continuous video streaming and remains static.

In a different approach, a robotic system integrates a PIR sensor to identify trespassers and sends alerts to security personnel via SMS using a GSM module. This model also does not support continuous video streaming and is inherently static. An architecture based on Raspberry Pi and ESP8266 establishes communication between the border site and control center, allowing for multiple control operations, including the management of a machine gun and electrical systems. However, it struggles with efficient continuous video streaming.

A reprogrammable robot equipped with multiple sensors for detecting metals, bombs, smoke, and electromagnetic fields also includes a camera for video streaming. This robot can carry payloads and utilize RF transmitters, but it suffers from limited coverage and object recognition capabilities. Additionally, an intrusion detection system using Crossbow TelosB motes offers features like self-organization and reliable message delivery but fails to pinpoint the intruder's exact location.

Other research highlights the use of RADAR systems for monitoring suspicious activity around secure locations, suggesting the need for a hybrid scalable network to improve security. Various intrusion detection systems also utilize datasets to enhance detection accuracy, though some models face challenges such as iris detection difficulties due to eye infections or lens duplication issues.

Despite advancements, many existing systems exhibit limitations, such as inadequate coverage, challenges in accurately locating intruders, and the potential for false alarms. Given these drawbacks, the objective of our proposed

robotic system is to enhance border security through effective communication and operational control. The system is designed to alert intruders and activate an electric fence if necessary, while transmitting images and data to the control center via the Internet of Things (IoT). Furthermore, control capabilities will be accessible through a mobile application, providing a comprehensive solution to border security challenges.

III.PROPOSED SYSTEM

The proposed system incorporates a 180-degree controllable motor that enables scanning in two dimensions: horizontal and vertical. It integrates advanced cameras designed for effective monitoring in challenging conditions such as fog, darkness, and high humidity. A night vision camera assists in accurately aiming a laser pistol in telescope mode. Additionally, a warning system controlled by the monitoring center alerts personnel of any infiltration attempts. The laser pistol serves as a deterrent against potential intruders, while a controlled electric shock feature in the border fence prevents unauthorized movement.

IV.SYSTEM DESIGN

The proposed robot is mobile and robust, equipped with wheels for enhanced mobility in various situations. It features a 360-degree rotating camera that detects motion and sends notifications to the control center. The system utilizes a PIR sensor, with data transmitted to the control station via the internet. A self-activating buzzer alerts intruders to their presence in a restricted area. Live streaming capabilities allow for continuous media delivery to the control site, facilitating area surveillance.

The robot also includes a facial recognition feature that distinguishes between authorized and unauthorized individuals. If an unauthorized person is detected, the control station can direct the robot to take appropriate actions. Additionally, a motor-controlled gun, which is manually operated from the control station, is mounted on the robot for emergency situations. An electric fence can also be activated based on instructions received from the control center, while sound sensors help pinpoint the intruder's location.

The design is divided into two main components: the border area and the control site. Both the camera and motor functions are managed by a Raspberry Pi. Communication between these two sections is established through the internet, connecting the network of sensors at the border via the Internet of Things (IoT). The system's functionality is organized in flow diagrams that outline the software routines at both the border site and the control center. When the PIR sensor detects movement, it triggers an alarm for the intruder. If the alarm is disregarded, a buzzer sounds to reinforce the warning. The control center can send instructions to manage the laser gun and electric fence as needed. The robot system combines sound sensors and cameras to determine the precise location of intruders, all of which can be manually controlled through the BLYNK app. Live streaming capabilities further enhance monitoring, while the facial recognition feature ensures that only authorized personnel can gain access.

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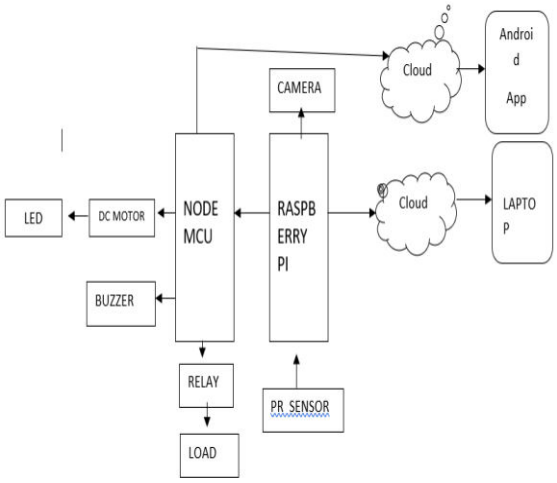

V.CONCLUSION

In conclusion, the proposed border security system represents a significant advancement in intrusion detection and monitoring technology. By integrating mobile robotics, advanced sensing capabilities, and real-time communication through the Internet of Things (IoT), this system enhances the efficiency and effectiveness of border surveillance. The use of a 360-degree rotating camera, PIR sensors, and facial recognition technology allows for precise detection and identification of individuals, while features such as a laser pistol and controlled electric fence provide proactive deterrents against unauthorized access. This innovative solution not only reduces the burden on human soldiers by automating critical monitoring tasks but also enhances their safety by minimizing direct confrontation with potential intruders. The system's ability to operate under various environmental conditions, coupled with its remote control capabilities via mobile applications, ensures comprehensive coverage and rapid response to security threats.

Overall, the proposed system offers a robust and reliable approach to border security, contributing to national safety while effectively addressing the limitations of existing models. Future enhancements could focus on further improving detection algorithms and expanding the range of sensors, making this system an adaptable solution for various security challenges.

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