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Review of New Trends and Challenges of Android-Based Home Security Robot

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ABSTRACT

Home security by itself is very costly and not many people, especially those who are living in rural or sub urban areas, are able to afford it. Hired security guards or even guard dogs are also slowly losing their usability and credibility in an age where burglars are sneakier, stealthier, and more technologically equipped to disable alarm systems. The Security Patrolling Robot vehicle moves in a set path while keeping its “eyes” peeled for any non-recognized intruders. The planned framework will utilize an infrared-based sensor following framework for supervision of various designated zones. The development of a robot is additionally controlled consequently through obstacle recognizing sensors to stay away from to avoid unnecessary collisions and possible damage to the robot. The working principle of the robot is that it screens every zone to recognize any interruptions, which is achieved utilizing a camera which is mounted on top of the robot to record the surveillance for the viewing of the client. The principal goal of this undertaking is to recognize the worrying exercises in the regions where the human presence cannot be detected. This robot will become a great contribution to the community. It is easily operated and can be handled by senior citizens, who may or may not be proficient with technology.

1. INTRODUCTION

Nowadays, as technology advances, several robots equipped with highly specialised integrated systems are specifically employed to perform such dangerous tasks diligently and precisely. Each year, the development of intelligent robots for military purposes accelerates. The US military inventory now includes over 12,000 ground robots and 7,000 unmanned aerial vehicles. Along with the US, 44 other countries are now exploring unmanned military systems. It is not as if the human role in war is diminishing. War continues to be a human endeavour, motivated by our flaws and revealing both our best and worst characteristics [1]. In addition, it is important to note that the use of robotic equipment indicates significant changes in military [2], healthcare [3] and smart city [4].

One of the examples of smart city s an intelligence home. An intelligent home can be defined as a house with advanced automation systems that enables the owners to monitor and manage the building functions in advanced conditions, such as the lighting, temperature, multi-media, security, window and gate operations [6]. The clever gate with the Android app is a smart home example. The system will be monitored using "intelligent" feedback and information automation technology.

In recent years home automation has increased significantly due to increased affordability and advances in smartphones and tablets which allow large-scale connectivity. The premium research service of the Business insider anticipates that the number of smart homes shipped will rise from 83 million in 2015 to 193 million in 2020 [5].

Researchers made use of Android technology and ZigBee, Wi-Fi wireless sensor communication network to provide a flexible and convenient wireless solution for the construction of smart home security system [6]. Android is a mobile operating system, middleware, and key applications. Android supports Wi-Fi, Bluetooth, and wireless data over cellular networks (GPRS, EDGE (Enhanced Data Rates for GSM Evolution), 3G, and 4G). Android provides a wealth of useful libraries and tools for developing rich applications. A comprehensive set of tools built specifically for Android

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provides developers with high productivity and deep insight into their applications. Bluetooth is an open standard specification for RF-based short-range connectivity that promises to revolutionise computing and wireless communication. It is a low-cost wireless networking system for portable devices like laptops, PDAs, and phones. It will also allow desktop computers to connect wirelessly to monitors, printers, keyboards, and eventually the CPU. The system could be controlled by a microcontroller. The microcontroller connects Bluetooth and DC motors. The Bluetooth module receives data from the Android phone and feeds it into the controller. The controller responds to the DC motors and the Robot. The project's robot is frequently programmed to move in all four directions. The controller s programmed n Embedded 'C' [7].

This paper proposes the robot records the surveillance process with the help of the camera. These saved recordings are reviewed by the user and if there are any problems observed, then a report is made. Generally, patrolling robots are mostly used in military areas, hospitals, shopping malls, restricted zones, industrial areas, and agricultural areas. The robot uses a ESP32 based camera sensor which will be recording the entire surveillance and keeping the data of the checkpoints, and anything detected. It moves in a random set paths because it need to cover the whole area of the designated area. It is also equipped with variety of sensors like a camera, ultrasonic sensors, passive infrared (PIR) sensors and infrared (IR) sensors.

Home automation system is use of information technologies and control system to reduce the human labour. The rapid growth of technologies influence us to use smartphones to remotely control the home appliances [8]. The utilization of Bluetooth innovation in an advanced mobile phone today is not only for the exchange of information and documents as it were. Bluetooth technology is used as one of the applications of home automation system [9]. To produce autonomous systems, the system must be able to track targets/recognize objects based on computer vision. Robots are also expected to be able to recognize faces/objects that can be enemies to be conquered [1].

The proposed project aims to propose a home security patrol robot using Bluetooth and Wi-Fi technology. This project discusses the various important segments of the trends and difficulties of an android based wireless controller for the said home security patrol robot that is using Bluetooth technology.

After this introduction, literature review is presented in Section 2. Section 3 focuses on the recent trends and challenges faced by home security patrol robot using Bluetooth technology. Section 4 describes the project methodology. Section 4 discusses the overview of the proposed model. Section 5 focuses on the overview of the proposed model. Section 6 shows the discussion result analysis. Section 7 concludes the paper.

2. LITERATURE REVIEW

Figure 1 indicates the proposed block diagram of the security patrol robot. [10] stated that the no object recognition at the dead zone area, for example, Sharp GP2D12 IR distance sensor dead zone between 0 to 4 cm. IR sensors also gives an inaccurate detection result with transparent or bright coloured materials. Detection results also depend on the weather conditions and the sensing reliability of IR sensors decreases with moisture and humidity. Furthermore, IR sensors can sense IR radiation from the sunlight, which can cause correctable or non-correctable errors with the output. Besides that, if an analogue IR sensor is used, signal losses will occur at the amplifier circuit. Meanwhile, PIR motion sensor requires a long calibration time and is sensitive to thermal radiation. Besides that, PIR sensor is insensitive to very slow motions or to objects in standing mode. The existing system of a machinery system is where the mobility of the machinery is depended upon a person to exert an amount of force upon it to get the machine to move. Therefore, the robot will only move towards and along a specified object when it is controlled by a person who must remain in front of the robot. This Security Patrolling Robot project proposes a semi-autonomous robot where no remote control or an external force is used for controlling the robot's movement. It intelligently detects the nearest object present on its path through the distance and ultrasonic sensors and moves along with it if it detects motion from the object based on the instructions supplied. Table 1 shows the details of the literature review and Section 3 describes the trends and challenges faced by the implementation of Bluetooth technology in the working design of the security patrol robot that also uses various other functions.

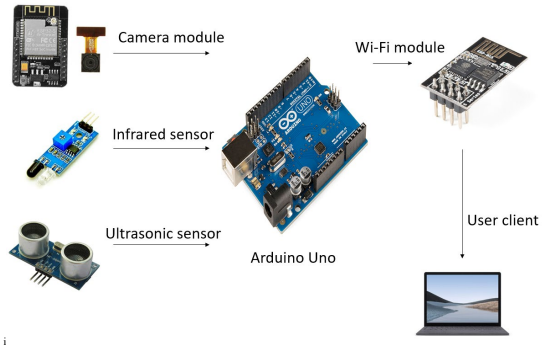

Fig. 1. The proposed block diagram of the security patrol robot.

Table 1. Literature summary.

Paper	Technology Used	Variables Studied/Research Design	Results/Findings
M. S. Shah and P. B. Borole, (2016) [11]	Laptop, tablet, internet, Arduino, smartphone	Establishment of long-range communication for surveillance Creating a robot that can handle all terrains	Surveillance was able to be created within the range of the connection and was able to provide live feed to the handler.
J. Patoliya, H. Mehta, and H. Patel, (2015) [12]	Smartphone, Bluetooth, Arduino, camera	Controlling an autonomous robot to move through enemy lines and provide intelligence	A Bluetooth connection was made, and the robot was able to deliver results to the master controller.

		Testing its efficacy at night	
P. Surendra Kumar, Venkatesh Vinjamuri, (2016) [13]	Arduino, ZigBee technology	Implementing a wireless robot control system for monitoring purposes	Robotic vehicle that can operate both autonomously along a given pre-defined path Operated manually in the inspection systems Like surveillance AV camera wirelessly connected with temperature & humidity sensor Operate vehicle wirelessly using ZigBee.
C.-W. Lan and C.-Y. Chang, (2020) [14]	Stereo vision system, radio frequency identification, Wi-Fi module	The robot has independent patrolling without path planning, checking, intruder detection, and wireless backup.	Robot searches for passable path using depth information Follows detected intruder, takes picture and uploads in real-time. Approaches detected inspection checkpoints and signs in electronically. When all patrolling checkpoints have been completed, surveillance ends.
A. Khanna and R. Anand, (2016) [15]	Arduino UNO, DC Motor, RGB LED, L298N Motor Driver	The obstacle-avoiding robot car detects the distance to surrounding objects in front of the robot car and determine the direction away from the nearest obstacle.	The robot uses similar hardware components for the build of the concurrent obstacle avoidance robot
N. Cameron, (2019) [16]	Motors, camera, PWM driver	Mobile robot that can independently perform indoor and outdoor safety inspections.	Robot uses homemade lidar sensor for checkpoint marking and environment analysis.
Y. Wang, (2017)[17]	Robotic arms, ultrasonic sensors, temperature sensors, visionary sensors	Autonomous robot that has multiple functionalities like robotic arms, ultrasonic sensors, and visionary sensors	Robot can be used to work in hazardous environments that can cause harm to humans.
R. Hasan, S. Asif Hussain, (2018) [18]	Infrared sensors, ultrasonic sensors	Decentralized human-aware navigation for shared human-robot workspaces based on the velocity paradigm	Robot can be used to transport small items around the office.

3. RECENT TRENDS AND CHALLENGES

According to [5], it is observed that in the event of any natural disaster the first 48 hours are very important to save human life. At recent years, many robots took part in human rescue operations. At places where it was dangerous to send rescue teams, taking advantage of robots, both security of rescue teams was maintained, and results were improved.

Mobile devices have been integrated into our everyday life consequently, home automation is becoming increasingly prominent features on mobile devices [6]. A security system has been developed that interfaced with an Android mobile device. The mobile device will be communicated through Bluetooth by the shortest way. The mobile application can be loaded onto any compatible device, and once loaded, interface with the appliances easily commands to ON, OFF, or to check the status of the appliance to which is installed can be sent quickly from the mobile device via a simple, easy to use GUI. The security system then acts on these commands, taking the appropriate action and sending a confirmation back to mobile device.

The challenge of task planning and simulation in time, space, force, energy, and cost, possibly with virtual-reality envisioning aids has never been greater [19]. There is also the issue of whether general-purpose robots in humanoid form make sense; experience suggests that the physical form of a robot is best determined by task context. How to analyse human robot interaction tasks so as to predict the best physical form is itself a challenge.

Since most of the Bluetooth attacks are undetected and unreported, it is not specifically known when and how the first Bluetooth attack was carried out [20]. But there is some information regarding the detection of some of the attacks. In 2001, researchers at Nokia Bell Labs detected flaws in the pairing mechanism and mentioned that Bluetooth communication can be intruded. The first PIN cracking attack was detected in April 2005 by researchers at Cambridge University. Surveillance attack using Bluetooth device was first reported in August 2005 by police department at Cambridgeshire, England.

4. METHODOLOGY

Figure 2 indicates the proposed flowchart of the working mechanism of the robot. To create the security patrol robot, the methodology has a simple approach. First, the coding is created using Arduino. It is then implemented into an Android app that is being used to control and monitor the robot. When the robot has been placed at a certain area, the instructions are fed to the microcontroller to begin the usage of the robot. The infrared sensors and ultrasonic sensors will monitor the surrounding for any intruders. Should an intruder be detected, the camera will then snap a photo and upload the picture directly to the user via Wi-Fi or Bluetooth. A simple hardware architecture is used to ensure cost-effective hardware. The architecture consists of the following components: Arduino UNO, IR sensor, ultrasonic sensor, L293D Motor Driver Shield, Servo motor and ESP32 Camera Module.

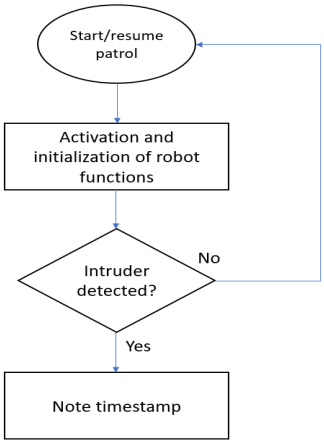

Fig. 2. The proposed flowchart of the working mechanism of the robot

5. OVERVIEW OF THE PROPOSED MODEL

5.1 Proposed Model

The patrolling is started and once it comes across an individual, it captures images at a good resolution which is actually enough to identify whether the individual is an intruder or not. Interfacing all the required sensors to the microcontroller individually with respective codes would make it accurate enough. These sensors would even be operable even at night. All the sensors will be interfaced through their respective analog pins, which will enable us to get more readings than a simple digital 0s and 1s. This robot will move slowly and give accurate information of the situation, and a 24/7 monitoring will require a lesser time to charge the Li-Ion batteries. This robot will be optimized and will consume less power, simultaneously.

The ESP32 camera module which has a built in Wi-Fi module, will connect over a Wi-Fi network on a unique IP address which will make itself to be uniquely identified by the user while connecting it. Due to the obvious limited Wi-Fi range, it will and should not leave the premises for external surveillance. Possible implementation of machine learning will implement pictures to be used as training data and will make the robot identify new faces which are not registered, capture their images instantly and sends to the user/handler. Should machine learning not be implemented due to the complexity of coding, an alternative functionality can be utilized instead, where the robot captures the image of the intruder and sends it to the handler, for manual verification and action (example: triggering alarm, alerting authorities).

5.2 Block Diagram

Figure 3 depicts the block diagram of the proposed project "Security Patrol Robot." This prototype has 3 main parts: the server, processor + sensor and the user client. The implementation of microprocessors and sensor modules and the integration of a Wi-Fi module and image processor falls under the field of microprocessors and microcontrollers. The IR and ultrasonic sensors handle intruder detection and obstacle avoidance, the Wi-Fi module connects to the internet for the database link up and the servo motors enable autonomous movement. The processed recording will then be sent to a server-linked database that has upload web, history and real time info web services that utilize the knowledge of server-side programming.

Remote users can access the previous data that has been created by the robot on previous surveillances for analysis. The data may be classed into area checkpoint, time of detection and intruder images. The user client can view the processed image via their personal computer or laptop, which can be created with the in-depth knowledge of computer networks. The database will be connected to a single server that will have image processing functionalities via any software that can be used that is available on the internet Figure 4 shows the proposed block diagram of the security patrol robot.

5.3 Circuit Diagram

Figure 4 indicates the proposed circuit diagram of the security patrol robot whereas Figure 6 depicts the proposed robot model. As it can be seen, the robot model has wheels for its proposed autonomous movement. The Arduino board is mounted on a strong sturdy material body. The ultrasonic and infrared sensors are also mounted for the obstacle detection and avoidance. The camera module is located below the sensors for surveillance recording

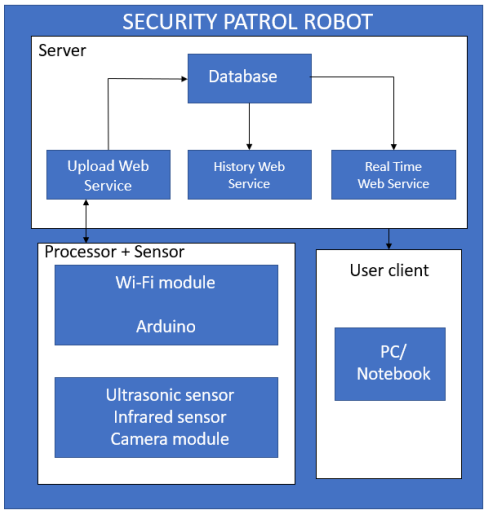

Fig. 4. Block diagram.

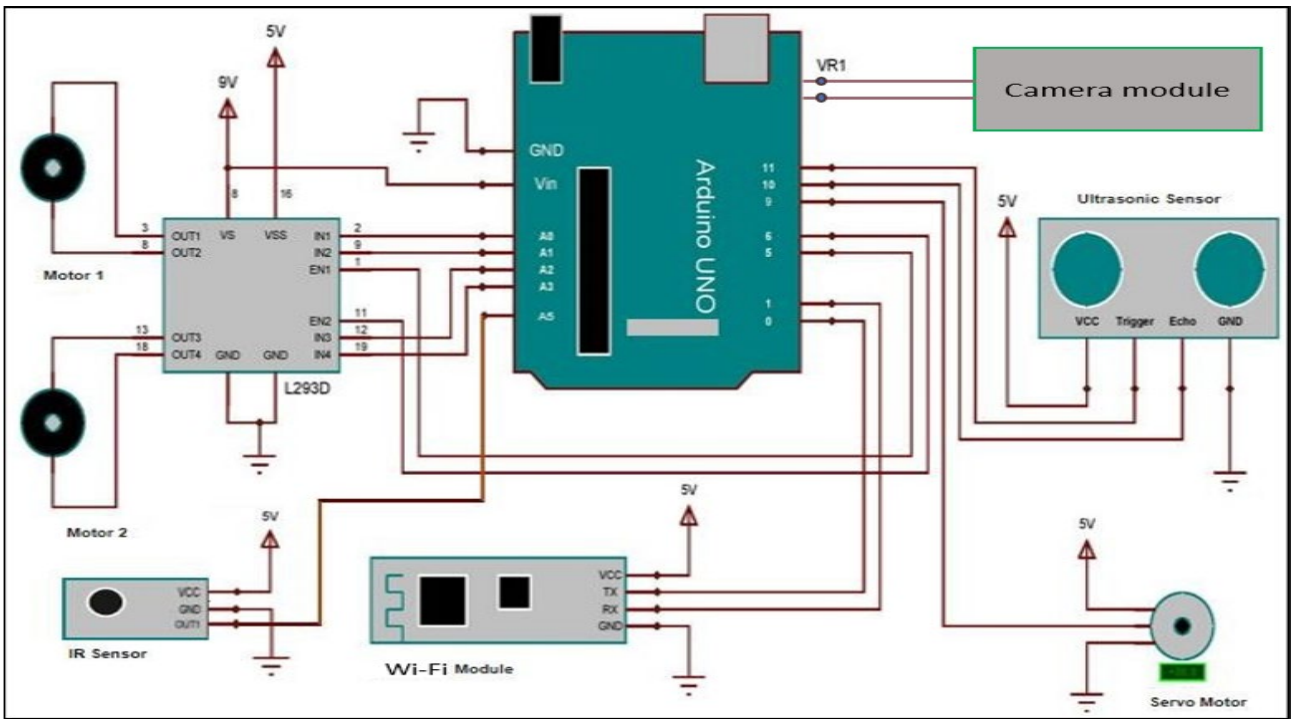

Fig. 3. The circuit diagram of the security patrol robot.

6. DISCUSSION

Figure 5 indicates the proposed robotic model. The Robotic engineering applications involve in manufacturing, surgical procedures, space industry, military, and health informatics. Today, robots are becoming a part of everyday life and these elements relieve us from various dangers [21]. With the rapid development of mobile robotics, communication, computer, artificial intelligence, and sensor technology in recent years, it has laid a solid foundation and good prospects for research and development of the security patrol robot [22].

Therefore, the study of security patrol robot has broad application prospects, and it has become a new research of

Fig. 5. The proposed robot model.

service robots in recent years. With the advancement of technology, human work is gradually being replaced by robots. The use of patrol robot is an example. For facilities such as schools,hospitals, or shopping malls, patrol robots are being used to detect suspicious events, and to prevent such facilities from being damaged, or occupants from being attacked. A relevant organization or company may hire additional security workers for night patrol, however an intelligent patrol robot can be more reliable, in the sense that a robot does not get tired, lose concentration, or forget to complete rounds, if correctly programmed [23].

7. CONCLUSION

This paper improves the efficiency of surveillance by a security patrol robot for users. The system delivers accurate intruder detection and checkpoint marking processing and information. It contributes to the reduction of burglaries or robberies, which is becoming more and more of a concern. In the future, users will be able to worry less about their facilities or homes or organizations being plundered by robbers or burglars or have any ruckus created by any intruders who somehow manage to break into the said location.

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