

# Machine Learning based Crowd Detection and Monitoring System

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***Abstract:** The COVID-19 pandemic has reminded everybody that the spread of the sickness can reason similar situations round the arena. In order to store your infection and provide extra remedy, it's far vital to locate people and observe the system to ship to the general public vicinity. By keeping effective social distancing, many new illnesses can be minimized. This concept stimulated the introduction of a real-time human assets management and monitoring system (CDMS) for far flung residing. This article presents complete autonomy for humanities research in terms of time and monitoring to help instructional institutions higher divulge researchers on this subject. This system is advanced using Open CV based on Histogram of Oriented Gradients (HOG) and Support Vector Machine (SVM) to capture and depend on the style of humans acquired on a pattern. The device sounds an alarm to inform humans and observe the regulations if the collection exceeds the brink/accepts extra human beings inside the group.*

**KEY WORDS-** Object Detection; Crowd Detection; Machine Learning; Histogram of Oriented Gradients (HOG); Support VectorMachine (SVM)

## I. INTRODUCTION

Gatherings had been seen in many places including railway stations, buying shops, spiritual locations, airports, public games, and so forth. CCTV may be critical in such places and offer the specified get entry to control the crowd. Crowd tracking and monitoring has many applications together with social control in the course of the

worldwide pandemic, public safety, traffic tracking, accumulating restrictions together in case of emergency, website layout to read people's conduct, anti-attack and many different matters. This has led researchers to increase the model to an expansion of tasks, consisting of counting, measuring velocity, measuring motion, and measuring behaviour. To use this people

detection tool, the principle purpose is to discover one-of-a-kind items within the video after which classify them as humans. A sub field of artificial intelligence referred to as expertise-collecting tools to educate machines to act like people using information and algorithms. Object detection is a department of computer vision that identifies particular objects in motion pictures and snapshots. Object identity includes spotting gadgets and classifying them in keeping with their look (which include people, animals, bushes, or cars). Product discovery presents data about "What products are in" for all automatic algorithms. In the beyond, this assignment changed into completed by human people, however it took a long time, the calculation charges have become too large and there has been a chance of mistakes. With the emergence of laptop-primarily based algorithms for computerized detection and tracking, the need for human supervision is reduced, therefore enhancing the general efficiency of the time at an affordable fee cried.

There are many algorithms to be had inside the database to reach people. There are two varieties of item detection: gaining knowledge of primarily based on non-neural/traditional gadgets and strategies primarily based on neural/deep search, as shown in Figure 1. In non-neural

techniques neural neuronal, the principle traits of people are extracted from the use. Function extractors created artificially inside the conventional human seek direction, that's then used to teach the model to distinguish human beings from different gadgets and whole the walker's look for the intention. Non-neural strategies consist of: scale invariant function refactoring (SIFT) [1], Viola Jones function detection framework, the usage of Haar capabilities [2], histogram features of orientated gradients (HOG) [3] and lots of others . Neural networks or deep gaining knowledge of perform greatest detection the usage of styles registered in an photograph the use of more than one layers inclusive of enter layer, hidden layer, and output layer. Gaining deep knowledge of the basic objective identity strategies fall into two organizations: most regression-primarily based algorithms like YOLO, SSD and place-stimulated algorithms like R-CNN, SPP- NET and Fast R-CNN.

Deep getting to know strategies can't remedy troubles inside the same manner or with some traces of code as conventional object detection techniques. Traditional algorithms work the same for all pix and there are numerous. For example, the capabilities of deep neural networks are unique to education records, and if

designed poorly, they may now not work properly for pictures that aren't a part of the facts and textual content of education. It has been demonstrated that these obligations can be executed the usage of large files, however this can be time-eating and impractical for recording software program. The method of identifying artifacts could be very accurate; therefore, it is feasible to determine whether your solutions may be powerful outdoor of the mastering environment.

effectiveness of HOG combined with the SVM classifier to detect multiple individuals from a sample.

This article is divided into 5 parts: Part II discusses the tasks involved in crowd sourcing, Part III describes the methods used to manage the CDMS schedule, and Part IV describes the experiment. Finally, final remarks and the future scope are discussed in Chapter V.

**II RELATED WORK**

Many researchers have used diverse extraction and categorization strategies to reap the visitor's findings. This article describes the paintings in progress to recruit travellers [4]. The HOG function is the most widely used discriminator inside the literature, in accordance to research [3]. Its ability to as it should be document region/gradient information, combined with the non-uniformity of lighting fixtures, is an vital part of its quality. According to research [5], pedestrian seek the usage of HOG affords the maximum correct consequences with negative effects. Almost all gear today use HOG or one of its variants in aggregate with SVM to reap precise effects. Support vector device (SVM) is taken into consideration a preferred method for many classifications, consisting of pedestrian class [6]. Many

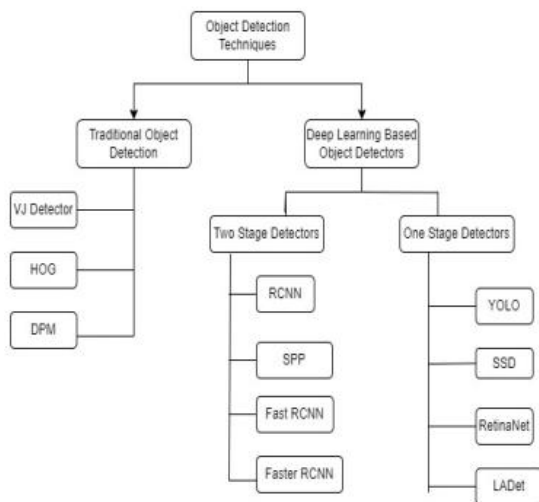


Fig. 1. Classification of Object Detection Methods

Open CV does, however, include a mechanism for selecting individuals. It has per-trained HOG (Histogram of Oriented Gradients) and linear SVM models to detect individuals in images and streams. The AI model is designed to use human features including hands, legs, head, etc. Once smart, the model can be used to search for people in videos and photo streams. This article examines the

research whose consequences are published in the literature are seeking for to estimate the quantity of human beings and count people. The gadget proposed by using [7] uses HOG and SVM to create crowd detection systems that trigger alarms when crime dedicated. To enforce crowd counting in all public regions and improve calculation accuracy, B. Vivekananda's framework [8] uses a light-weight CNN (LW-CNN).

Since the outbreak of Covid-19, social distancing has long past via many reviews the use of unique strategies. To prevent the unfold of the ailment, [9] and [10] evolved a crowd manipulate system using deep getting to know for distance category. Their framework detects the manipulate of social distancing and indicators are generated while there is a contravention of social distancing. Yang et al. [11] proposed a consistent body based totally AI monocular camera to track long-distance positioning. The proposed strategy makes use of social values to manipulate get admission to to regions of hobby and keep away from visitors congestion.

Therefore, consistent with information evaluation, HOG is the great representative for monitoring distribution, and SVM presents correct performance with less difficulty than other techniques.

### III METHODOLOGY

The real-time CDMS planning process for distance learning in schools is shown in Fig.2. The videos/images are received by IP cameras installed at different locations in the school. These recorded videos are saved on the server for further analysis. Machine learning techniques are used to understand people walking in the video space. The most important tasks that need to be performed on the device are: background extraction, unique extraction using HOG and SVM to identify pedestrians that appear to be the same humans or non-humans.

Once human detection has taken place, they are automatically assigned to remote monitoring devices that trigger alarms if proximity rules are violated.

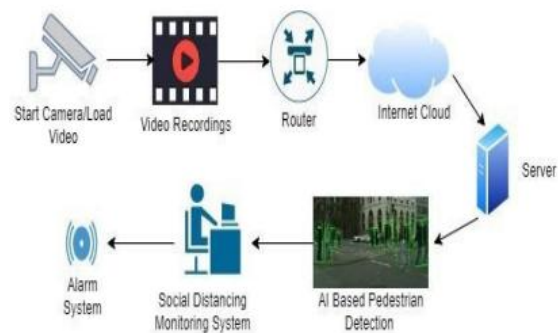


Fig. 2. Proposed Framework

#### A. Later withdrawal

Due to Hog's urgent wishes, actual-time occasions regularly require background utilization.

Subtraction strategies [12] [13] [14] to locate motion. Images are mechanically decided on while movement is detected as a substitute of every photograph. When historical past subtraction is used, the pixel positions in the images can be compared to determine the distinction among the extraordinary values. If the background is removed, the foreground pixels are considered to be transferring and the historical past pixels are every day. When the historical past extraction technique detects motion, HOG with SVM Classifier is enabled for human detection.

**B. Histogram of Oriented Gradients (HOG)**

Histogram of Oriented Gradients (HOG) [3] [15] [16] is a technique that makes use of computer vision to locate gadgets and extract capabilities with excessive accuracy. HOG is a special descriptor that uses aspect publications or using gradients to identify objects and decide their shape. It divides the picture into cells and creates a gradient histogram for the pixels in each cell.

These gradients can be evaluated as proven in equations (1) and (2) using the So-bel operator:

$$S_x(y,x) = Y(y, x + 1) - Y(y, x - 1) \tag{1}$$

$$S_y(y,x) = Y(y + 1, x) - Y(y - 1, x) \tag{2}$$

Wherein Y(y, x) stands for the pixel depth with the coordinates cost (x, y). S<sub>x</sub> (y, x)

and S<sub>y</sub> (y, x) respectively depict the horizontal and vertical gradients.

Equations 3 and four can be used to decide the importance (S) and orientation (θ) of the gradient.

$$S = \sqrt{S_x^2 + S_y^2} \tag{3}$$

$$\theta = \arctan\left(\frac{S_y}{S_x}\right) \tag{4}$$

The cellular is assessed according to the orientation of the gradient. Filtering is used to find gradients in horizontal and vertical instructions. [1, 0, 1] and [-1, 0, 1] are used to use the filter in the horizontal and vertical guidelines, respectively. The histogram of all cells serves as an instance. By creating a community histogram degree over a big window of spatial areas, normalization is finished for each region in the search window to attain the correct result. The last vector, which may be used for machine detection, is also referred to as behavior vector. Additionally, the SVM classifier, that could become aware of whether the subsequent object is human or the current item isn't always, is designed using feature vectors.

**C. Support Vector Machine (SVM)**

SVM is a extraordinary learning device to categorize diverse training methods. The SVM classifier approach [6][17][18] seeks to growth the difference among instructions. SVM works properly in lots of areas, particularly while there may be

little records to be had. SVM, is used to resolve the type and regression trouble. SVM is strong to many real-international issues and is well acceptable to each linear and nonlinear situations. Linear SVM (Fig. 3) is used even as it entails directly isolating the information factors using a hyperplane and a instantly line. Nonlinear SVM (Fig. Four) is used when a directly line can't be used to categorize the records. We have kernel functions for this. They alternate space from nonlinear to linear.

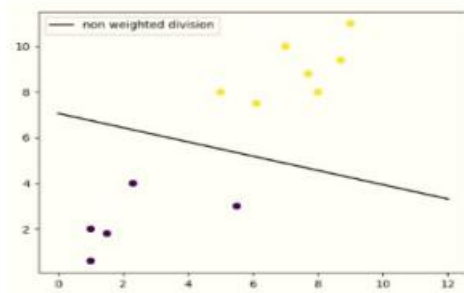


Fig. 3.: Linear SVM

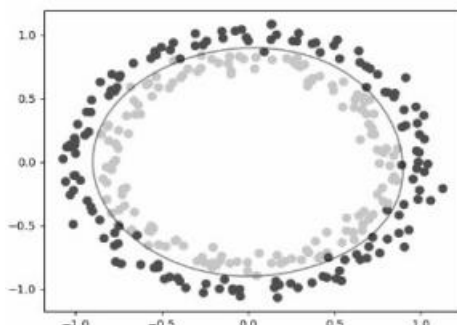


Fig. 4: Non-Linear SVM

**D. Quality Control and Monitoring (CDMS)**

Real-time CDMS specializes in monitoring public spaces to identify human groups. The complete operation of the device is shown in Fig.5. First, video sequences are obtained from surveillance

cameras installed at different locations. Then the frames are extracted from the video and we remove the background material from the frames using background subtraction, simple foreground material eight are kept for further work. The HOG and SVM algorithms then detect people and the problem of people in a group has become to prove the pattern of differences.

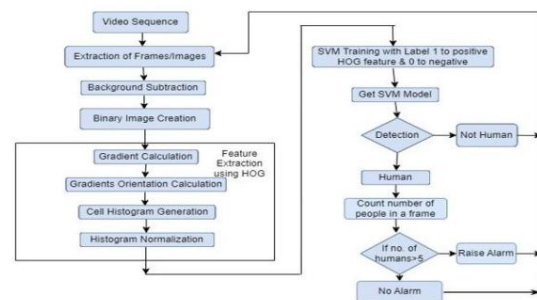


Fig. 5: Work Flow of Human Crowd Detection System

The alarm machine is activated while the human rely is greater than the edge value inside the cluster. Here we've got taken threshold value as five as noted in COVID-19 suggestions [19] [20].

**IV EXPERMIMENTS AND RESULTS**

In this test, the Massachusetts Institute of Technology (MIT) pedestrian data set [21] is used for the study and test version. This file contains two hundred control photos and 509 school photos of people walking downtown (more left-right of these). It is best to have a front or back view and a small number of tasks. Hyper settings are adjusted to achieve better accuracy.



The machine was converted to production and testing was carried out at the CMRIT campus. This device has successfully predicted many aspects of human well-being in everyday weather conditions. The output screenshots are shown in Figures 6 and 7. Human detection in low light conditions is shown in Figure 6 and human detection in daily light is shown in Figure 7. The system has been evaluated based on the number of students in a group and triggered the alarm if the number of students was found to be greater than five. , make the environment safe to save your immune system.



Fig. 6: Detection in low light



Fig. 7: Detection in normal light

Table 1 shows the outcomes captured underneath exceptional conditions. In ordinary, bright lights situations, the system can appropriately estimate the variety of scholars. But in low light, the anticipated pupil depend is inaccurate. The system can expect the variety of college students in wet weather, but in cloudy weather the result is inaccurate. Thus, a few discrepancies have been found between the expected and actual results below low mild and negative climate conditions.

TABLE 1: OUTPUT PREDICTION UNDER DIFFERENT SCENARIOS

S.No	Output under different scenarios	Condition	Expected Output	Predicted Output
1	Image with 3 persons	Normal	3 persons	3 persons
2	Image with 3 persons	High Brightness	3 persons	3 persons
3	Image with 4 persons	Low Brightness	4 persons	3 persons
4	Image with 4 persons	Raining	4 persons	4 persons
5	Image with 4 persons	Fog	4 persons	3 persons

The common score is provided as a metric underneath (Table 2), which allows show how nicely the version is operating.

The percentage of predictions made the usage of the take a look at facts is known as accuracy. The concept in the back of a machine gaining knowledge of model is its capacity to become aware of the proper conditions. Additionally, the version disappears while it finds the best one. The percentage of real false positives detected

with the aid of the sample is called specificity. Precision refers to the variety of true positives divided with the aid of the total number of expected positives. The F1 rating is a compromise between precision and inversion.

TABLE 2: PERFORMANCE METRICS

Measure	Values
Sensitivity	0.666
Specificity	0.918
Precision	0.40
Accuracy	0.90
F1 Score	0.498

From the results obtained in Table 2, it may be concluded that the HOG + SVM pair gives promising outcomes with a excessive price of accuracy.

## V CONCLUSION

Using Open CV and Python, we evolved a crowd detection gadget for the school. This model is used to search human beings and count them. To try this assignment, we use the HOG description set of rules in conjunction with the SVM classifier supplied with Open CV, permitting us to discover people in pix. We have tested the device in tough situations such as low mild, fog, rain, and so on., and found that the accuracy is ninety%.

Despite the latest improvement in the pc and associated paintings, the excessive-

overall performance gadget and the paintings of time tracking nevertheless face a few critical issues that ought to be turned into resolved. These issues variety from issues together with camera placement, to billing, installation, protection and community bandwidth utilization, to greater complicated issues including the Photo sturdiness in distinct climate and lighting fixtures situations, installation cost, privateers concerns, etc.

For crowd evaluation, this newsletter presents quality results in phrases of precision. During a plague, those techniques can be used with video surveillance to screen humans. In busy areas such as railway stations, transport stations, corporations, roads, purchasing gates, colleges and colleges, mass inspection works nicely and can be executed using this approach as a precept. The gadget has many promising potential expansion efforts to improve its consequences. It may be used for lots purposes, consisting of detecting abnormal behaviour, controlling public occasions, counting people, catching individuals who are lost, and so on from video surveillance photographs.

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