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SECURITY PATROLLING ROBOT

Mrs. Deepali Yewale, Assistant Professor, Department of Electronics and Telecommunication, AISSMS Institute of Information Technology, Pune.
Yugandhar Deshmukh, AISSMS Institute of InformationTechnology, Pune.
Rutuja Deshmukh, AISSMS Institute of InformationTechnology, Pune.
Shruti Dalal, AISSMS Institute of InformationTechnology, Pune.

ABSTRACT
This research paper is about our final year-project which is security patrolling robot. As we are aware that everyone now-a-days need security to keep their valuable items secured. This case study presents the design and implementation of security personnel equipped with advanced monitoring and threat detection capabilities. Raspberry Pi as its central processing unit, an array of sensors, Bluetooth module and a set of motor driver and efficient patrolling in diverse environments. This project demonstrates a comprehensive solution for enhancing security through autonomous robotic surveillance systems.

Keywords:
Surveillance, Security, Raspberry Pi, Multi-sensors, Smart camera.

I. INTRODUCTION
Security is an important asset for many organisations, businesses and homeowners. It also prevents harm to people and protects property from theft or destruction. Companies and homeowners allocate serious budgets for security measures The average annual salary for a security guard is approximately $25,000. As the number of alarms, monitors and rented security increases, the cost also increases. In 2011, U.S. homeowners spent an estimated $20.64 billion on home security. Statistics show how important security is for businesses and homeowners. In this project, the robot which emphasizes increasing concern for home security. It explores the development of security robots focusing on autonomy, environmental adaptation, and human-robot interactions. The research specifically delves into three functionalities: home security monitoring, network-assisted interactions, and self-navigation patrol for a wheeled mobile robot. It works almost identical to a computer. Various types ofsurveillance systems are available, such as monitor, CCTV, etc. In these types of surveillance systems,the person who is stationary and situated in that area can only see what is happening in that location. And here, even though the user travels from one location to another, he / she can keep track at the exact moment of what is going on in that particular place. Also, it provides anonymity on both sides, is another plus. Raspbian OS is the operating system which is used here.
The robot is powered by a Raspberry Pi microcontroller and uses ultrasonic & sound sensors along with an 8MP camera. The robot is designed in such a way that it can move in all horizontal directions using a DC motor by itself and by leveraging the sensors, monitor all the activity within the predefined area. The activity detection model analyses the data collected by sensors and detects any suspicious activities & alerts the users regarding those suspicious activities via near real-time emails and text messages. The surveillance robot's brain is the Raspberry Pi module. Based on the Raspberry Pi microcontroller, it has an integrated camera. The Raspberry Pi can be used for data transmission and remote control since it has Bluetooth and Wi-Fi connectivity. Wheels and Motors: You'll need wheels and motors to make the robot mobile. You can use tracks for more difficult terrains or wheels for a wheeled robot, depending on the design.
The work of Motor Driver is to regulate the robot's motors' speed and direction, a motor driver circuit is required. The Sensors are required so that you can add a variety of sensors, such as ultrasonic and infrared ones, depending on your application. An important advancement in security technology is the incorporation of the Raspberry Pi in surveillance robots. Its ability to integrate AI-driven features, wireless connectivity, and compact design make it a significant player in the continuing evolution of

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surveillance systems. The Raspberry Pi surveillance robot is evidence of the potential for creative solutions to ensure safety and security.

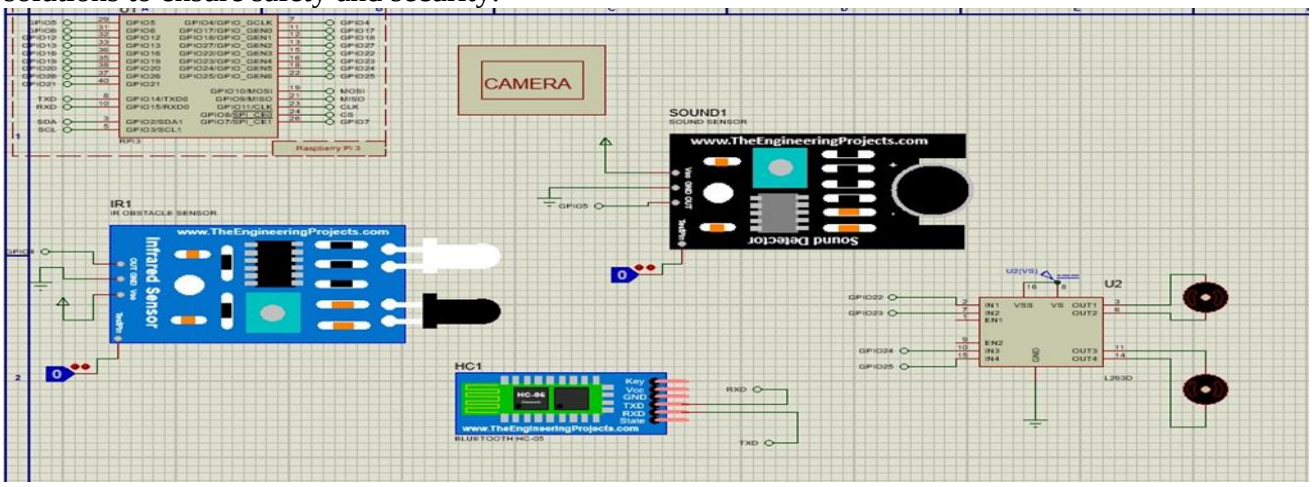

Figure 1: Circuit Diagram

II. LITERATURE REVIEW

Raspberry Pi is used as a main controller. This multi-sensor system makes security surveillance more effective and avoids false alarms. The sport processor utilizes multiple sensors which can detect secure risks. Multi-sensors include light sensors, sound sensors, and IR motion sensors. They also use a mobile application interface which can operate and customize the SPR. This whole model is linked to a local network and can managed from anywhere by anyone accessible in that specific local network. A framework was proposed to create a live streaming and monitoring system in real-time using this whole model linked to a local network so it can operate easily accessible.

[1] Hou-Tsan Lee, Wei-Chuan Lin, and Ching-Hsiang Huang proposed a robot system that was installed on a PC server, a self-driving car, and a few small clever systems through networks to give surveillance and remote-control functions. The recommended surveillance android utilizes the RFID method to steer the car move in motion.

[2] The robotic system is designed using Arduino mounted with ESPCAM 32. In this paper they have used sound sensor, ultrasonic sensor, DC motor and L298 motor driver. This designed robot surveillance and patrol the area assigned to it. It can be used as a women safety and also it is used for monitoring the particular area. Also, it is useful for child monitoring system. So that parents who work in office can monitor their children.

[3] The authors Tazeb Mishrak, Hasib Zener, and Monic Farhan Keren Haz employed multi-sensors, GSM, Bluetooth, and an Android app. All sensors are directly links to ATMEGA328 using a 16MHz microcontroller (Arduino Uno) that is utilized as the primary controller.

[4] Face recognition can be still a so very much complex task when one image of a prompt a is very noisy, and stopped by various other obstacles. Low-resolution, the camera not facing and not being properly. These issues contribute to one extraction of characteristics and Face recognition system, which is unstable as a consequence. In this paper, the system proposed incorporates the very novel idea of using hair-like traits, which were widely utilized in Item recognition and the probabilistic facial classification Reconnaissance. The system proposed is simple, real-time, efficient, and robust against most of the issues described. Experimental findings in public databases display the proposed. The system outdoes the state-of-the-art facial recognition systems.

[5] The paper describes that it is the implementation of a new representation as pics, named "Integral descent" which so the detector to measure their features very quickly the second is a learning process AdaBoost basing algorithm, which selects a small number from essential visual features and produces from a bigger collection Extremely elliptical the third contributors consists to a method for combining ever more complex classer in "cascade" what allowing background regions from the classier Image to

be discarded quickly while spending more calculating on promising regions like objects may be the cascade Seen like a special focus-of attention mechanism for the objective that, unlike previous approaches, provides statistical guarantees who are unlikely to have the object of interest in discarded regions, In the face-recognizing domain the machine Returns equivalent detect rates to the best previously systems.

[6] Embedded remote video control device, focuses on ARM and hurried motion Stimulus algorithm (2011 International Conference on Instrumentation, Measurement and Control) Jian Wang Automation department, Harbin Automation Institute University of Technology 150080, Harbin Heilongjiang: Actual H.264 code focused video chaotic encryption schemes can be applied to two categories: prior to H.264 encoding, the initial video data is encrypted with chaos; subsequent to H.264 encoding, it gets encrypted with chaos. The core setback of the two categories of schemes is that the paradoxical problem between desirable safety and swift frame rate is not thoroughly resolved. This paperintroduces an innovative H.264 codec-focused videochaotic encryption scheme to address the issue, where the original video data is encrypted by a stream cipher and location scrambling with chaos after H.264 encoding.

[7] 1Dr M Senthamil Selvi,2M. Faesa Fathima3 S. Dhivyua, 4 S. Mouriya: The Raspberry Pi 3 microcontroller is a powerful and adaptable platform that can handle a wide range of tasks, as suggested by its selection. The presence of a Wi-Fi router suggests that wireless communication is possible, allowing for data transfer or remote control. It's possible that IR and proximity sensors are utilized to identify obstacles and make sure the robot can successfully navigate its surroundings. When a DC motor driver is used, motor control capabilities are implied, enabling the robot to move precisely and react to its surroundings. These elements working together point to the possibility of an allencompassing robotic surveillance system with autonomous operation and real-time monitoring capabilities.

[8] Shraddha Londhe1, Pooja Shinde2, Sanket Mendke3, Sahil Dhage4, Prof. Dr. Niteen Futane: The presence of multiple sensors, including the voltage detector, HC-SR04 ultrasonic, and metal detector sensors, indicates that the robot has sophisticated environmental perception capabilities, allowing it to identify metals, obstacles, and track the condition of its batteries.

[9] Anandravisekar, Anto Clinton, Mukesh Raj, Naveen: The main objective of the suggested framework is to create a surveillance robot that uses Internet of Things (IoT) technology to get around the restriction of limitedrange surveillance. This implies that the robot may be able to send information, including potentially video feeds, over the internet to allow for remote control and monitoring. Resolving the restricted range is a noteworthy progression, particularly in surveillance situations where instantaneous information is crucial using IoT.

[10] Abhijeet Dhule, Neha Sangle, Supriya Nagarkar, Asmita Namjoshi: The presence of a PIR sensor indicates that the system has motion detection capabilities, which are frequently used to identify the presence of people or other living things. A mechanism for controlled movement or orientation is implied by the Servo Motor, and a wireless communication capability enabling remote control or data exchange is indicated by the HC05 Bluetooth Module.

[11] This paper discusses an intelligent security system using a team of mobile robots. The system is designed to enhance security through coordinated patrols, real-time surveillance, and data collection. The robots are equipped with various sensors and communication capabilities to work collaboratively.

[12] The paper presents a self-propelled indoor surveillance robot designed to patrol and monitor specific areas autonomously. The robot uses RFID tags to navigate predefined routes and can be remotely controlled via smartphone. It includes features like face detection, image capture, and Wi-Fi connectivity to transmit data back to a central server, enhancing security and reducing the need for human.

[13] This study explores the development of a mobile security robot tailored for use in ship environments. The robot can operate both autonomously and via remote teleoperation, offering flexibility in monitoring and securing the ship. It addresses challenges such as navigation in confined spaces and the harsh maritime environment.

[14] It focuses on a mobile security robot enhanced with Ultra-Wideband (UWB) radar technology for precise indoor positioning and localization. This technology allows the robot to navigate and locate objects or intruders with high accuracy, making it suitable for detailed surveillance and security applications in complex indoor environments.

[15] This paper discusses the design and implementation of an autonomous security patrolling robot. The robot is equipped with sensors and cameras to detect and respond to security threats.

III. COMPONENTS USED

1. RaspberryPi

It is a mini-computer that is distributed for manifold applications. It has 40 pins and around 32pins are for GPIO. It has a 64-bit system-on-chip that operates at 1.5 GHz. I too offer improvedprocessing power. The RP 4Bmodel is available in mixed configurations like 1 GB, 2GB, or 4GB. It comes with connectivity alternatives like double band and Bluetooth 5.0 for wireless connection while Gigabit Ethernet for wired connectivity. It holds a peripheral connection by two USB 3.0 ports and two USB 2.0 ports. It holds dual micro-HDMI ports which are ideal formultimedia applications. It holds added features like a 2-lane MIPI DSI display port, and composite video port, and a micro-SD card slot for operative system and data storage.

2. IR Sensor

An Infrared (IR) sensor is a device that detects nearby objects in its surrounding atmosphere. These detachedsensors usually comprise three pins: VCC (power supply),GND (earth), and OUT (signal output). IR sensors are frequently applied in diverse uses like closeness scanning,entity detection, and hue discernment. They labor byradiating an infrared brightness and gauging the echo or disturbance of this radiance by objects in their proximity. This skill renders them priceless in mechanization,automatons, and commercial contraptions for jobs such as obstruction valuation and long-range directives.

3. ¼ 640x480 CMOS USB camera

This camera has a resolution of 640*480 pixels. It can be connected with the help of USB which is compatible with the RaspberryPi. It supports 30 fps tocapture smooth images and videos and it works

platform independent. It makes the use of Complementary Metal-Oxide Semiconductor image sensor for the same.

4. Bluetooth module

This HC-05 Bluetooth module is used and a very common renowned and versatile Bluetooth communication module. It is utilized with Bluetooth version 2.0+EDR (Enhanced data rate technology). Its operating voltage ranges from 3.3V to 5V DC. The module communicates with microcontroller using a serial UART interface. It has a communication range up to 10 meters. It consumes low power so it is suitable for battery operated devices. It typically features six pins: EN (enable), VCC (power supply), GND (ground), TXD (transmit data), RXD (receive data), and STATE (connection status). It used for wireless communication in embedded systems, few realize the HC-05 module supports an undocumented AT command mode, allowing developers to change its baud rate and other settings, enabling more customized communication protocols

5. Motor driver

It has 12 V supply voltage and 36 V output current. It has output current of 600mA. It is able to drive a DC motor ineither direction and also it can control the speed of the motor. It is dual bridge motor driver so with one IC we areable to interface two DC motors so that it can be controlledin both anticlockwise and clockwise direction. The L293Dcan drive two DC motors or one stepper motor simultaneously. It is called L293D motor driver. Its internal H-bridge circuits can actually be paralleled to double the current capacity, a trick often overlooked for driving more power-hungry motors. This protection is crucial for preventing damage to the microcontroller and ensuring the longevity of your project.

6. Sound Sensor

This sound sensor is able to detect the noise level in dbs. Ithas operating voltage in range 3.3V to 5V DC. Its operating current is 4 to 5 mA. Its microphone sensitivity is 52 to 48db. It has common output

interface that includes analogue voltage outputs, digital pulse outputs and serial communication interfaces such as UART and I2C.Typically, it consists of three pins: VCC (power supply), GND (ground), and OUT (output signal). The sensor oftenincludes a microphone to capture sound and an amplifier to increase the signal strength. When sound waves are detected, the microphone converts them into electricalsignals, which are then processed and sent to the output pin. It is called LM393 sound sensor. Its underlying design includes a comparator circuit that can be fine-tuned to detect specific frequencies or sound patterns, making it suitable for more sophisticated audio processing tasks than typically advertised. This allows the sensor to wake up a system only when a specific sound level is detected, making it ideal for battery-powered devices. Furthermore, by adjusting the onboard potentiometer, you can fine-tune the sensitivity to filter out background noise, a feature notcommonly explored in standard applications.

V. BLOCK DIAGRAM

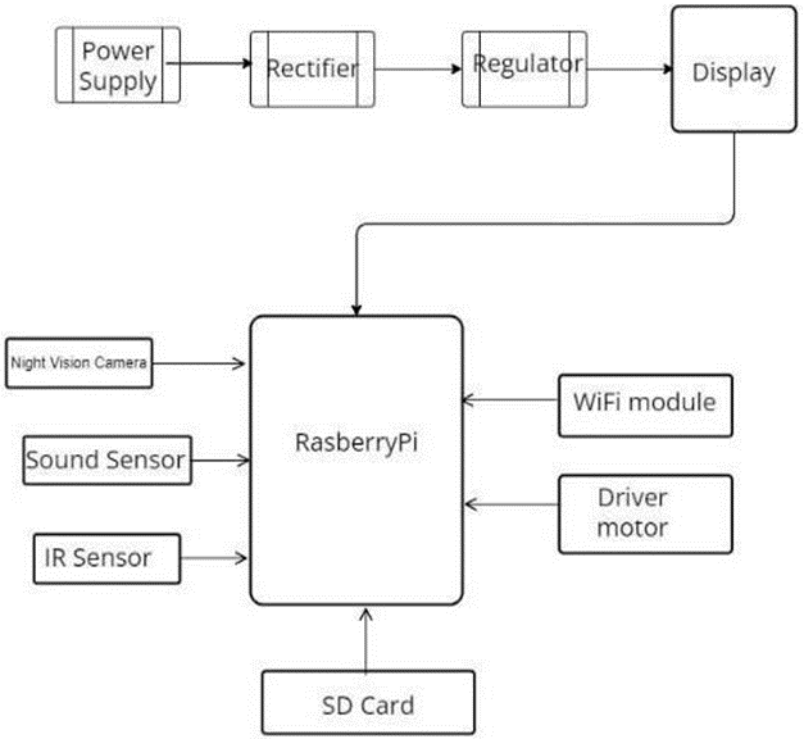

Figure 2: Block Diagram

VI. METHODOLOGY

The security patrolling robot is an advanced system designed to enhance surveillance and monitoring through the integration of multiple sensors and a high-quality imaging device. At the core of its human detection capability is a CMOS camera ¼, which is adept at capturing real-time images and video footage. This camera, with a resolution of 640x480 pixels, provides clear visualdata that is crucial for identifying potential intruders or monitoring activity within its vicinity.The robot's controlunit is a Raspberry Pi4B whichis a very powerful and versatile microcomputer that processes the datafrom the camera and coordinates the actions of the robot. The Raspberry Pi 4 ensures seamless operation and real-time response, making the robot efficient in executing its security tasks.

For obstacle detection and navigation, the robot employs a combination of ultrasonic and infrared (IR) sensors. These sensors work in tandem to detect and avoid obstacles, ensuring smooth navigation through various environments. The ultrasonic sensors measure the distance to nearby objects using sound waves, while the IR sensors detect changes in the infrared light, indicating the presence of objects or humans. This dual-sensor approach not only helps the robot avoid collisions but also enhances its ability detect human presence.

The robot's connectivity and alert mechanismsfurther enhance its functionality and user control. It can be operated via a Bluetooth module connected to the owner's mobile phone, allowing for remote control and real-time adjustments to its patrol routes and behaviours. In the event of detectingsuspicious activities, the robot sends alerts to the owner via email, providing timely notifications that can prompt immediate action. It controls and email alerts ensures that the owner can maintain oversight and intervene when necessary, making the robot a reliable and responsive tool for modern security.

VII. RESULT

The development of security patrolling robots has revolutionized surveillance technology. These robots use advanced sensors and autonomous control to monitor areasmore effectively than traditional guard patrols. Equipped with night vision cameras and microphones, they can navigate and patrol designated areas, detecting andresponding to unusual sounds or activities. The key to affordable and cost-effective was always our primary target and it has been a challenge in deploying these advanced robots. To tackle this, researchers have created an inexpensive security robot with multiple sensors and a user-friendly mobile app. This robot offers autonomous patrolling and versatile functions, including various alarm systems, making high-tech security more accessible. Overall, these robots enhance security by providing continuous, reliable monitoring. They can navigate autonomously, detect obstacles, and capture real-time footage, ensuring comprehensive surveillance. This technology aims to improve security measures, making them more efficient and cost-effective for broader and modern use in order to optimize security concerns.

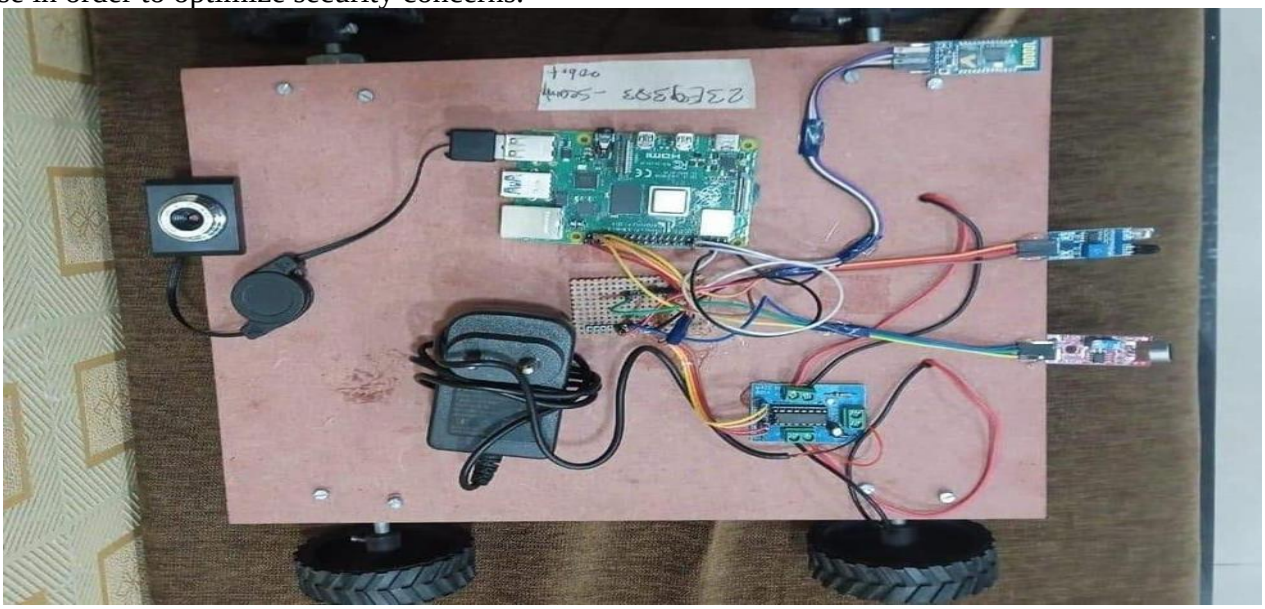

Figure 3: Actual Robot photo

VIII. FUTURE SCOPE

The future of security patrolling robots looks promising with several potential advancements. Firstly, these robots could become more intelligent andautonomous, equipped with advanced artificial intelligence to learn and adapt to different environments. This would allow them to handlea widerrange of tasks, recognize potential threats moreaccurately, and make more independent decisions without human intervention. Secondly, the integration of advanced sensors and improved connectivity will enhance their surveillance capabilities. Future robots might include more sophisticated cameras, thermal imaging, and other sensors to detect a variety of threats suchas intruders, fires, or gas leaks. With better connectivity, these robotscan communicate more effectively with other security systems and personnel, providing real-time updates andcoordinatedresponses. Another significant development will be in their usability and affordability. As technology advances, thecost of producing these robots is expected to decrease,making them accessible to a broader range of users,including small businesses

and residential areas. They might be used for various tasks such as guiding visitors in public spaces, assisting in emergency situations, and performing routine maintenance checks. This versatility will make them valuable assets in various industries, contributing to safer and more efficient environments.

IX. CONCLUSION

Hereafter, manufacturing the design, development and deployment of our security patrolling robot we came to a conclusion that it will have major leap furtherin surveillance technology, so we providing efficient and very reliable monitoring solution for that. This project will enhance security by operating autonomously and detecting abnormalities and suspicious activities using through camera, sound sensor and IR sensor. Which are cost effective, user friendly and easy-to-use making it a valuable asset andan addition to modern security systems.

X. REFERENCES

[1] M. L. V. N. B. S. Kumar, N. S. Murthi Sarma, Ch. Sridevi, A. Pravin "ARM9 Based Real Time EmbeddedNetwork Video Capture and SMS Alerting system."
[2] Krishna Kishore, B. Chinna Rao, P. M. Francis, "ARM Based Mobile Phone- Embedded Real Time Remote Video Surveillance System with Network Camera," International Journal of Emerging Technology and Advanced Engineering, vol.2.
[3] Kavitha Mamindla, V. Padmaja, Ch. Naga Deepa, "Embedded Real Time Video Monitoring System using Arm," IOSR Journal of Engineering, vol.3.
[4] Tasleem Mandrupkar Manisha Kumari Rupali Mane, "Smart Video Security Surveillance with Mobile Remote Control." Ray, P.P. Internet of Things for smart agriculture: Technologies practices and future direction. J. Ambient. Intell. Smart Environ. 2017, 9, 395–420.
[5] Nava Jeevan Raju O. and Praveen P, "Video monitoring and motion detection system based on arm Linux platform and http protocol with SMS capability."
[6] Wang Liwei Yan Shi Xu Yaqui, "A Wireless Video Surveillance System based on 3G Network," Conferenceon Environmental Science and Information Application Technology.
[7] Zhaomin Zhu, Takashi Morimoto, Hidekazu Adachi, Osamu Kiriyama, Tetsushi Koide and Hans Juergen Mattausch, "Multi-view Face Detection and Recognition using Haar-like Features."
[8] P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simple features," in Proc. of IEEEConference on Computer Vision and Pattern Recognition, Kauai, HI.
[9] Tahzib Mashrik, Hasib Zunair, Maofic Farhan Karin "Design and Implementation of Security Patrol Robot using Android Application" 2376-1172/17 $31.00 © 2017 IEEE DOI 10.1109/AMS.2017.20.
[10] Y. Shimosasa, J. Kanemoto, K. Hakamada, H. Horii, T. Ariki, Y. Sugawara, F. Kojio, A. Kimura, S. Yuta,"Some 6481 results of the test operation of a security service system with autonomous guard robot",26th AnnualConference of the IEEE on Industrial Electronics Society, Vol.1, pp.405- 409, 2000.
[11] S. Chia, J. Guo, B. Li and K. Su, "Team Mobile Robots Based Intelligent Security System", Applied Mathematics & Information Sciences, vol. 7, no. 2, pp. 435-440, 2013.
[12] H. Lee, W. Lin and C. Huang, "Indoor Surveillance Security Robot with a Self-Propelled Patrolling Vehicle", Journal of Robotics, vol. 2011, Article ID 197105, 2011.
[13] L. Chung, "Remote Teleoperated and Autonomous Mobile Security Robot Development in Ship Environment", Mathematical Problems in Engineering, vol. 2013, Article ID 902013, 2013.
[14] R. Salman and I. Willms, "A Mobile Security Robot equipped with UWB-Radar for Super-Resolution Indoor Positioning and Localisation Applications", in International Conference on Indoor Positioning and Indoor Navigation, 13-15 Nov. 2012.
[15] J. Garcia, A. Alsuwaylih and S. Tosunoglu, "Security Patrolling Autonomous Robot", in Florida Conference on Recent Advances in Robotics, 14-15 May 2015.