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REVIEW ARTICLE

ARTIFICIALLY INTELLIGENT PEOPLE COUNTER

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ABSTRACT

To detect and count people, carries on to be a troublesome exercise, this difficulty has been promptly manifested by nearly all the analyses over and done with in the extensiveness of counting a large number of people. Presently very much popular is the monitoring of passages or premises, by the use of traditional systems, putting into service video footage capture. This article demonstrates a solution wherein getting a headcount of crowd will no longer need people to strain their vision; requires two steps: Face Detection and Face Tracking. Our proposed software identifies nearly all the relevant features of likely faces in the frame, and tests have put on display the software is advantaeous when put in applications to maintain count in case of emergencies like earthquakes or fire hazards; or high security places such as Military Base, government banks, etc.

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INTRODUCTION

Artificial Intelligence has emerged as a great futuristic domain, whose many chapters are yet to be disclosed. One of the intriguing chapter is Face Detection[1] and Face Tracking. The face is the most distinctive part of any human being which separates them from other humans. With the help of AI, faces of person can be identified and tracked separately. Keeping the exact count of people at any given time within any large premise is ideally very difficult to do. Generally this is done based on estimation, which can vary from person to person or by continuously monitoring the CCTV footage and keeping the count manually. But both these methods mentioned, just aid in monitoring of a particular area. Monitoring, detection, tracking and Counting of people with the help of the same CCTV footage can be an added advantage to the already existing technology. With the rise in security levels, it is becoming essential to have an enhanced application of CCTV. The aim of this project is to design an application, the main purpose of which is to count the number of people entering and leaving any premises, involving cutting edge technologies such as Artificial Intelligence and Deep Learning, thereby getting increased efficiency in the desired results. Firstly, training of the machine is done with multiple sample human face images.

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Then from the CCTV footage face detection takes place in real time, followed by assigning a face Id to each face. The faces are tracked across simultaneous frames and lastly the count of people is displayed in a specific amount of time.

LITERATURE REVIEW

Nowadays, there is a large demand for people-counting systems that offer greater efficiency and lower prices. For many businesses, one of the most important basic metrics is traffic; how many people came through the door.

- Long before the invention of electronic people counters, manual people counters were used. This was done by a store employee standing near the entrance of the store and by clicking on a counting device each time a person entered the store. This was inaccurate due to the high level of human error involved.
- Another traditional way were the pressure sensitive sensors that counted walk-ins depending on the number of footsteps on a pressure sensitive platform.

The people-counting system can be widely used for tasks such as video surveillance, security, statistical analysis of people accessing an area, and other value added services.

The following three new counters were used in large number in the last decade and are still extant in some of the systems used.

1st generation: Infrared beam counters (2002): This is a single, horizontal infrared beam across an entrance. When the beam is broken count is added. Since a person normally enters and leaves by the same door, dividing the count by two gives a measure of people. Beam counters usually require a receiver or a reflector mounted opposite the unit with a typical range from 8 ft to 20 ft. Even though it has many disadvantages infrared counters are still widely used due to being cheap and simple.

2nd generation: Thermal counters (2005): Thermal Counters use array sensors that detect heat sources. These systems are mounted overhead for accuracy. Thermal people counters are a popular choice in some situations due to following reasons:

- Thermal sensors are hardly affected by low/variable light conditions than optical sensors, and can even be used in complete darkness
- Patterns on flooring that may disrupt optical sensors do not affect thermal sensors
- Various limitations of thermal counters:
- Thermal counters cannot be mounted on a high ceiling without using a narrow-angle lens.
- It is difficult to verify the accuracy of the counter.
- Accuracy is reduced in places with variations in thermal conditions.

3.3rd generation: Video and WiFi counting (2012)

Two types of 3rd-generation people counters are

- Video counters use complex algorithms and camera imaging to count the number of people directly from a video tape.
- Wifi counting functionality collects WiFi probe request signals from shoppers' smartphones, including outside the store.

Firstly, using the existing security system for traffic counting eliminates the need for additional hardware on the back end. For instance, output of already installed CCTV cameras can be given as input to the Open CV[1] functions in Python 3.5. Second, traffic count data is captured in the security system control panel and can be accessed using the existing interfaces or applications. No other display device is needed and hence the hardware requirement of the system is minimized. Jorge,et.al studied that advantages of this system are twofold. Jorge, et al.'s[3] motive was to try the Open CV library and see how quickly and accurately webcam face tracking could be implemented. The counter requires two steps: detection and tracking. The detection is based on identification of people's faces through preprocessed image correlation with several circular patterns using Haar Cascade[4] Algorithm. Finally, the system updates the counters[5] based on the direction of the trajectories. Further problematic situations, such as occlusions, people grouped in different ways, scene luminance changes, etc., were used by Jorge, et al. to validate the performance of the system.

Proposed System

The software application makes use of Python 3.6[1] programming and OpenCV 3.1 library to process the live CCTV footage. A neural network is trained with a cascade of classifiers provided by OpenCV. The reasons for using Python are its compatibility with Artificial Intelligence systems and features such as object oriented programming and large comprehensive standard library. Program includes training the system first, through images of faces of people across the world. The algorithm used for face detection is Haar Cascade[2] Algorithm and the detection itself is unsupervised. Input to the program are test images, which are then converted into their respective grayscale images by color image processing.

Our system can also work effectively with CCTV systems that give output in Binary or Grayscale instead of color images. Increased accuracy in face detection can be provided by the Haar Cascade algorithm due to its features such as high robustness and the fact that the algorithm is adept in distinguishing faces from non-faces. The next step is the face detection itself, which involves giving emphasis on face shape features rather than face color features. Face tracking requires the location and size of human faces in an image. This is done by performing image segmentation and representation which involves drawing colored rectangles around each face. Face tracking often uses machine learning (ML) algorithms to keep track of human faces after face detection is already performed in previous frame of the video. Each face detected in the previous frame is assigned a Tracking ID. The rectangular box is labeled Person X, where X is the tracker ID assigned to every face, which changes, after performing the most difficult part, that is, comparison of consecutive frames of video in real time. The assignment of new Tracking ID happens only under following two conditions:

- The centre point of tracker must lie in the region of face detected.
- The centre point of face detected must be within the tracker region.

The block diagram (Fig. 3.1) clearly shows three distinct blocks i.e. first pre-processing whose input is the real time video frames followed by proper sizing of the frames to make it compatible with the the machine. Then, deciding the frame rate for the input frames which indeed will depend on the type and model of CCTV whose frame per seconds differ. The second main block is the processing block, which is the heart of the system proposed. This block has 3 predominant features i.e Detection, Monitoring and Tracking. The input to the face detection block is received by the colour image processing block. The face detection uses the Haar Cascade Classifiers for accurate face detection. This detection is done by monitoring the key characteristic attributes of a human face like the shape of nose, ears, eyes, forehead lining, etc.

These may obviously vary from person to person but the outline of every feature remains the same. Next comes the Tracking system wherein a separate tracker is assigned to each frame containing a face. Now if a face gets out of a corresponding frame then a new tracker gets assigned to the face, in this way the number of people coming into the frame and going out of the frame can be monitored. The total number of people thus can be calculated which is the purpose of the proposed system. There is constant updation of the tracker which ignores the earlier one and ascribe the new coordinates to the new face. Lastly, the display device which will show the actual count of the people traversed inside and outside of the premise. The output device can be a LCD display linked to the CCTV or just a machine which is protected and used by the officials only.

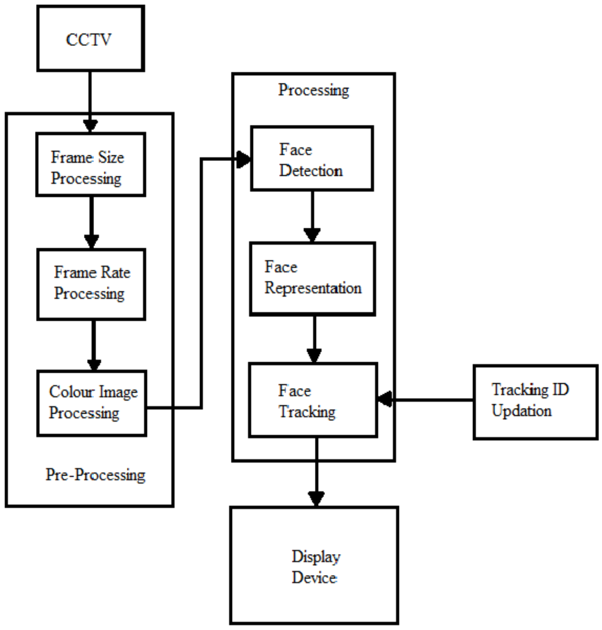


Fig. 1. Block Diagram of the Surveillance Counter

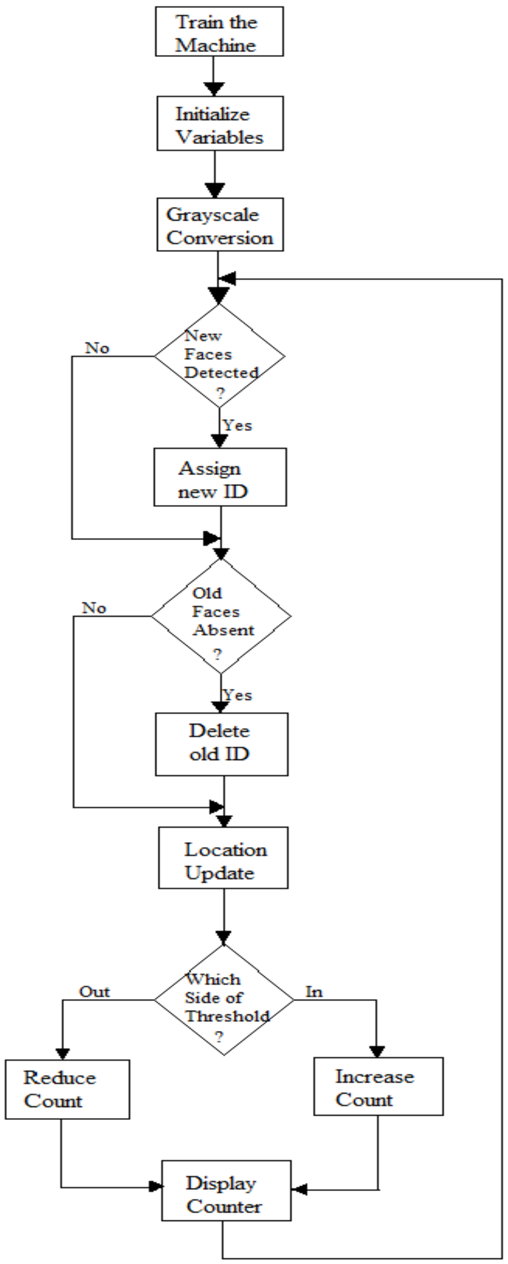


Fig. 2. Flow Chart

The system is trained to operate with various ambiguities like person wearing a cap (Fig 4.2) or spectacles (Fig 4.3). It successfully detects a person from a distance of 3.5 metres as depicted in Figure 4.4.a. The system was tested under various lighting conditions and it was found that adequate amount of lighting is required for successful detection of faces. It was also noted that person should walk at speed of 0.4m per second in order to get detected.

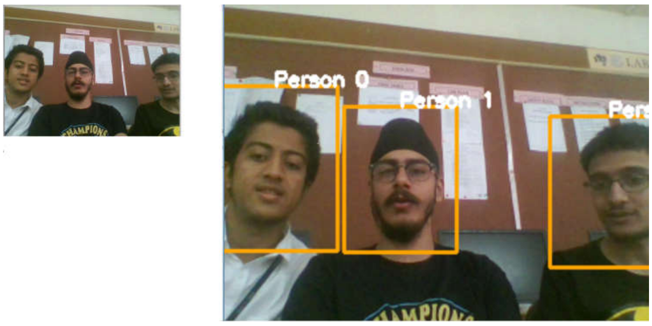


Fig. 3. Output before threshold was added

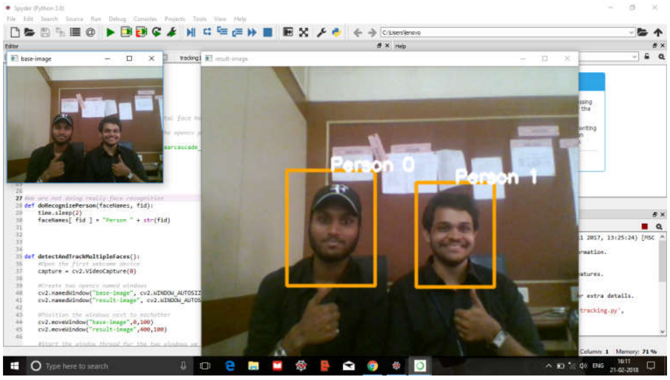


Fig. 4. Person with cap detected

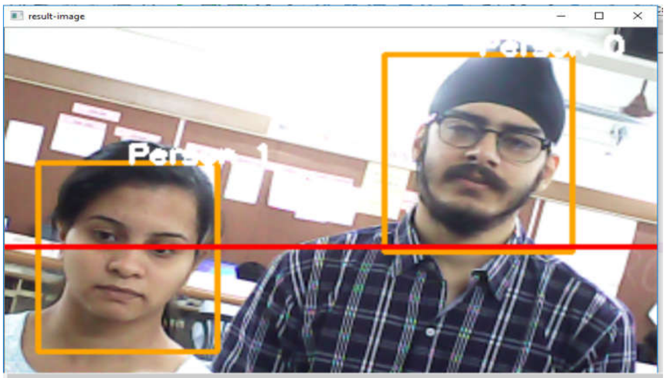
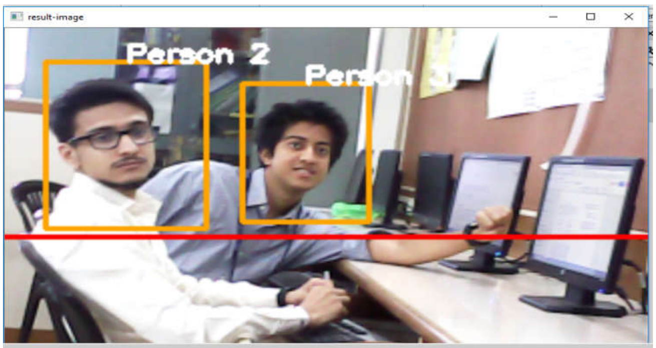
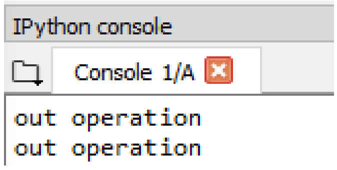


Fig. 5. Person with spectacles detected



4.4.a



4.4.b

Fig. 6. a)People above threshold counted as out b) Console showing output

Table 1. Advantages and disadvantages of Haar Cascade algorithm

Advantages	Disadvantages
• High Detection Accuracy- 90-95% True Positive Accuracy • Low false positive rate- Detection of a non-face is very less	1. Computationally complex and slow- Processing time increases with more number of faces[5] 2. Limitation in difficult lighting conditions

Table 2. Comparison of camera results

Camera used	Camera Quality	Distance upto which face is detected	Time required
Lenovo G40 laptop internal webcam	1.3 mp	1.2m	1 sec
QHMPL PC webcam	12 mp	3.5m	2-3 secs

Conclusion

This paper presents a customized approach for face detection for real time video capture and processing using Haar Cascade algorithm. The algorithm is robust and can be modified according to various sources of input i.e. CCTV, webcam, stored video. This is demonstrated using OpenCV and python since OpenCV is a cross platform library of programming functions that is primarily targeted at real-time computer vision. The proposed system was designed to be implemented in apartments, offices, museums, colleges, theatres. It can also be extended to videos with very complex background where size of faces is small. The system can be enhanced to perform recognition and associated application such as Biometric recognition system, voter verification and access control.

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Glossary

1. AI - Artificial Intelligence
2. CCTV – Closed Circuit Television
3. LCD – Liquid Crystal Display
4. mp - megapixels
5. ML - Machine Learning
6. OpenCV – Open Computer Vision

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