ABNORMAL CROWD BEHAVIOUR DETECTION BASED ON THE HABITAT LOCATION

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***ABSTRACT*: Crowd density estimation and abnormal crowd behaviour detection have become increasingly important subjects of research in computer vision. Some of the issues in crowd analysis include perspective distortion, occlusions, illumination changes, etc. Crowd density estimation and crowd behaviour detection plays a vital role in security systems, congestion control and public space design. We propose a novel framework for crowd density estimation and abnormal crowd behaviour detection. In crowd density estimation, we propose a novel feature extraction method by combining the texture and pixel features of crowd. These features are then given to a neural network to estimate the level of crowd density and perspective distortion has also been handled. In abnormal crowd behaviour detection, we propose a novel edge based feature points extraction method that eliminates the need to remove the static feature points in the subsequent frames. KLT tracker has been used to track the points and to determine the principal direction of motion of each feature point a direction count algorithm is proposed. The motion attributes such as principal directions, speed are used to model the crowd behaviour based on threshold values. Experimental results show that our proposed method identifies the crowd density level with accuracy 95% and crowd behaviour with accuracy 97%.**

***Keywords*: Video, Crowd density, MATLAB**

1. INTRODUCTION

Crowd behavior analysis in video surveillance systems has become an important research topic in computer vision. Surveillance cameras are being used in various public places such as malls, cinema theatre complexes, sports stadiums etc. for safety purposes. However, their use is limited to identifying the cause only after the abnormal crowd behavior has occurred. Also, the number of surveillance cameras in use today exceeds the capability of human operators who monitor them. Thus, it is not feasible to have enough operators to continuously monitor the videos from each camera. The task of monitoring requires complete attention without any distraction. Thus there is a need for the system to be able to identify any unusual crowd behavior that occurs and alert the operator instantly. There are several complex challenges associated with the work, making this subject relevant in terms of research. A straightforward extension of the techniques that are used for analyzing non-crowded situations will not be suitable for analyzing crowded scenes. Crowds are difficult to treat semantically owing to a number of challenges such as occlusions, clutter, low resolution, illumination changes, and the associated complexities. During the analysis of non-crowded scenes, individuals are identified and tracked based on certain features of human body. The same cannot be applied to crowded scenes as it would be difficult to isolate individuals in the presence of occlusions. The aim of the project is to analyze the existing work and provide a better solution for crowd density estimation and crowd behavior analysis.

1.1 OBJECT BASED APPROACH

In the object-based approach, the crowd is treated as a simple sum of individuals. The understanding of crowd behaviour is performed through some kind of segmentation or detection of individuals. The detection of individuals can be performed by identifying certain distinguishing parts of human body such as head etc. However it is difficult to isolate individuals in dense crowds due to the presence of occlusions, clutter etc. The use of the object based approaches is limited to low dense crowds. Mostly this approach is used to identify single person's behaviour. For example, a person going against the dominant flow (one individual trying to enter a sports arena after the match is finished) could indicate some abnormal behaviour. Thus while analyzing dense crowds for abnormal behaviour identification the object based approach does not prove much helpful.

1.2 HOLISTIC APPROACH

In the holistic approach, the crowd is treated as a single entity and not as a sum of individuals. This method directly tackles the problem put forth by the object-based approach. Holistic approaches usually try to obtain global information like the dominant flows and speed of motion etc. The local information such as a single person moving against dominant flow is usually disregarded. Such local information is indeed not much useful while identifying behaviour of the crowd as a whole. In this project, the holistic approach has been used to identify the crowd behaviour. The first step in crowd behaviour analysis is to extract feature points of interest. This will be followed by tracking the feature points in subsequent frames. With the help of information obtained from the tracking process, the motion attributes such as the direction and the speed of motion are computed. Using these motion attributes, the crowd behaviour is classified as normal or abnormal. Feature points are the major source of information using which the crowd behaviour is analyzed. Some of the feature points descriptors commonly used are Harris

Corner detector, Shi-TomasiKanade detector etc. Harris Corner detector is known for its robustness against illumination variations and noise. However, these feature point descriptors extract even the static points in the video. Such static points need to be identified, eliminated and then replaced with new feature points of interest. Thus in crowd behaviour analysis, it is better if the feature points extracted are associated largely with the portion of crowd under consideration. The next step is to track these feature points in the subsequent video frames. This gives information about how every point has moved in the video, i.e., its location in every frame of the video. Optical flow is the most widely used technique to track feature points. Lucas Kanade and Horn-Schunck are the most famous optical flow algorithms.

2. SYSTEM ANALYSIS

In this paper, two challenging areas of research in computer vision have been considered – crowd density estimation and abnormal crowd behavior detection. These two areas are the major topics of research in computer vision. There are several challenges associated with crowd density estimation and abnormal crowd behaviour detection. In our proposed work, we try to overcome these challenges and provide a better solution.

The proposed system is Crowd behaviour analysis in video surveillance systems has become an important research topic in computer vision. Surveillance cameras are being used in various public places such as malls, cinema theatre complexes, sports stadiums etc. for safety purposes. However, their use is limited to identifying the cause only after the abnormal crowd behavior has occurred. Also, the number of surveillance cameras in use today exceeds the capability of human operators who monitor them. Thus, it is not feasible to have enough operators to continuously monitor the videos from each camera. The task of monitoring requires complete attention without any distraction. Thus there is a need for the system to be able to identify any unusual crowd behavior that occurs and alert the operator instantly. There are several complex challenges associated with the work, making this subject relevant in terms of research.A straightforward extension of the techniques that are used for analyzing non-crowded situations will not be suitable for analyzing crowded scenes. Crowds are difficult to treat semantically owing to a number of challenges such as occlusions, clutter, low resolution, illumination changes, and the associated complexities. During the analysis of non-crowded scenes, individuals are identified and tracked based on certain features of human body. The same cannot be applied to crowded scenes as it would be difficult to isolate individuals in the presence of occlusions. The aim of the project is to analyze the existing work and provide a better solution for crowd density estimation and crowd behavior analysis. Thus, in this project, a system that covers the major issues and performs distinguishingly has been developed. In future, the present system shall be enhanced such that it performs more distinguishingly and offers better results with greater accuracy of prediction, thus assuring security in public places.

III. SYSTEM DESIGN

In crowd density estimation, crowd region is extracted by Perspective Distortion Correction – Pixel Features and GLCM-Haralick's features extraction and given to artificial neural network to estimate the level of crowd density. A neural network usually involves a large number of processors operating in parallel and arranged in tiers. The first tier receives the raw input information, analogous to optic nerves in human visual processing. Each successive tier receives the output from the tier preceding it, rather than from the raw input, in the same way neurons further from the optic nerve receive signals from those closer to it. The last tier produces the output of the system.Typically, a neural network is initially trained, or fed large amounts of data. Training consists of providing input and telling the network what the output should be. For example, to build a network to identify the faces of actors, initial training might be a series of pictures of actors, non-actors, masks, statuary, animal faces and so on. Each input is accompanied by the matching identification, such as actors' names, "not actor" or "not human" information. Providing the answers allows the model to adjust its internal weightings to learn how to do its job better.For example, if nodes David, Dianne and Dakota tell node Ernie the current input image is a picture of Brad Pitt, but node Durango says it is Betty White, and the training program confirms it is Pitt, Ernie will decrease the weight it assigns to Durango's input and increase the weight it gives to that of David, Dianne and Dakota.

3.1 USE CASE DIAGRAM

A use case is a set of scenarios that describing an interaction between a user and a system. A use case diagram displays the relationship among actors and use cases. The two main components a user or another system that will interact with the system modeled. A use case is an external view of the system that represents some action the user might perform in order to complete a task.

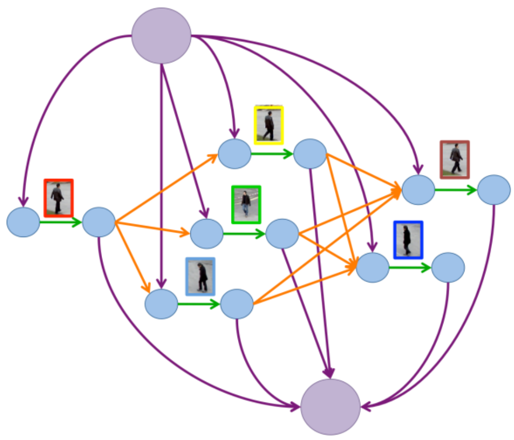


Fig 3.1 Use case diagram

3.2 ACTIVITY DIAGRAM

Activity diagram is another important diagram in UML to describe dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as an operation of the system.

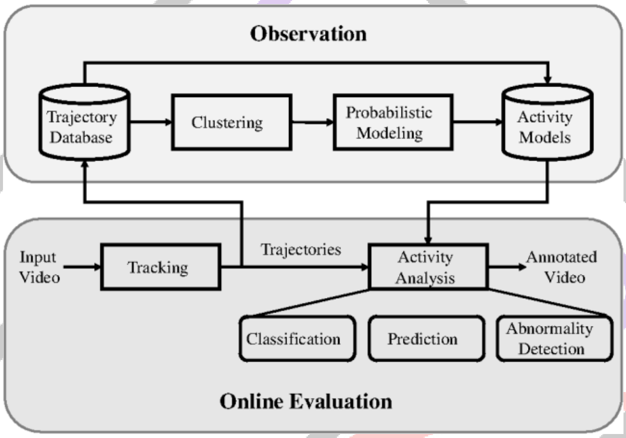
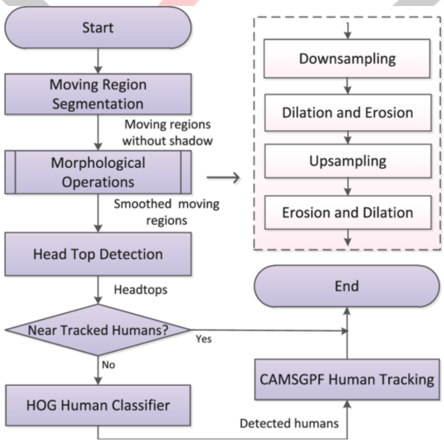


Fig 3.1 Activity diagram

4.3.4 DATAFLOW DIAGRAM



IV. IMPLEMENTATION AND TESTING

The work in crowd density estimation revolves around classifying the crowd density in the input video as very low, low, medium, high or very high. The pixel and the texture based methods are combined to estimate the level of crowd density.A parameter known as the weight of the foreground binary mask is calculated after the foreground mask has been obtained. This is done as follows

$$\text{Weight of foreground binary mask (w)} = \sum_{\text{Pixels}} (m*h)$$

where,
m – mass of pixel (foreground – 1, background – 0)
h – height (y- coordinate) of pixel in the frame

To extract the texture features, first the gray level co-occurrence matrix (GLCM) is constructed for the grayscale foreground mask. From the gray level co-occurrence matrix the Haralick's texture features namely Energy, Contrast, Correlation and Homogeneity are extracted. Among other Haralick's texture features, these features are robust and give more information about the texture of the input video.To estimate the level of density in the given input video, these features are extracted from the input video and then given to the trained artificial neural network. The artificial neural network will then provide the predicted numerical value. From this numerical value, the level of density is estimated, again according to the table 4.1. With more videos for training, the level of accuracy in prediction gets increased.

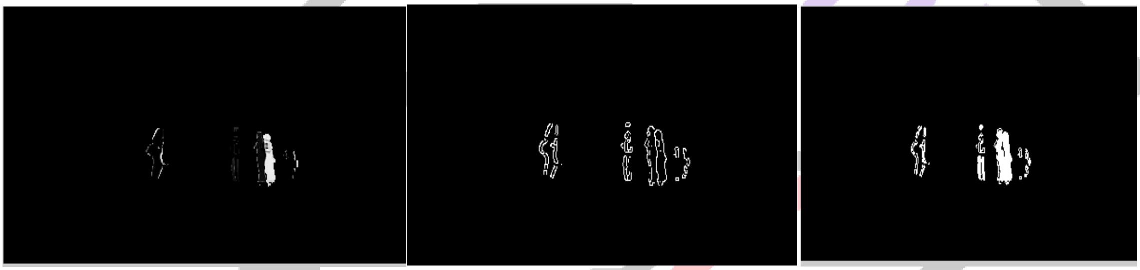
In this work, the holistic approach has been used for abnormal crowd behavior detection. That is, the crowd is treated as a single entity for processing, rather than a simple sum of individuals. The holistic approach is the most suitable for larger crowds. Since this work deals with varying crowd densities, the object-based approach which works well only for small group of crowds, is not suitable.

Table 4.1 Ranges of crowd density

Ranges	Level Of Crowd Density
0.0 - 1.5	**Very low**
1.5 – 3.0	**Low**
3.0 – 6.0	**Medium**
6.0 – 9.0	**High**
9.0 and above	**Very high**

4.1 CROWD DENSITY LEVEL –LOW

Fig. (a), (b), (c) depict the outcome of various steps in density estimation for an input video thatconsists of a low density crowd.



(a) (b) (c)

(a) After background subtraction (Approximate median filter). (b) After edge detection (Canny edge detector). (c) Binary foreground mask.

depicts the execution window of crowd density estimation for a low density crowd. The values of gray level co-occurrence matrix, the Haralick's texture features such as energy, correlation, contrast and homogeneity, the pixel feature, that is the weight of the foreground mask and the level of crowd density have been displayed.

4.2 CROWD DENSITY LEVEL – MEDIUM

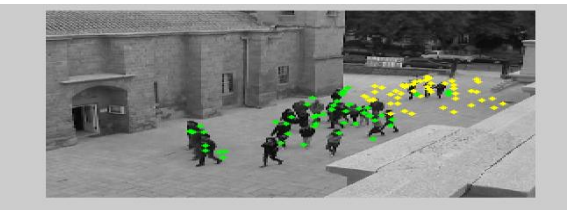
Fig. (a), (b), (c) depict the outcome of various steps in density estimation for an input video thatconsists of a medium density crowd.

(a) (b) (c)

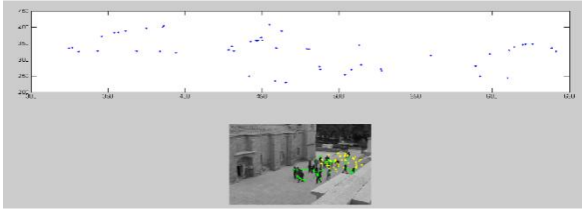
Fig. (a) After background subtraction (Approximate median filter). (b) After edge detection (Canny edge detector). (c) Binary foreground mask.

The below figure depicts the execution window of crowd density estimation for a medium density crowd. The values of gray level co-occurrence matrix, the Haralick's texture features such as energy, correlation, contrast and homogeneity, the pixel feature, that is the weight of the foreground mask and the level of crowd density have been displayed .

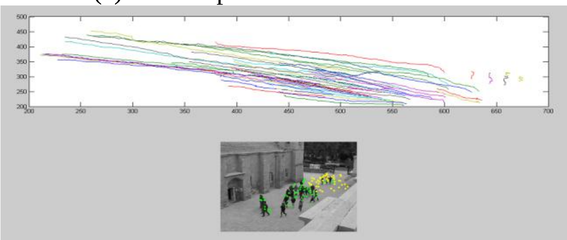
Output of crowd density level estimation (medium)



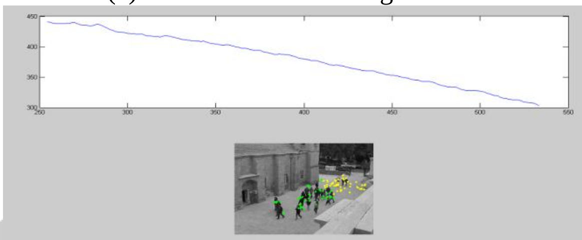
(a) Feature points extraction



(b) Crowd motion tracking



(c) Dominant directions of each point



(d) Results of clustering

Fig. shows the number of dominant directions , maximum speed in x and y direction and the behaviour for input video.

V. CONCLUSION

The crowd density estimation and the abnormal crowd behaviour detection framework proposed have been developed keeping in mind the challenges prevailing such as perspective distortion, static points elimination, occlusions, computational complexity etc., and the need to produce accurate results. With more videos for training, the results of crowd density estimation can be refined. Many projects that have been undertaken in crowd density estimation and abnormal crowd behaviour detection are context specific and are yet to be generalized.This project has been visualized in a holistic approach considering the critical issues that are daunting in the domain. The proposed framework for crowd density estimation and abnormal crowd behaviour detection has been developed in such a way that it is as general as possible and can be applied to most of the public places. The results are also fairly consistent in varying scenarios. Experimental results show that the accuracy of the proposed framework is 95% in crowd density estimation and 97% in abnormal crowd behavior detection. In the future work, a better system may be developed that distinguishes the moving crowd from other moving objects such as birds, vehicles etc.

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