Night Patrolling Robot for Suspicious ActivityDetection

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***Abstract*— Every human being needs a sense of security. The requirement for security has risen in proportion with the population growth. However, because of a scarcity of resources, effective protection is not possible. It costs a lot of money to get appropriate security that not many can handle or afford. The goal of the study was to find a solution to the issue by developing a system capable of providing strong protection at very low cost when long-term benefits are taken into account. The objective was to design and develop a robot that can travel around and survey the region and inform the command center if anything unusual was found. The system will be controlled manually on the server to find out its workplace's paths. The system is outfitted with a camera so that it can be used to capture built-in live video of the attacker and display it on the server.**

Keywords*— *Night Patrolling, Node MCU, Server

I. INTRODUCTION

People are seeking inventive methods to make their lives easier and more efficient as the globe progresses toward modernization. The security industry has evolved in terms of existing technological development, but it has yet to completely embrace technology. Because businesses have not yet adapted to the changing demand for the new market, the idea of using robots in the security industry is relatively new. Robots are a modern technology that transforms human life, as the key and emerging part of robots is self-control and self-transformation. Robotic systems are remotely controlled, computer-like devices. The available robots are costly and have limited capability, as well as the disadvantage of being subject to external sources of damage. The system focuses to solve the issue by developing a safety system for night patrolling at a minimal cost that utilizes commercially available technologies and equipment.

In many places of the world, the most important concern is safety. Women and men alike are still afraid in alone regions. So here is the proposed security patrolling robotic system using Node MCU. The proposed system which is patrolling the area is constantly moving and moving as directed by the admin.

The system moves in a certain path and has a camera that is attached on hardware for assuring the security of the area. It is controlled manually on a server for night patrolling. The forward, backward, left, and right locomotion of the system is done by the admin who is controlling the server. The system continuously live streams the area. Then, that live streaming of video is transmitted to the user/admin on the server using the Local area Network (LAN), then the user will then inspect it, and if any faults are discovered, the proper measures will be done. It monitors each area to find any problem through a combination of cameras. Also it scans the area to detect any humans while streaming the video of the situation in an area to the server. Besides just streaming the video the model also detects the suspicious activities of the person and gives an alert on the server.

Thereby, the paper presents a secured night vision patrolling system that works tirelessly and protects the property by safeguarding big areas on their own. Patrolling robotic systems are typically utilized in the industrial sector, military regions, hospitals, shopping malls, and national functions, among other places. The paper therefore put forward a Night vision security robotic system to patrols the areas and places and also secures the facility.

II. LITERATURE SURVEY

The overall concept of IOT-based sensing and monitoring systems for constructing an automated home is described in the study. The proposed device employs a Node MCU board and an Android OS smart phone to control the internet remotely. The heart of this system is the Node MCU, which may act as a mini web server and an interface for a variety of hardware modules. The activities are controlled using a third party application hence can't modify some features from scratch [1].

The designed scheme is a surveillance robot that can guard any site using a night vision camera. The autonomous unit is fitted with night vision cameras and sound sensors and moves at various speeds[2].

As a result of rising violence against women, safety of women has become a serious concern in all parts of the world as a result of growing violence against them. The current system either lacks one of these elements or requires a high-end microcontroller, such as the Raspberry Pi, to function properly. As a result the women's night patrolling

robot makes the most of its characteristics, such as sound sensors, ultrasonic sensors, ESP cameras, and IoT, to patrol in its designated area with the least amount of human interaction. As noticed the camera starts capturing only when just sound is detected in this setup [3].

The Raspberry Pi is equipped with a night vision camera in this suggested frame work [4], which aids in the detection of humans or other issues detected by the sound sensor. The framework employs a predetermined method of watching. It has the ability to filter sound in a location.

To protect the entire facility, any minor sound causes the Blynk robot to send an alert to the individual in the system [5]. The low light camera allows us to observe live footage through the phone or tablet and capture the surroundings, which we can then transmit to the viewer.

The Wadoro (WAtch DOgROBot), an independent robotic system designed for nighttime monitoring in open regions such as roofs. It cannot recognize images of multiple persons are present in the database [6]

Utilizing the data mining to harvest unstructured data for previously undisclosed relevant information. Focusing on crime statistics, the authors anticipated criminals. The paper [7] gives different types of criminal analysis using several machine learning. Four algorithms namely Adaboost, Bagging, Stacking, Enhanced Reweight mechanism in the ensemble were also considered. Results show that in most cases. 95% accuracy is given by the new ensemble algorithm to correctly predict the crimes.

The designed system is a surveillance monitoring robot with a webcam that can protect any site. The robotic vehicle is equipped with a video surveillance camera and audio sensors and moves at defined levels. During patrolling, it employs a predetermined line to follow. If the sound is detected, it stops at specific locations and carries on to the next. When a person is spotted, the system employs an RF-based Controlling Section to control the robot's direction. It uses a 360-degree swivel camera to monitor the region for any invasion.[8]

The fundamental idea behind this invention is that if a lady perceives danger, all she will have to do is press the device's button. When the gadget is turned on, it uses GPS to track the women's whereabouts and transmits emergency alerts through GSM to pre-registered cell phones as well as the cop's command centre. The pulse sensor measures the victim's pulse and, in the event of a medical emergency, provides the device's current GPS position to the ambulance via SMS every 10 seconds. The key feature of this method is that it is compact and portable. Precision and dependability are ensured by the employment of advanced components. [9]

The goal of the study [10] is to find a key to the issue by creating a system which can give high security in very low cost, when the long-term consequences are considered. The robot has GPS tracking embedded in to help it figure out how to get around its workplace. When the moment comes, the robot is also outfitted with a security camera that can capture live footage and photographs of the attacker. For reducing the cost the author was not able to optimize some things which can still be possible in near cost.

III. METHODOLOGY

The proposed system is an electronic model that is prepared for performing altered activities in this manner overriding human work, giving significantly exact results and beating the limitations of people.

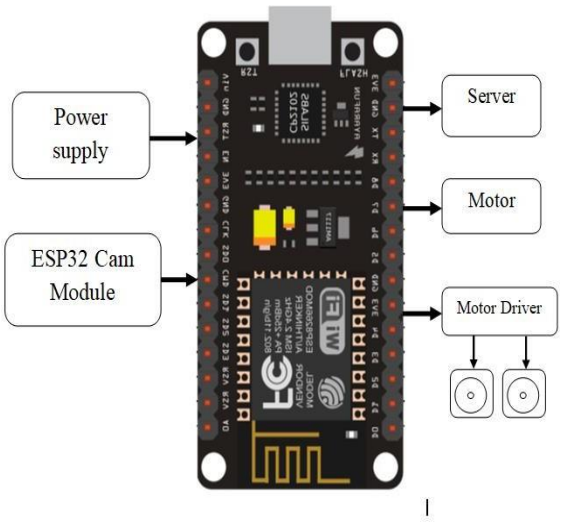


Fig.1. Block diagram of night surveillance system

From Fig. 1 it can be realized that the component on the Node MCU which is taken as the input is the camera module and for the output we will be using dc motor, motor driver and server which can be seen in the block diagram. In the system, the powering to the Node MCU is with 5V and 3A supply. The model has used Li-Po batteries to power the system and motor driver to control the motors. It is the communicator between the Micro Controller and the Motors and also bridge between power supply and the Motors. And the CAM module is used to capture the surrounding and to host the stream on the Boards server. The gear motors are only associated with the left, right, forward and backward movement of the robotic system by different combination of commands given by the Node MCU to the Motor driver.
By using the stream over the server the system processes the image processing model on it which will detect the activities which has been fed in the systems image processing model which will give the signal about the activity happening in the video stream.

An external power source providing 5 V and 3A is used to power the Node MCU. Lithium-ion batteries are used (Li-ion). The device that regulates the motor is known as the motor driver. It's used to regulate the motor's rotation and acts as a link between the motor and the battery, allowing it to be destroyed instead of the motor. The motor driver is also connected to the Node MCU, allowing for optimal speed configuration. The ESP32 Cam Module is also used to capture and monitor streams on the server.

A. Working

The developed system for night patrolling secures the area for any abnormalities or any suspicious activity to which it will send the signal to the main server whenever it detected any suspicious activity while processing through video streaming. The model of the system consist of three main components i.e. an ESP32 camera module, node MCU and motor driver. The system basically monitors a particular area as operated by the admin. The connection of network for operating the server will be through LAN. The locomotion of the system is controlled manually that is done through Node MCU by the GPIO Pins and accordingly the hardware module of the system will move in either forward, backward, left or right direction. Using Teachable machine the system will be able do image processing through which it will be able to identify humans in the area, look for any abnormalities in the area and detect whether the humans are caught doing any suspicious activity. If any of the mentioned parameters or any intruder is identified or detected then the alerts will be sent to the server which will then be controlled by the admin and actions will be taken accordingly.

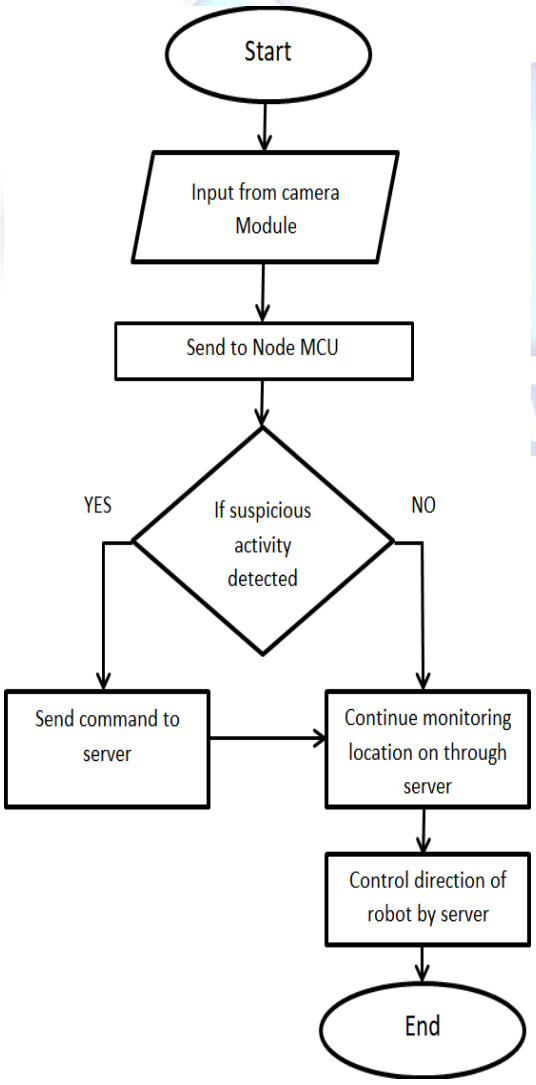


Fig.2. Functionality flow of the night surveillance system

B. Hardware requirements

1. ESP32 Cam Module: The ESP32-CAM is an ESP32-based development board with an embedded camera that is small and inexpensive. The board has Wi-Fi, Bluetooth, and low-power BLE thanks to two rising 32-bit LX6 CPUs.

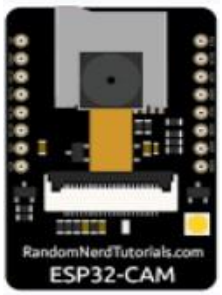


Fig.3. ESP-32 Camera Board

2. ESP8266: The ESP8266 is a low-cost Wi-Fi microchip with built-in TCP/IP networking software and a microcontroller. This small device connects microcontrollers to a Wi-Fi network and performs basic TCP/IP communications using Hayes-style instructions. It has a 32-kilobit instruction RAM, an 80-kilobit user data RAM, and a 64-kilobit boot ROM. It has 2.4 GHz Wi-Fi 802.11 b/g/n, as well as 16 GPIOs and many other features.

Fig.4. ESP-8266

3. Motor Driver: The L298N Motor Driver Module is powered by the potent L298N Motor Driver IC. The L298N is a dual H-Bridge motor driver that can simultaneously regulate the velocity and distance of two DC motors. DC motors with voltages ranging from 5 to 35V and peak currents of up to 2A can be powered by the module. This motor driver module controls the speed and direction of two DC motors up to 40V 3A.

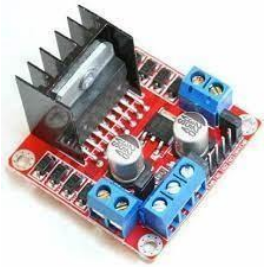


Fig.5. L298N Motor driver

IV. TECHNOLOGIES

1. Django: Django is a Python-based internet system that utilizes the model template (MTV) design paradigm. Django Software Foundation hosts this event (DSF). Django's major purpose is to make building sophisticated, web-based websites easier. The framework promotes component reuse and "connectivity," minimum code, low integration, quick development, and the idea of avoidance of duplication.

2. Ngrok: Ngrok is a cross-platform tool that enables developers to connect their local development server to the Web with easeThe program makes your locally hosted web service seem to be hosted on a ngrok.com subdomain, removing the necessity for a worldwide IP or domain name on the local network.

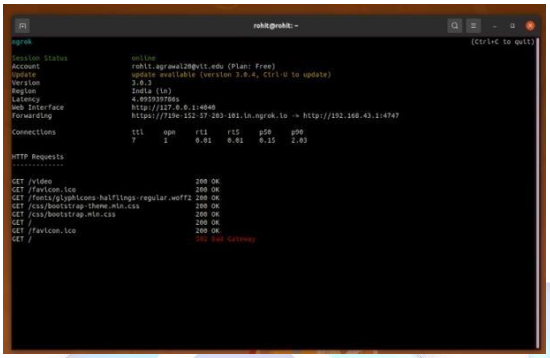


Fig.6 Ngrok

3. Teachable Machine: A teachable machine is just web-based software that quickly and easily generates models. It is capable of detecting sights, noises, and postures. It's also adaptable. It may be used to teach a model how to recognize pictures and posture using photographs or a live webcam. Teachable Machine generates a Tensorflow model that can be used in any website app, Android app, or other platform. We use a teachable machine in our proposed system.

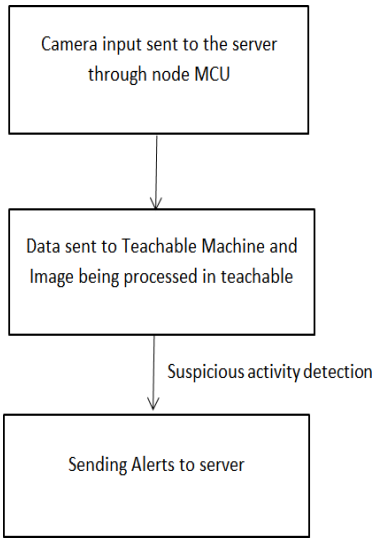


Fig.7. Functionality flow for Teachable machine process

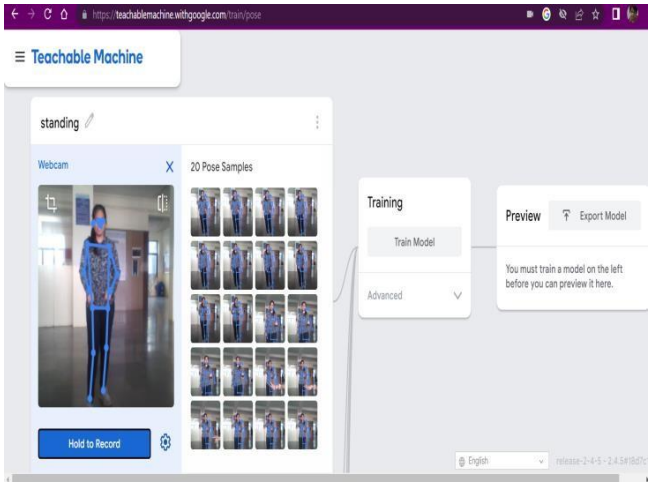


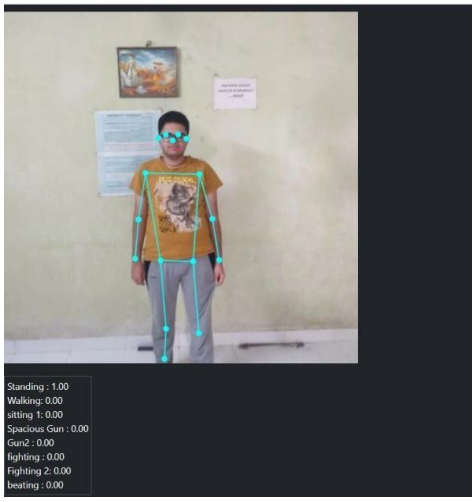
Fig.8. Providing data set for machine learning training

V. RESULT AND DISCUSSION

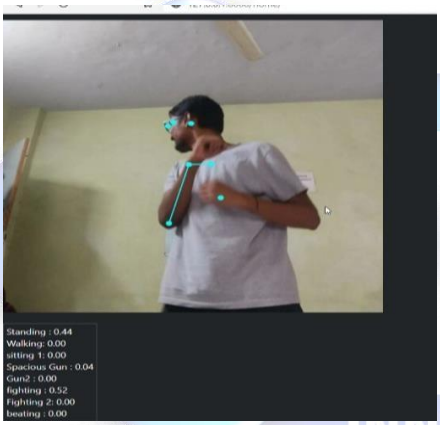
The hardware was successfully implemented. The system moves through the controls as shown in the fig.8. The upward and downward arrow is for moving the hardware model of the system in forward and reverse direction. And the left and right arrows are for changing the way it is moving in. The central button is to stop the model.

Fig.9. Locomotion controls

Fig.10. Hardware assembly



The system is able to detect human first which itself is sufficient as one security aspects and advanced is it is able to detect the movement.
The human detected by the system is standing still so the system concludes that the person is not doubtful and no any suspicious activity is detected.



When a system captures a human being suspicious in a ways like fighting, holding gun, or beating anyone then it will be displayed on the screen in a form of numbers.

After reviewing several papers it was found that almost all the available system that worked on the night patrolling system were claiming to use a complete minicomputer as the processing unit like Raspberry Pi. The systems are not fully utilizing the resources available. On the other hand the proposed system will be working using a Node MCU which is just a wi-fi supported microcontroller and a Camera Module which will cause in drastic reduction in the cost.

Another advantage is of using external camera module and to process it at server the system is able to execute not only one but more models on the same video stream which can proved very effective by instead on developing only one very complex model to developed different models according time place and circumstances and to run them get the sum output of all the models which individually will not be very complex as compared to a one model with various specifications. Below figure shows the comparison graph for the cost, complexity and weight of proposed system and existing system.

TABLE 1: Comparison based table for Night patrolling robotic systems

Approaches (Paper Title)	Main Component	Sensor used	Complexity / Cost	Software / Technology used
Existing Model				
Night Vision Patrolling Rover Navigation System for Women's Safety Using Machine Learning	Raspber-ry pi 3 Model, Night Vision Camera	Sound sensor, IR sensor	High Complexity, High Cost	Confusion Matrix(Data science)
Night Vision Security Patrolling Robot Using Raspberry Pi	Raspber-ry Pi 3	Sound Sensor, PIR Sensor	High Complexity, High Cost	Open CV
Proposed Model				
Night Patrolling Robot for Suspicious Activity Detection	Node MCU ESP8266, ESP32 Cam Module	No any sensor	Less Complex, Very Low Cost	Teachable Machine, Ngrok, Django

TABLE 2: Accuracy Table for various Test Cases

Parameters	Accuracy					
	Test 1	Test 2	Test 3	Test 4	Test 5	Average
Standing	98%	97%	99%	98%	96%	97.6%
Walking	83%	88%	92%	90%	89%	88.45%
Sitting	66%	72%	64%	58%	75%	63%
Fighting	59%	67%	87%	94%	86%	73%
Gun	89%	78%	91%	92%	87%	87.4%

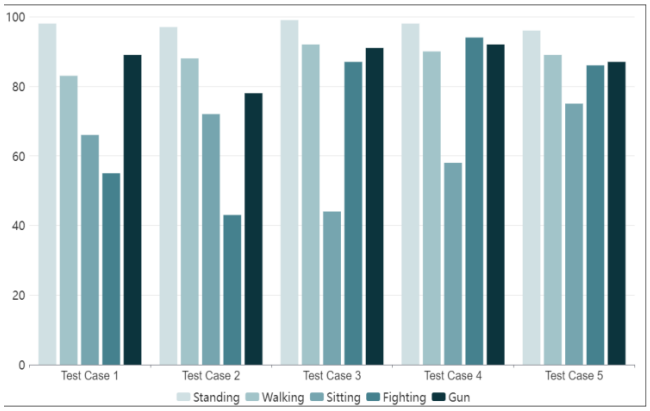


Fig.11. Model Performance Evaluation Chart

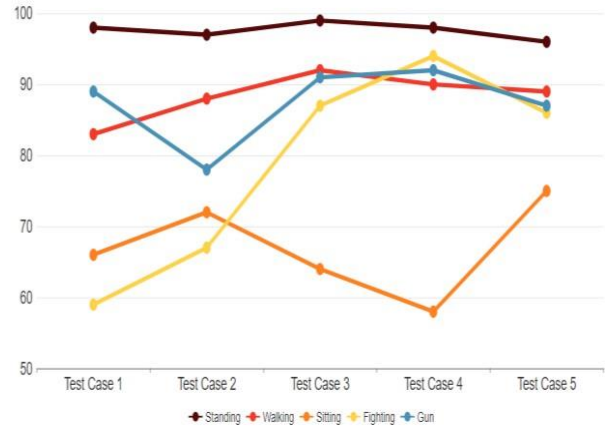


Fig.12. Model Accuracy at various test samples

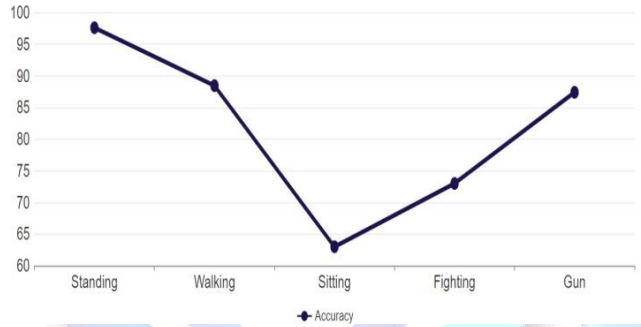


Fig.13. Model Average Accuracy plot

Hence the proposed Night Vision patrolling system proves to decrease the cost of the system while reducing the complexity of processing in Image processing models and giving more flexible and efficient Models.

VI. FUTURE SCOPE

Patrolling Robots are designed to help us protect from the dangerous situations and provide security in a particular location. This technology will also assist police in making arrests and searching for criminals. Because women's safety is an issue to worry in many places of the world these days, this robot could prove to be a valuable resource. As far as the future scope of this system is concerned, this robot can be a Good Samaritan in reducing crimes if implemented in areas. Further improvements and modification could be done to make the system more advantageous and applicable such as making the system autonomous. The accuracy and additional features could be improved in the image processing model. With better dataset according to the specific application we can feed more data and make more accurate models.

VII. CONCLUSION

The proposed system can create an impact in the reduction of crime rates in less cost and compressed kit and concept can be operated manually as well as automatically. Also live video streaming is available to ensure more safety. The ability of the proposed Night Patrolling Robot System is to keep public safe. Improvement can be made by the use of ultra-compact technologies.

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