iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IX **Month of publication:** September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31545

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Human Detecting Robot based on Computer Vision - Machine Learning

Mithilesh P. Padhen[1], Kamlesh S. Shimpi[2], Ruchita D. Thakur[3], Prof. Prakash V. Sontakke[4]

[1, 2, 3]*Student, Dept. of Electronics and Telecommunication Engineering, Pimpri Chinchwad College of Engineering, Pune, Maharashtra, India 411044*

[4]*Asst. Professor, Dept. of Electronics and Telecommunication Engineering, Pimpri Chinchwad College of Engineering, Pune, Maharashtra, India 411044*

Abstract: ***In the recent decades, several advanced and creative applications have been cultivated and implemented by scientist, visionary engineers and researchers on robots, for illustration such as search and rescue, surveillance, detection, traffic monitoring, weather monitoring and so on what was recently reviewed as science fiction or inconceivable futuristic into reality, making our lives much easier, delightful and more fascinating. The Robots have transitioned era of machines that can make everyday things and they are exceptional because they can generate wide type of actions based on the identical machine. The current ongoing progress in robotic intelligence and machinery provoked substantial changes in enabling robots to perform a broad spectrum of detection missions with increasing level of intricacy. Operations such as search, rescue and detection require a large camera hedging and thus making robots an appropriate tool to execute advanced tasks. At the same instance, the expanding inclination of machine learning applications in computer vision provides an exceptional insight into the drive of this project. This project demonstrates an approach which makes it possible to identify the existence of human in the atmosphere with human object detection algorithm using computer vision capabilities. The intention of detecting human presence in intended area is to mitigate unlawful entry into forbidden area, unlawful logging activities as well as saving the human lives in unintentional conditions. Also, the consequences of this project are anticipated to magnify the exercise of robots for supervision and vigilance purpose to save time and cost.***

Keywords: Surveillance, Detection, Monitoring, Computer Vision, Machine Learning, etc.

I. INTRODUCTION

The Video Monitoring and Rescue has played paramount role in the exploration in last few years. The application has comprehensive range of purposes like supervision of various traffic equipment [1-4], experience the human comportment. In supervision schemes diverse sort of cameras are helpful for surveillance like fixed cameras, and pan and tilt cameras [5,6]. These cameras are specifically used for inhouse security [6,7]. In home safety arrangement various types of cameras are fitted on edge [7] surface with broad range of angels to trace the object.

These detection procedures require a computer or a laptop for supervision [8]. In recent times, various devices use a user functioned robot [9] with a camera for the intention of supervision. The camera which is typically fitted on the robot is capable to shift to diverse locations.

The robots having more categorization are more dynamic in nature than the fixed cameras. Primarily used supervision robots are robot possessing wheel compositions. The wheel robotic compositions are more convenient for flat podium [9]. Due to the advancement in wireless communication technology, the videos acquired by robot can be seen distantly on tablets, laptop and human held devices [10,11].

Restrictions in the capability of humans to attentively supervise video surveillance live footage [12] led to the insist for development [13] of computer vision, artificial intelligence, natural language processing and machine learning technology [14] that could implement the task efficiently. Humans enhancing the experience of a single video monitor for greater than twenty minutes lose 95% of their knack to maintain attention adequate to discern required substantial events.

With two monitors this is cut in half again. Given that many equipment has large number of cameras, the assignments are clearly further human ability. In general, the camera views of vacant classrooms, data storage centers, parking lots or large monuments are extremely boring and thus attention is rapidly attenuated. When there is involvement of monitoring of multiple cameras, typically having a straight surface with split screen views and which is rotating every several seconds between one set of cameras and the next, the visual tedium is rapidly astonishing.

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While video supervision cameras [15] with higher execution by users ranging from automobiles and complexes to educational institutions and business houses to government owned subsidiaries such as power plants, conclusion that video supervision process proctored by humans was unrealistic, complex, tedious and unproductive.

Comprehensive video surveillance systems were expelled recording for possible medical science use to recognize someone, after the reality of a theft assault, unexpected intention. Where broad spectrum of camera views was utilized, specifically for wide ground coverage, harsh restrictions were invented because of insufficient resolution and sensitivity. In these instances, it is impracticable to recognize the intruder because their image is so small on the monitor.

The main goal of our work is detection of the person in the frame with the assisting of computer vision techniques [15]. We hope the designed work can easily detect the human present in the frame with the assist of Raspberry Pi. The project specifications are summarized as follows:

To detect the object/person in the video streamed by camera this is mounted in the Robot using Computer Vision [15] and Machine Learning [16] technology.

1) Using the most famous and efficient open computer vision platform for the initial trial of this project use the OpenCV library for face detection

2) Wi-Fi/Internet Technology is a rising technology through which it can get connected to wider range. Raspberry Pi is a processor which has inbuilt Wi-Fi to get internet connectivity.

3) It comprises all the features which are implemented in tablets or laptops. So, the operating of Raspberry Pi robots with help of android application drives the system competent and dependable.

4) The system providing the efficient and reliable operation of human detection without providing the special background.

The system providing the flexibility to move the robot in the desired space on desired region [17,18] to carry out the process of real time human detection.

II. LITERATURE REVIEW

Suet Peng Yong et.al [1] give rise to human object detection using utilization of deep learning techniques for the with the help of 3DR solo drone furnished using the go pro camera in order to real time monitoring and coverage of forest area.

Suet Peng Yong [1] et.al provide the knowledge of the video processing using convolution neural network and provide the knowledge of how to select the perfect dataset for specific project there are many data sets available on kaggle, GitHub and other platform but which dataset to be used is depends on the requirement of the system.

Ashish U. Bokade et.al [2] explain about the video surveillance using smart phone and Raspberry Pi. In this, with the help of Raspberry the motion of robot can be observed and controlled. The process of detection can be carried out successfully and results can observe on the user's smart phone.

Jun Zhang et.al [3] deliver standards of the jumping robot which is advantageous over the conventional robot which cannot move on the hard surfaces or jump to a higher range. It gives idea about PIR sensor as well as jumping robot forming zig-bee WSN allows communicating with one other and providing flexibility to jump on stairs to move to the higher surfaces from the ground up-to the range of 105 cm.

P. K. Padhy et.al [4] explain about the conventional PI/PID algorithms which have the reference path for the tracing for moving the robot from one point another giving continuous feedback with the help of phase and gain margin providing good performance and robustness and provides the perfect idea of how the robot will bereave to certain surface while travelling on it and it also provide the knowledge of what specification and which component should be used for this system 12v, 100RPM and 100mA current rating DC brushless motor will be used.

Christian Micheloni et. al [5] explain about the the problem of the surveillance and the security of indoor environments is addressed through the development of an autonomous surveillance vehicle (ASV). The ASV has been designed to perform, in addition to the classical robotic tasks (e.g., navigation and obstacle avoiding), the tracking of objects (e.g., persons) moving in indoor environments. The selection of the target object to be tracked can be decided by a remote operator or autonomously by the ASV itself in the case that a suspicious behavior has been detected.

Lili Yang et. al [7] explain safety and security into consideration together and proposes a phone-out-only policy for ensuring security and virtual home environments for safety. A remote monitoring and control system for a security camera is used to illustrate the new methodologies for safety and security.

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III. METHODOLOGY

A. Selection of Architecture

1) Block Diagram

The following Fig. 1. shows various blocks/components interconnected with each other.

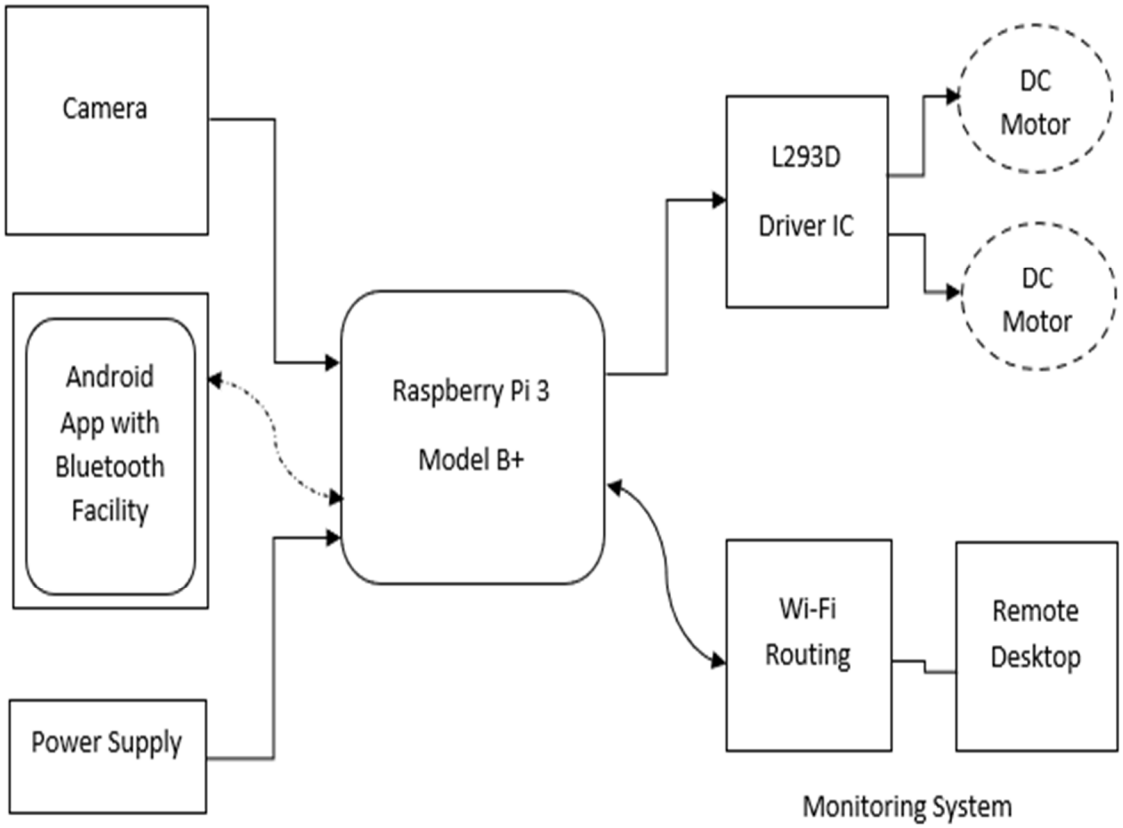


Fig. 1. Block Diagram

Initially, the camera will be mounted on the robot. The camera will get interfaced with the Raspberry Pi 3B+ as well as Raspberry Pi is the main processing unit of the robot. The camera is Logitech C270 HD Webcam having resolution 1280*720 pixels. The DC Motors will be interfaced with the Raspberry Pi for managing the movement of the robot. The DC Motor is 12V as well as 100 RPM having the current rating as 100mA. Initially, the camera will capture the video data which will be real time in the nature with the diverse background then by using the Wi-Fi of Raspberry Pi this video data will be send to desktop or computer and on the desktop using Computer Vision video data will be processed in real time to detect the various humans present in the video.

The robot will be having various ability to run and avoid hard surfaces. The movement of robot will be managed through the Bluetooth terminal mobile application using keypad keys, the most important task of the robot is to travel from point A to point B without any interference. This action of the robot will be operated by the user, the user will control robot using four commands of the applications such as forward, backward, leftward and rightward which will eventually help the robot to move in the forward, backward, left and right direction. And also, there is provision for the rotational movement of the Camera which will be mounted on the servomotor. With using commands through the application, the servomotor will start circular motion which will produce wide and enhanced view for detection through the camera mounted on the servomotor. Using the assistance of the Raspberry Pi Wi-Fi, this video in real time will transfer to the laptop in the desired framework on which video processing will be done. The L293D motor driver IC provides two 12V output pins form this two 12V pins two motors will be connected to form a H-bridge structure.

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2) Flow Chart

The following Fig. 2. shows the flow associated in successful detection of human with help of robot.

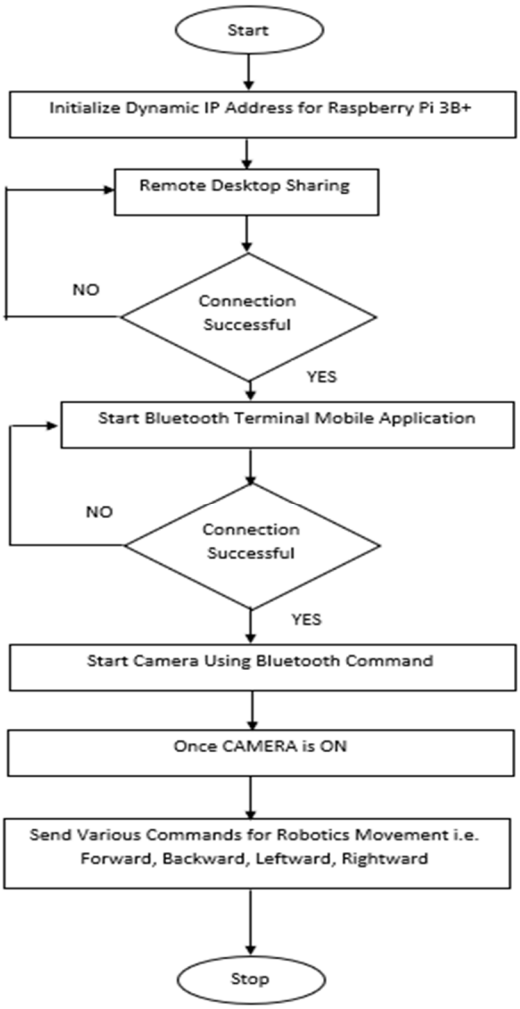


Fig. 2. Flow Chart

Initially, the connection between the Local Area Network (LAN) and Dynamic IP address from the router is established and then after the process of successful establishments then it goes further for next step of the operation. If the connection establishment is not successful then it repeats the operation of establishing the connection between dynamic IP address from the router and the local area network (LAN) until it becomes successful. This process is performed to establish the connection between Raspberry Pi Model 3B+ and the desktop on which the video processing is to be done with the Computer Vision.

Now the next step is required is to start the Bluetooth terminal mobile application which initially runs on the android platform and it generally requires the permission for activating the Bluetooth. This process is performed repeatedly for further successful completion of detection process. After Successful Initiation of Bluetooth with assistance of android application, the camera will start with the help of Bluetooth command using keywords and once the camera is On, the robot is able to perform various activities such as forward, backward, leftward and the rightward movement with the help of the various Bluetooth commands using keyword. Also, the rotational movement of the servomotor can be obtained through the Bluetooth commands. With the help of these commands the robot is able to stop all the operations such as forward, backward, leftward and rightward as well as the circular movement of the servomotor and In-between these processes humans visible in the video frame will be detected. And after successful detection of humans the rotational motion of servomotor can be stopped as well as camera can be turned Off with the help of Bluetooth commands and robotic movement of the bot will also be stopped.

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B. Hardware Implementation

1) Circuit Diagram

The following Fig. 3. shows the circuit diagram connections required for connecting various peripherals on to the Raspberry Pi 3B+.

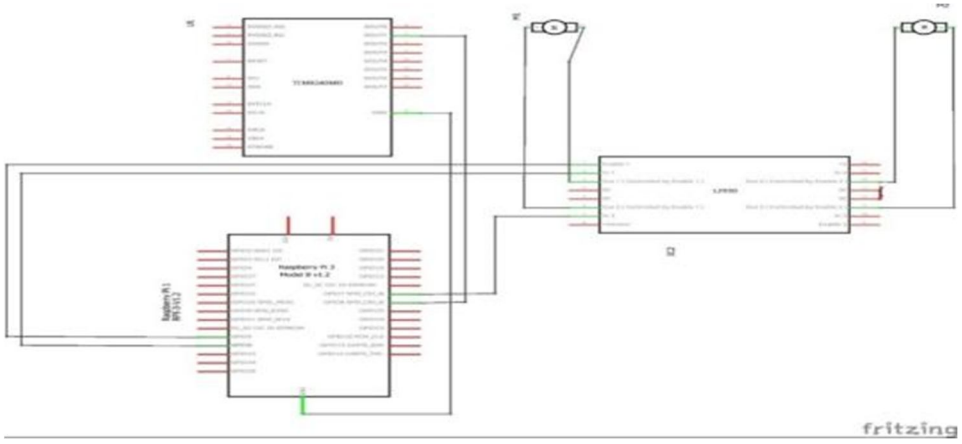


Fig. 3. Circuit Diagram

2) Interfacing Diagram

The following Fig. 4. shows the interfacing diagram required for interfacing various peripherals onto the Raspberry Pi 3B+.

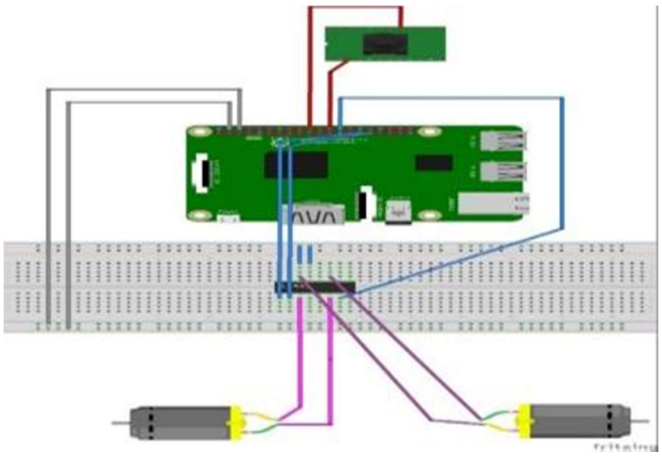


Fig. 4. Interfacing Diagram

C. Software Implementation

The following figures Fig. 5., Fig. 6. and Fig. 7. show the software implementation done for detection of humans.



Fig. 5. Rectangular Contour Detection



Fig. 6. Human Shaped Contour Detection

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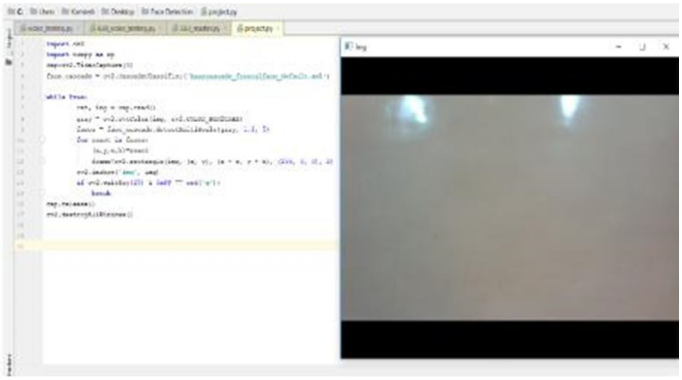


Fig. 7. Haar Cascade Detection

IV. EXPERIMENTS

The human detection is the most important task, for performing this task OpenCV [15] framework is used, the testing strategies here divided into the two different algorithms to get the final goal. The used two different algorithms are contour technique and haar cascade classifier algorithm and using these two algorithms the aim is to eventually find out which have better efficiency [19] and which will help to achieve desired results. The contour technique uses the fundamentals of image processing which converts the image into black and white then find out the absolute difference between the two consecutive images and highlight the differences in the contour form. The haar cascade method uses ensemble learning approach of machine learning where group of weak learners collectively provide best result. These algorithms are explained in further points:

A. Contour Technique

A contour is a closed curve connecting all the uninterrupted points having some color or severity, they represent shapes of objects found in an image. Contour detection is a beneficial technique for shape investigation and object detection and for the purpose of recognition. The following is the test video on which contour technique is applied.



Fig. 8. Image of Contour

Then absolute difference is calculated between the two consecutive frames to highlight the movement in the video.

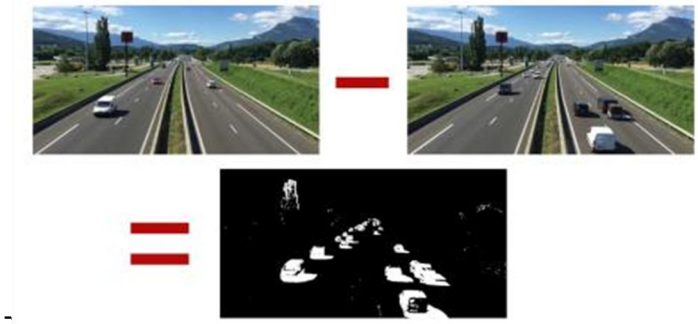


Fig. 9. Absolute Difference Image

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Then this absolute difference image is converted to Gray scale for better image processing and then the gaussian blur techniques are applied on this Gray scale image to reduce the noise from the image. In gaussian blur technique the input is blur so noise is eventually reduced.

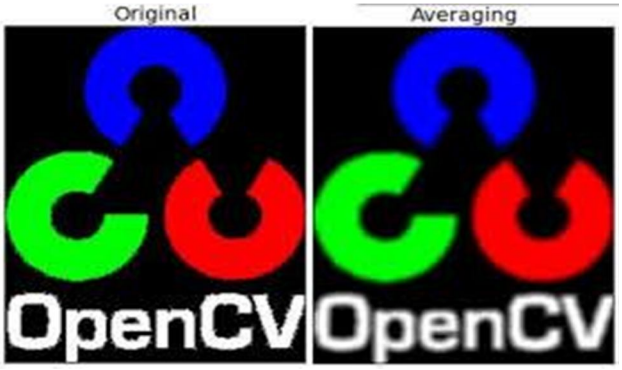


Fig. 10. Gaussian Blur Image

Then from the gaussian blur image the threshold is found out for further processing. Here, the issue is briefly simple. If pixel value is greater than a certain value, it is allocated one value (White), else it is allocated another value (Black).



Fig. 11. Gaussian Blur Image

Then from this threshold image the dilation is performed for reduction of the noise. After gaussian blur process the image got shrink to maximize the image to some extend the dilation is performed. The results obtained are as follows:

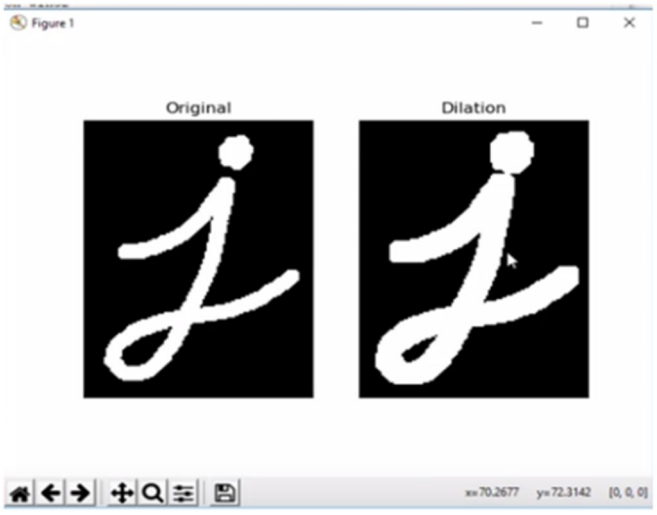


Fig. 12. Number Dilation Image

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From the dilated image, the contour observed is as follows in the Fig. 13. In this Fig. 13., it can be seen that the contour structure is formed around the humans present in the image.



Fig. 13. Number Contour Image

Then on this contour image using the square function contour is converted into the square.

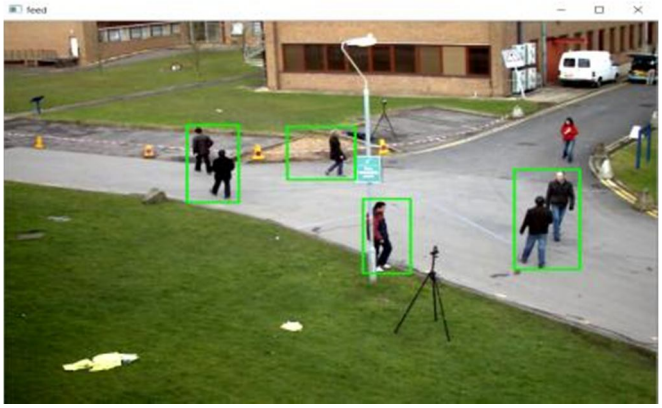


Fig. 14. Final Image

B. Haar Cascade Classifier

The cascade classifier comprises of an assembly of stages, where each stage is a group of weak learners. The weak learners are basic classifiers which is known as decision stumps. Each stage is trained utilizing a technique which is known as boosting. Boosting provides the potential to train a highly precise classifier by using a weighted average of the decisions constructed by the weak learners.

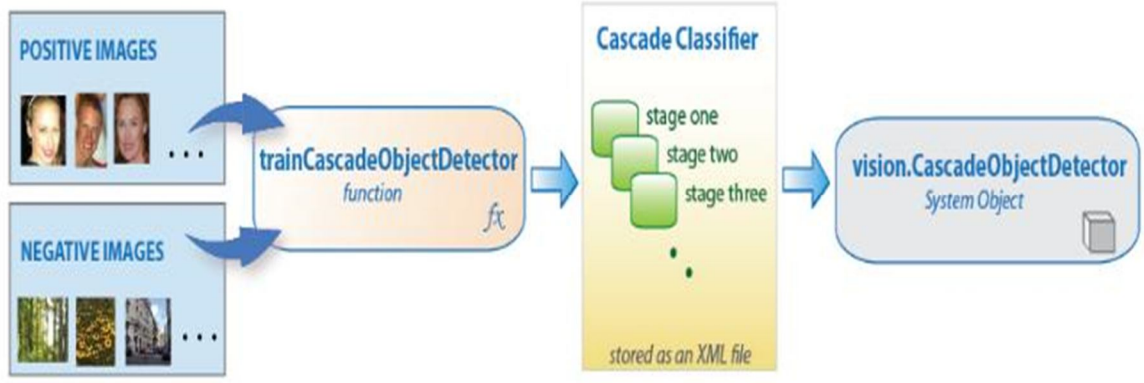


Fig. 15. Cascade Classifier

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The Image Processing is done for the conversion of Colored Image to Gray Scale Image.

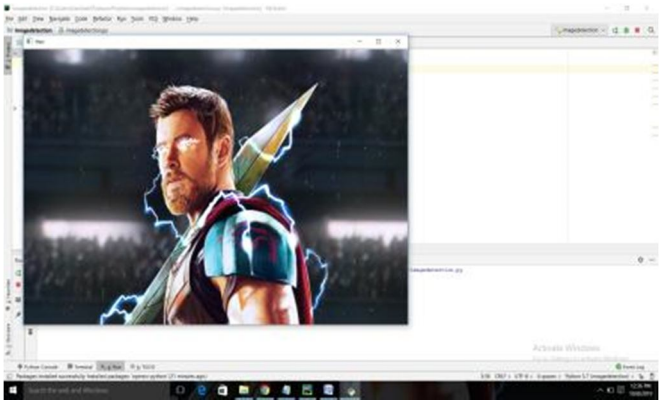


Fig. 16. Real Colored Image

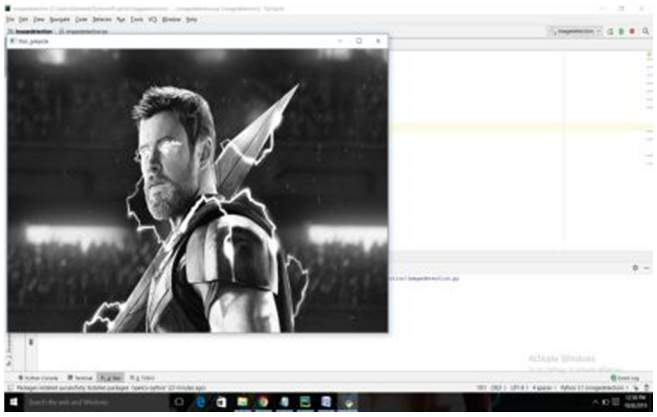


Fig. 17. Gray Scale Image

V. RESULTS

The proposed both algorithms i.e. contour technique and haar cascade classifier gives result for real time video processing in human detection but the contour technique is more suitable for still camera where movement of the camera is not allowed as the main requirement for contour technique is camera must be still, the contour technique is more suitable for still CCTV camera and in this project the camera is moving as it is mounted on the robot so the haar cascade classifier is used in final project [20].

Then to understand the face detection basics, face detection [21] is done using OpenCv library on test image set and the results obtained are as follows:

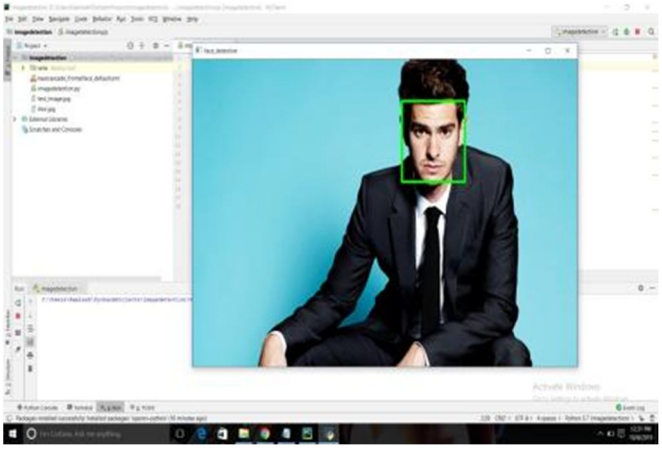


Fig. 18. Face Detection on Test Image

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Then with the help of Webcam and OpenCv execution of the operation of face detection can be performed. Now, In the Fig. 19., as there is only one human present in the camera frame, a square structure which is in green color is formed on his face. Now, when there will be many humans present in the camera frame, the square structure which is in green color will be formed on everyone's face which will be present the camera frame [21-23]. As the humans in the camera frame are moving the square structure on the faces of humans will also be moving according to the movement of the humans. Thus, it becomes convenient and efficient to detect number of humans according to square frames present.

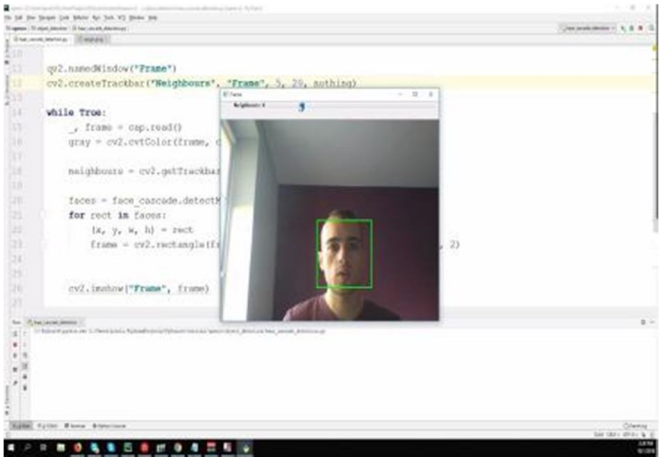


Fig. 19. Face Detection Test in Real Time

VI. CONCLUSION

This human detection technology enables fast, reliable, and efficient means of delivering tailor-made results which can still be made inexpensively due to automation of processes and artificial intelligence developments. This human detection robot based on computer vision and machine learning technology provides an overall excellent low-cost solution to the conventional products available in the market. This technology improves the whole status of detection of humans through its rapid developments in different applications.

VII. ACKNOWLEDGEMENT

We, the authors, would like to thank Pimpri Chinchwad College of Engineering Pune for the support and providing facilities which helped us in reaching current state of our project. Also, we are grateful to all the staff and colleagues who have helped directly or indirectly in completing this project.

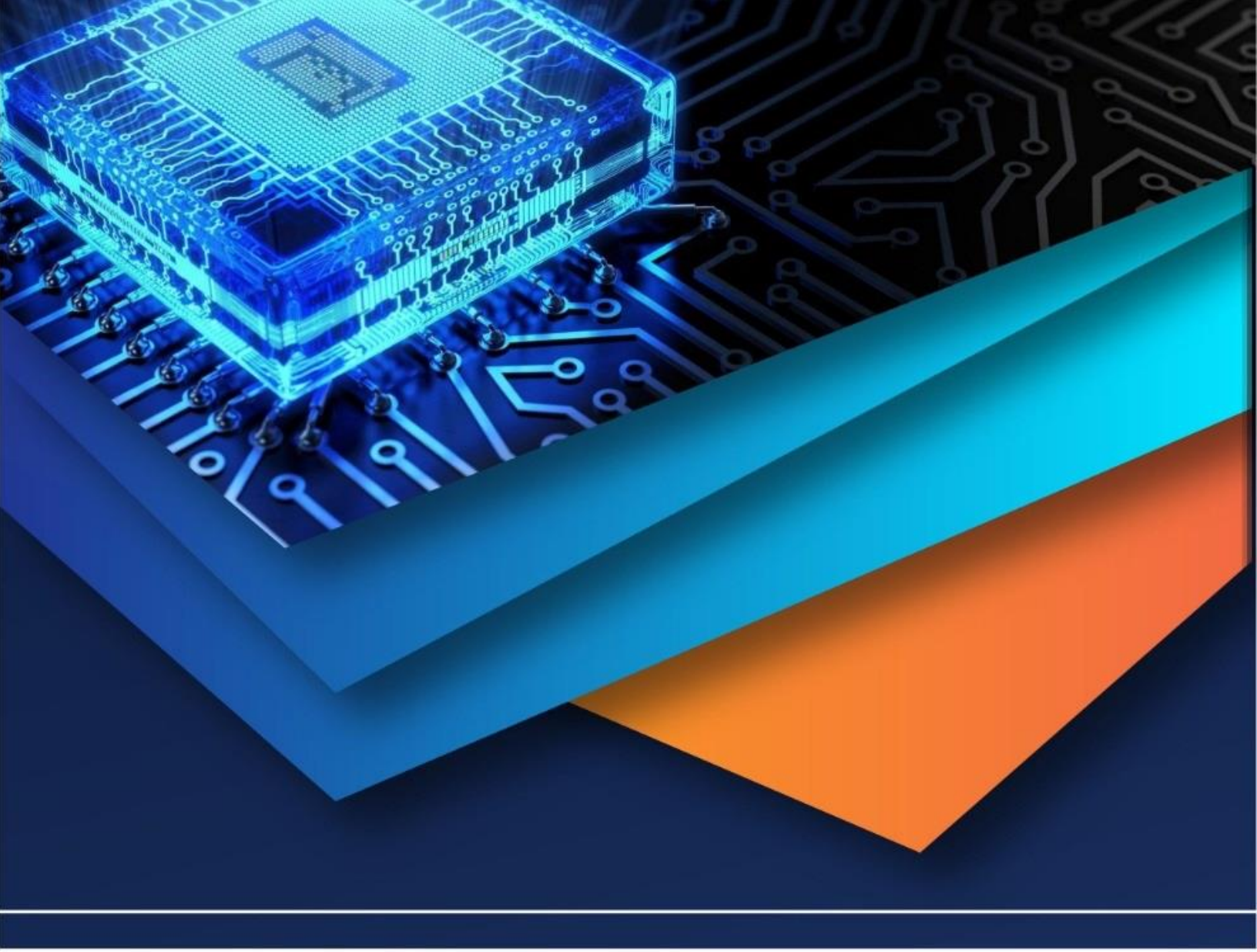
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