HYBRID APPROACH FOR REAL TIME CROWD ACTIVITY USING SEGMENTATION

[1]Nirav V Ramprasadi , [2]Prof. Pooja Shah
[1]PG student ,Computer Department Shankersinh Vaghela Bapu Institute of Technology, Gandhinagar , Gujarat , India
[2]Professor ,Computer Department Shankersinh Vaghela Bapu Institute of Technology, Gandhinagar , Gujarat , India

Abstract : Crowd analysis becomes the most active-oriented research in computer vision, now days a wide attention has been paid to crowd control and management in the intelligent video surveillance area. Such scenes have a need of human assessor to monitor multiple video screens, presenting crowds of people in a frequently changing sea of activity. In this paper, we propose an innovative approach for real-time crowd behavior detection using SIFT feature extraction technique in Video Sequences. For any detection and classification the feature extraction and feature optimization is very important metrics. So in proposed work SIFT feature extraction technique are used in appropriate segmented for background subtraction in video sense. We focus on the motion trajectories to observe the crowd behavior of the personnel in the crowd and Optical flow methods are used to acquire the streak lines and path lines of the crowd personnel trajectories. In which we can compared propose work with previous existing work. And we calculate the performance metrics like precision rate, recall rate, and accuracy.

I. INTRODUCTION

The term crowd is defined as "The number of peoples gathered together in disorganized way". The crowd is divided into two categories: (1) Structured crowd and (2) Unstructured crowd. In structured crowd the peoples are moves in the same direction (e.g. traffic on a road). On the other hand, unstructured crowd the peoples are moves in different direction at a different time (e.g. railway station and supporting event). Anomaly detection is the process for identifying the events, items and observations. Which do not conform the pattern of a group? The supervised anomaly is detecting data set which is labeled under abnormal and normal with in assumption. In proposed work, we face with the problem of anomaly detection in crowd videos and offline learning. This research is highly used for to monitoring and surveillance the public places, sport events and crowded area etc. The devise method is automatically used to analyze the behavior of crowd behavior in video sequences. Surveillance systems are gives due to insufficient numbers of supervisors are watching the footage and natural capacity of humans. It is comprehensible, when we consider the large numbers of cameras which are require in administration. The monotonic character of the footage gives the alertness in events and provides a quickly response. And the main goal of video surveillance is to detect abnormal human behavior .he abnormal event that occurs uncertainly, suddenly and they bring up in emergency situation[3].

- The crowded scenes are more common as the human population escalates reliably. Nowadays everywhere we can find the crowded scenes in this universe.
- The safety, security and management of the peoples in the public places like airport, railway station and shopping malls have been a big challenge. The abnormality detection in the crowded scenes benefits significance. "Group of People who are related to one another".
- The introduction of the vigilance cameras becomes a common task which automatically detects the abnormal crowd behavior, thus providing the security
- The vigilance work is to invigilate the movement of every person in that event. Yet, it is slight difficult for the crowd events of high density. The occlusion is one of the severe obstacles, where detecting and tracking of the individual becomes tedious and cumbersome. Another problem is crowd behavior definition. Since we can encounter lot of crowd behaviors, however defining each of them is impossible.
- Humans are capable in extracting information of behavior patterns in vigilance area, real time monitoring of scenes for the irregular contexts and gives potential for immediate response
- The surveillance cameras play a prominent role in providing reliable security to mankind. The need for real-time automated surveillance system which can help to monitor the occurrence of certain hazardous events is in high demand. Many unusual events include terrorist attacks, unusual behaviors, bomb placement, traffic-related issues, ATM attacks, etc. require an immediate attention to prevent the damage to the society. Real-time detection of such abnormal events is a key issue since it requires the attention of security personnel all the time without leaving a space for human errors.
- scenes have a need of human assessor to monitor multiple video screens, presenting crowds of people in a frequently changing sea of activity.

1.1 Objective:

- Object detection involves detecting instances of objects from a particular class in an image.
- The objective of the system is to conduct a research which reviews a relevant role of object detection in the image processing and analyzes how the technology might be adopted by specific industries. This study aims to analyze the object detection technique.
- The long-term goal of this project is to design and develop a smart camera-based surveillance system for crowded places, e.g. airports, metro stations, and shopping malls.
- To using more video are crowd based.
- To Pre processing techniques for remove the noise.
- To using the morphological operation of the abnormal crowd analysis.
- To classify normal and abnormal activities with high accuracy using SVM Classification.

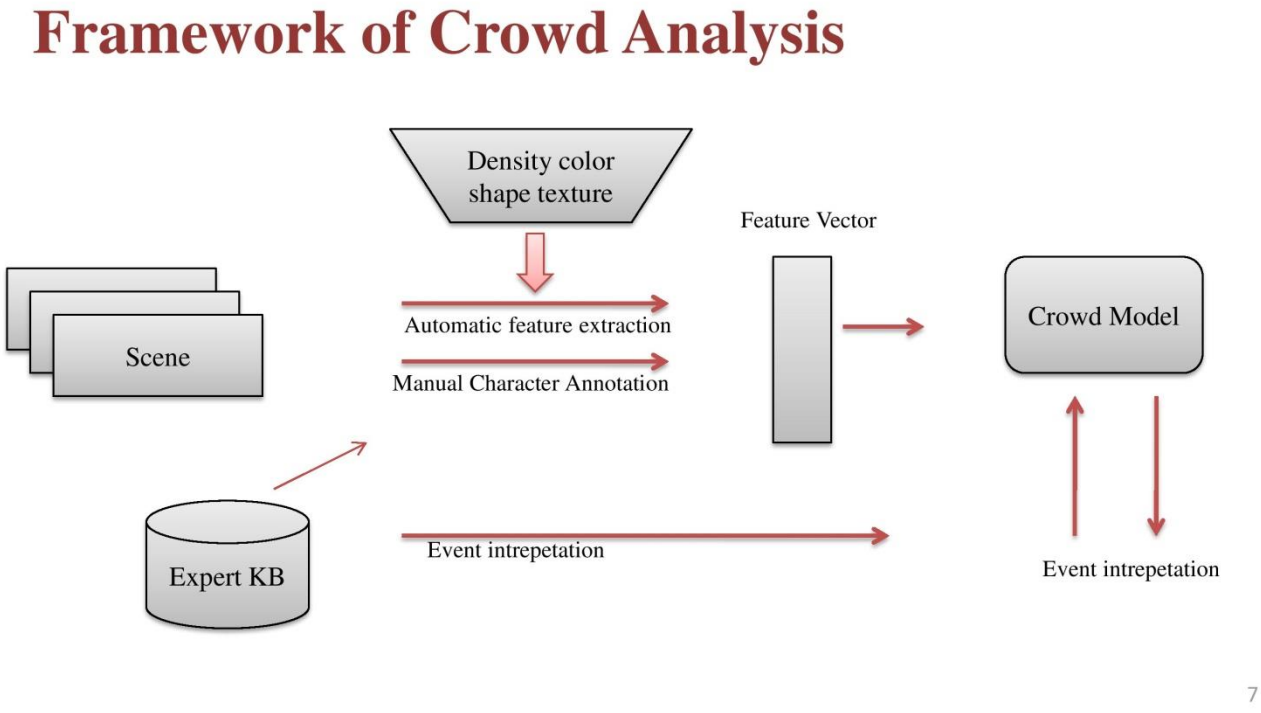

Figure 1.1(a):Framework of Crowd Analysis[11]

Crowd Scene Can Be Divided Into Two Types

- **Structured crowded scene :** The terms structured crowded scene can be described as crowd moves coherently in common direction, motion direction does not very time, each spatial locations of the scene supports only one dominant crowd behavior over the time. For example marathon race, queues of people event and traffic on the road.
- **Unstructured crowded scene:** the term unstructured crowded scene represents the random crowd motion; different participants moving different direction at different times, each spatial location supports multi –modal, and crowd behavior. For example people walking on a zebra crossing in opposite directions, exhibitions, sporting event, railway stations, airport and motion biological cells.

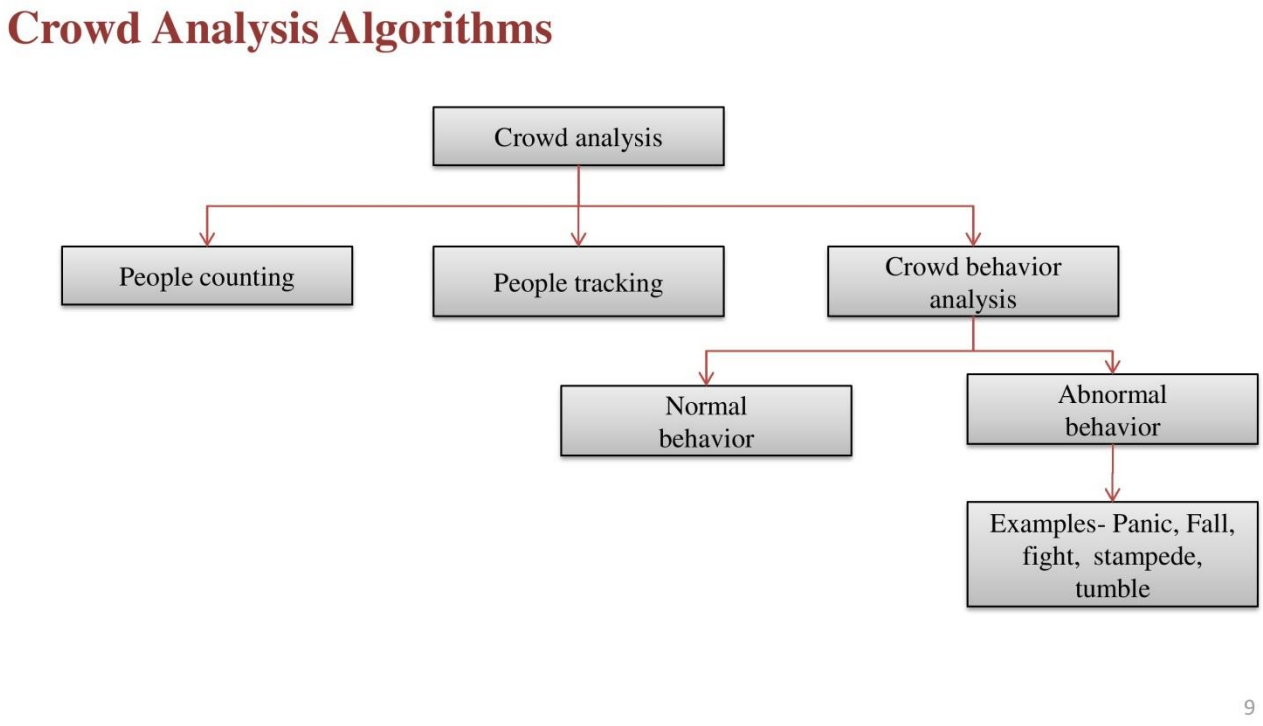

Figure 1.1(b): Crowd Analysis Algorithms[12]

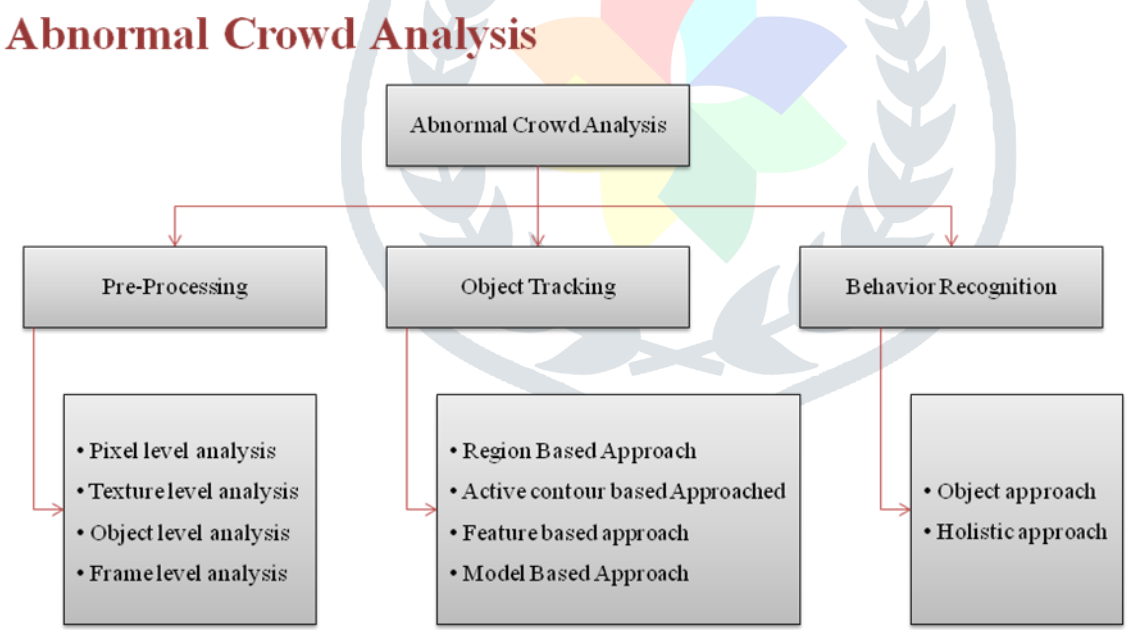

Figure 1.1(c) : Abnormal Crowd Analysis [12]

Chapter 2

2.1 Literature Survey

2.1 Literature Review (Paper vise)

Sr no.	Year	Title	Journal	Paper Insight
1	**2018**	Crowd counting via scale adaptive convolution neural network.	IEEE	In this paper they system a scale-adaptive convolutional neural network to automatically estimate the density maps and pedestrian numbers of crowd.
2	**2018**	Crowd abnormal detection using two-stream Fully Convolution Neural Networks	IEEE	This paper proposed a method based on deep learning to address the problem of abnormal events detection in crowd scenes
3	**2017**	Real-Time Crowd Behavior Detection using SIFT Feature Extraction Technique in Video Sequences	IEEE	They have introduced a method for crowd detection from a moving principle based on real-time crowd behavior detection using SIFT feature extraction technique in Video Sequences.
4	**2016**	Global Abnormal Events Detection in Surveillance video – A Hierarchical approach	IEEE	The hierarchical approach helps to increase the speed and accuracy.
5	**2015**	Image Segmentation Techniques Networks	IRJET	In this paper, Image segmentation has a promising future as the universal segmentation algorithm and has become the focus of contemporary research Scenes

Sr no.	Year	Title	Journal	Paper Insight
6.	**2015**	Abnormal Event Detection using Recurrent Neural Network	IEEE	This paper, They provide a new model of detecting abnormal event using recurrent neuron network. In their model, the RNN succeeded to model the temporal distribution of the features and could predict the feature of the future frames based on its historical input.
7	**2014**	Abnormal Crowd Tracking and Motion Analysis	IEEE	This paper has shown that it is feasible to use well established image processing techniques for monitoring and collecting data on crowd activities.
8	**2014**	Zernike Moments and SVM for Shape Classification in Very High Resolution Satellite Images	IAJIT	This papers ,they shown use of Zernike moment's descriptor as a measure of shape information.
9	**2011**	EDGE DETECTION TECHNIQUES FOR IMAGE SEGMENTATION	IJCSIT	This paper an attempt is made to review the edge detection techniques which are based on discontinuity intensity levels. The relative performance of various edge detection techniques is carried out with an image by using MATLAB software

2.2 Detailed Review of Literature

1) Paper-1: Crowd counting via scale adaptive convolution neural network

Author : Lu Zhang,Miaojing Shi,Qiaobo Ch.

Publication: IEEE

Summary :

The task of crowd counting is to automatically estimate the pedestrian number in crowd images. To cope with the scale and perspective changes that commonly exist in crowd images, state-of-the-art approaches employ multi-column CNN architectures to regress density maps of crowd images. Multiple columns have different receptive fields corresponding to pedestrians (heads) of different scales. We instead propose a scale-adaptive CNN (SaCNN) architecture with a backbone of fixed small receptive fields. We extract feature maps from multiple layers and adapt them to have the same output size; we combine them to produce the final density map. The number of people is computed by integrating the density map. We also introduce a relative count loss along with the density map loss to improve the network generalization on crowd scenes with few pedestrians, where most representative approaches perform poorly on. We conduct extensive experiments on the ShanghaiTech, UCF CC 50 and WorldExpo'10 datasets as well as a new dataset Smart City that we collect for crowd scenes with few people. The results demonstrate significant improvements of SaCNN over the state-of-the-art.

2) Paper-2 : Crowd abnormal detection using two-stream Fully Convolution Neural Networks

Author : Hongtao Wei,Yao Xiao ,Ruifang Li,Xinhua Liu

Publication : IEEE

Summary : The safety of public places and the monitoring of abnormal events have always been important, and there are a lot of crowd abnormal events detection methods have been proposed in recent years. Most of these proposed methods design complex hand-crafted features to represent the surveillance videos, although these methods can achieve satisfactory results, however the disadvantages of the immense computational complexity and affected by scene variations are obvious. This paper exploits Fully Convolution Neural Networks (FCN), which has been proved to be powerful in image processing, to extract the features of videos. In order to get more useful appearance information and motion information, both the individual video frame and the optical flow of a pair of consecutive video frames are used as the input to a pre-trained FCN. In this paper, the two-stream CNN for video classification is changed to be two-stream FCN, then we utilize a novel method to compute abnormal coefficient based on the feature map from FCN. Our method is validated on abnormal detection benchmarks, and the results show it is competitive with the state-of-the-art methods.

3) Paper-3 : Real-Time Crowd Behavior Detection using SIFT Feature Extraction Technique in Video Sequences

Author : Prasad Nitish Ojha,Shivali Choudhary ,Dr. Vrijendra Singh,

Publication : IEEE

Summary : These days Crowd behavior detection in video surveillance is a latest research area in the field of computer vision. It focuses on the demanding assignment of monitoring crowded events for outbreaks of violent behavior. Such scenes have a need of human assessor to monitor multiple video screens, presenting crowds of people in a frequently changing sea of activity. In this paper, we propose an innovative approach for real-time crowd behavior detection using SIFT feature extraction technique in Video Sequences. For any detection and classification the feature extraction and feature optimization is very important metrics. So in proposed work SIFT feature extraction technique are used in appropriate segmented for background subtraction in video sense. After that feature extraction is applied in all regions, but a suitable feature extraction is not possible. To overcome this problem we have used Genetic Algorithm to optimize the extracted feature set. A genetic algorithm is best optimization technique and also operates in large data set. At last performance metrics of proposed work is calculates. In which we can compared propose work with previous existing work. And we calculate the performance metrics like precision rate, recall rate, and accuracy. The real-time crowd behavior using SIFT feature extraction technique in Video Sequences is implemented using Image Processing Toolbox within Matlab Software.

4)Paper-4 : Global Abnormal Events Detection in Surveillance video - A Hierarchical approach.

Author : N. Patil, Prabir Kumar Biswas

Publication : IEEE

Summary: In this paper, global abnormal events detection in the crowded scene is proposed. The proposed algorithm is based on a hierarchical approach. The method uses the histogram of optical flow orientation as a feature descriptor along with the magnitude of the optical flow to capture the motion. The nonlinear one-class support vector machine (SVM) classification algorithm is used to learn the normal events from the training data. After learning, one-class SVM detects abnormal events in the frame. The algorithm is fast with improved accuracy since it omits the background subtraction step and adopts hierarchy. The proposed method is tested on benchmark UMN unusual crowd activity dataset which contain global abnormal events. Promising results are reported which evaluates the performance of the proposed method.

5) Paper-5 :Image Segmentation Techniques Networks
Author : Amanpreet kaur,Navjot kaur ,Xinhua Liu
Publication : IRJET
Summary : Image segmentation is the process of division of a digital image into multiple segments sets of pixels, also known as super pixels. The aim of segmentation is to simplify and change the representation of an image into something that is more meaningful , easier to analyze and easy to understand . Image segmentation is used to give the values of objects and boundaries of an selected image like lines, curves. Image segmentation is the most important field of image analysis and its processing which is mostly used in medical field to analyse the disease. It is also used in many scientific fields including, engineering and technology, face recognition and object. The major challenge of image segmentation is to remove the noise from image by using various methods and give the clear view of image. The main goal of this article is to propose methods improving image segmentation and give the clear object about image by using different techniques. This paper presents a brief outline on some of the most commonly used segmentation techniques like thresholding , Region based, Edge detection, fuzzy based and ANN based segmentation.

6) Paper-6 : Abnormal Event Detection using Recurrent Neural Network
Author : Xu-gang Zhou , Li-qing Zhang
Publication : IEEE
Summary: In this paper, we introduce a simple but novel model to detect abnormal event in surveillance video using sparse auto encoder and recurrent neuron network. In this model, we first train a sparse auto encoder to extract features and use a sequence of temporal continuous features to train a recurrent neuron network to predict the subsequent features. We classify the frame as normal and abnormal based on the prediction error of recurrent neuron network. Experimental result on a crowd activity dataset verifies the effectiveness of our model and the implication of recurrent neural networks in abnormal detection is also discussed.

7) Paper-7 : Abnormal Crowd Tracking and Motion Analysis
Author : G.Santhiya,K.Sankaragomathi,S.Selvarani,A.Niranjil Kumar
Publication : IEEE
Summary : Automated analysis of crowd activities using surveillance videos is an important issue for communal security, as it allows detection of dangerous crowds and where they are headed. Public places such as shopping centers and airports are monitored using closed circuit television (CCTV) in order to ensure normal operating conditions. Computer vision based crowd analysis algorithm can be divided into three groups; people counting, people tracking and crowd behavior analysis. In this paper the behavior understanding will be used for crowd behavior analysis. The purpose of these methods could lead to a better understanding of crowd activities, improved design of the built environment and increased pedestrian safety.

8) Paper-8 :Zernike Moments and SVM for Shape Classification in Very High Resolution Satellite Images
Author : Habib Mahi , Hadria Isabaten , and Chahira Serief
Publication : IAJIT
Summary : In this paper, a new approach for automated buildings extraction from VHRS images was proposed. First, image objects extraction is performed using the Mean Shift segmentation algorithm. Then, a Zernike moments-based descriptor is calculated for each object or segment. Finally, a SVMs-based classification using the feature vectors as input instead of the original objects is carried out to assign a class label to each of the segments. The main outcome of this work is the use of Zernike moment's descriptor as a measure of shape information. Consequently, by performing the classification on the obtained Zernike feature vectors instead of the original objects, a good Discrimination between object shapes can be achieved.

9) Paper-9 : EDGE DETECTION TECHNIQUES FOR IMAGE SEGMENTATION
Author : Muthukrishnan.R,M.Radha
Publication : IJCSIT
Summary : Interpretation of image contents is one of the objectives in computer vision specifically in image processing. In this era it has received much awareness of researchers. In image interpretation the partition of the image into object and background is a severe step. Segmentation separates an image into its component regions or objects. Image segmentation t needs to segment the object from the background to read the image properly and identify the content of the image carefully. In this context, edge detection is a fundamental tool for image segmentation. In this paper an attempt is made to study the performance of most commonly used edge detection techniques for image segmentation and also the comparison of these techniques is carried out with an experiment by using MATLAB software.

2.3 Theory Background

- **Business Problem Definition**

These days Crowd behavior detection in video surveillance is a latest research area in the field of computer vision. It focuses on the demanding assignment of monitoring crowded events for outbreaks of violent behavior. Such scenes have a need of human assessor to monitor multiple video screens, presenting crowds of people in a frequently changing sea of activity.

2.3.1 PRE-PROCESSING TECHNIQUE

- **Pixel level analysis**

Pixel level analysis is obtained through edge detection or background/foreground subtraction. Mostly focus on a low level features where extract the information based on density estimation rather than counting.

- **Texture level analysis**

Texture level analysis is similar like pixel level analysis that is used to estimate the number of people rather than identifying individual in a scene. The analysis of image patches is required for modeling and mostly focus on high level features.

- **Object level analysis**

Object level analysis: is identifying individual object in a scene. More ccurate result will be produced when compared to pixel and texture analysis.

- **Frame level analysis**

Frame level analysis model behaviors of the full scene within the field of view of a camera .

2.3.2 FEATURE EXTRACTION

- **SIFT [3]**

SIFT proposed by Lowe solves the image rotation, affine transformations, intensity, and viewpoint change in matching features. The SIFT algorithm has 4 basic steps.

- First is to estimate a scale space extrema using the Difference of Gaussian (DoG).
- Secondly, a key point localization where the key point candidates are localized and refined by eliminating the low contrast points.
- Thirdly, a key point orientation assignment based on local image gradient and lastly a descriptor generator to compute the local image descriptor for each key point based on image gradient magnitude and orientation.

- **SURF [5]**

SURF approximates the DoG with box filters. Instead of Gaussian averaging the image, squares are used for approximation since the convolution with square is much faster if the integral image is used. Also this can be done in parallel for different scales. The SURF uses a BLOB detector which is based on the Hessian matrix to find the points of interest. For orientation assignment, it uses wavelet responses in both horizontal and vertical directions by applying adequate Gaussian weights. For feature description also SURF uses the wavelet responses. A neighborhood around the key point is selected and divided into sub regions and then for each sub region the wavelet responses are taken and represented to get SURF feature descriptor. The sign of Laplacian which is already computed in the detection is used for underlying interest points. The sign of the Laplacian distinguishes bright blobs on dark backgrounds from the reverse case. In case of matching the features are compared only if they have same type of contrast (based on sign) which allows faster matching.

- **ORB [6]**

ORB is a fusion of the FAST key point detector and BRIEF descriptor with some modifications initially to determine the key points, it uses FAST. Then a Harris corner measure is applied to find top N points. FAST does not compute the orientation and is rotation variant. It computes the intensity weighted centroid of the patch with located corner at center. The direction of the vector from this corner point to centroid gives the orientation. Moments are computed to improve the rotation invariance. The descriptor BRIEF poorly performs if there is an in-plane rotation. In ORB, a rotation matrix is computed using the orientation of patch and then the BRIEF descriptors are steered according to the orientation.

- **Zernike Moments [9]**

Zernike Moments is a feature extraction technique. It is used to extract global features from an image. ZMs are the features generated by transforming the input image on a complex set of Zernike functions. This strategy deals with unit circle which is produced over the face in picture. The pixels located outside the circle are not involved in calculation. Then, it calculates the origin of the face to find the angle of the face. Moments are pure statistical measure of pixel distribution around center of gravity of characters and allow capturing global character shapes information. They are designed to capture both global and geometric information about the image. Moment-based invariants explore information across an entire image rather than providing information just at single boundary point, they can capture some of the global properties missing from the pure boundary-based Representations like the overall image orientation. In the discrete case the integral in the moment definition must be replaced by summation.

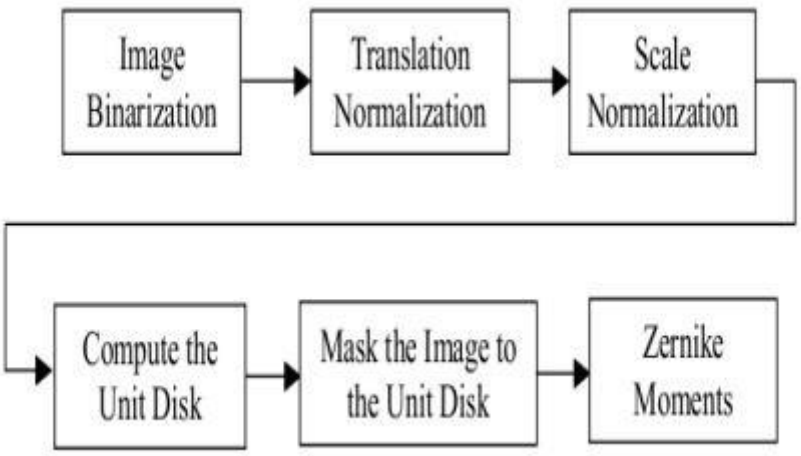

Figure 2.3.3(a): Block diagram of computing Zernike moments

The two-dimensional complex Zernike moments of a digital image with current pixel P(x,y) are defined as:

$$Z_{nm} = \frac{n+1}{\pi} \sum_x \sum_y P(x,y) V^*_{nm}(x,y), \; x^2 + y^2 \le 1$$

n and m are generally called order and repetition, respectively. The order n is a nonnegative integer, and the repetition m is an integer subject to the conditions: polynomials defined in polar coordinates as:

$$V_{nm}(x,y) = V_{nm}(\rho,\theta) = R_{nm}(\rho) \exp(jm\theta)$$

where ρ and θ represent polar coordinates over the unit disk and Rnm(ρ) is the real-valued radial polynomial of ρ given as follows:

$$R_{nm}(x,y) = \sum_{s=0}^{\frac{n-|m|}{2}} \frac{(-1)^s (n-s)! \, \rho^{n-2s}}{s! \left(\frac{n+|m|}{2} - s\right)! \left(\frac{n-|m|}{2} - s\right)!}$$

To calculate the Zernike moments, the image (or region of interest) is first mapped to the unit disc using polar coordinates, where the centre of the image is the origin of the unit disc. Those pixels falling outside the unit disc are not used in the calculation. The coordinates arethen described by ρ which is the length of the vector from the origin to the coordinate point and θ which is the angle from the x axis to the vector ρ, by convention measured from the positive x axis in a counter clockwise direction. Since their moment functions are defined using a polar coordinate representation of the

image space, Zernike moments are by nature rotational invariants where their magnitude values are unaffected and remain the same for original and rotated image. However, this coordinate representation does not easily yield translation and scale invariance . One of the indirect approaches to achieve scale and translation invariance is through expressing Zernike moments using centralized and normalized regular moments.

2.3.3 CLASSIFICATION

- **SVM**

Support Vector Machines (SVMs) are a relatively new supervised classification technique to the land cover mapping community. They have their roots in Statistical Learning Theory and have gained prominence because they are robust, accurate and are effective even when using a small training sample. By their nature SVMs are essentially binary classifiers, however, they can be adopted to handle the multiple classification tasks common in remote sensing studies

- **Genetic Algorithm**

Genetic algorithm is used to solve the problem of both constrained and non-constrained with selection criteria. In a large set of population, the genetic algorithm uses the random chromosomes to make it parents then make it to produce children. . The repetition goes on until good solutions have not been achieved on the basis on the fitness function.

2.3.4 APPLICATION

- **Visual Surveillance[13]**

Many places of security interests such as railway station and shopping mall are very rowded. Conventional surveillance system may fail for high density of objects, regarding both accuracy and computation. We can leverage the results of crowd behavior analysis to crowd flux statistics and congestion analysis anomaly detection and alarming and so on

- **Crowd Management [13]**

In mass gatherings such as music festivals and sports events, the crowded scene analysis can be used to develop crowd management strategies and assist the movement of the crowd or individuals, to avoid the crowd disasters and ensure the public safety.

- **Public Space Design [13]**

The analysis of crowd dynamics and its relevant findings can provide some guidelines for public space design, and therefore increase the efficiency and safety of train stations, airport terminals, theaters, publicbuildings, and mass events in the future.

- **Entertainment [13]**

With the in-depth understanding of crowd phenomena, the establishment of mathematical models can provide more accurate simulation, which can be used in computer games, film, and television industries . Some recent works have been proposed to synthesize crowd videos with realistic micro scale behavior .

2.4 Existing work

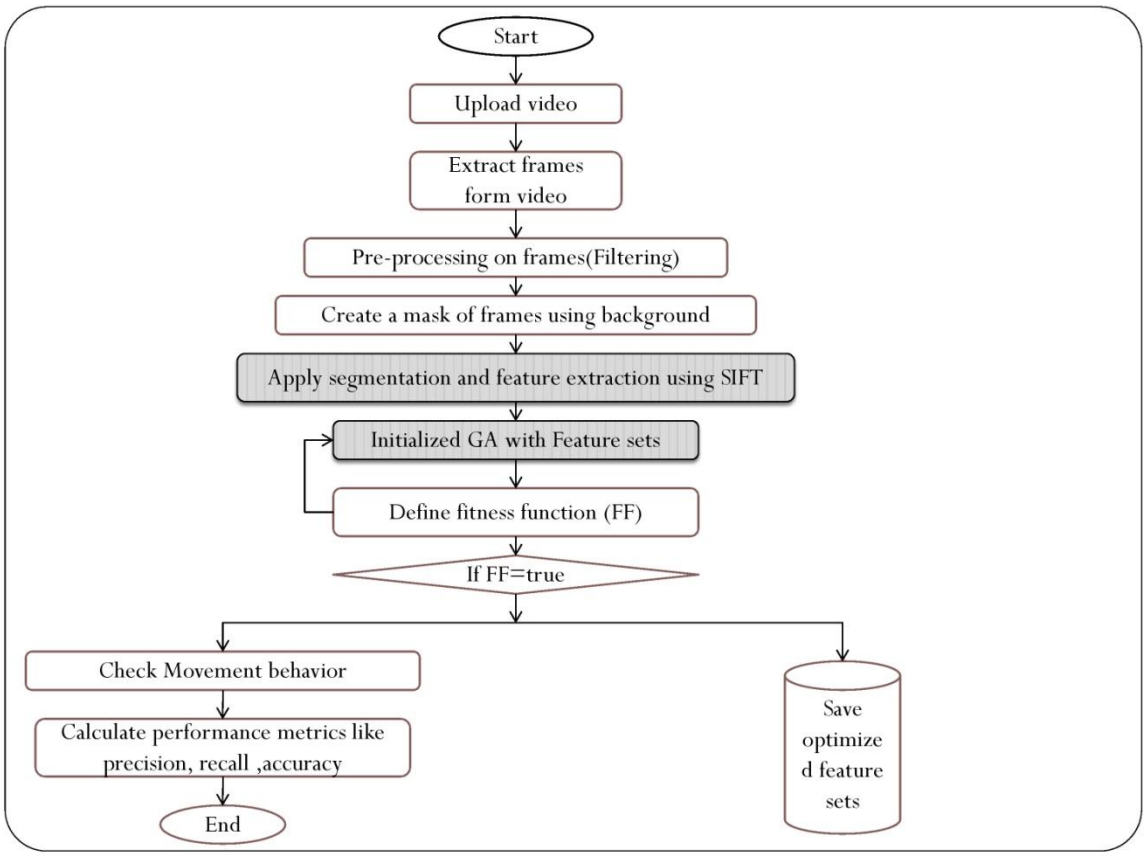

Figure 2.4(a): Existing work[3]

Step 1: Design and develop a particular GUI of propose work according to the requirements and after that upload the video.
Step 2: Extract the frames from the uploaded video.
Step 3: Apply pre-processing on each and every extracted frames.
Step 4: Develop a code for the creation of mask according to the frames.
Step 5: After that develops a code for the segmentation and SIFT feature extraction from the frames.
Step 6: Initialize genetic algorithm to optimize the feature set.
Step 7: After that set the fitness function of Genetic Algorithm according to the requirement so we can find out the appropriate and optimal feature sets.
Step 8: Check the movement behavior of feature set withrespect to the mask and blobs.
Step 9: After that to obtain the accurate result for crowd behavior detection, we can divide the video in multiple frames. And compute the performance metrics like Precision rate, Recall rate, Accuracy.

References

Research Papers:

[1]Lu Zhang , Miaojing Shi,Qiaobo Ch,Crowd counting via scale-adaptive convolution neural network ,IEEE,2018
[2] Hongtao Wei,Yao Xiao,Ruifang Li,Xinhua Liu,Crowd abnormal detection using two-stream Fully Convolution Neural Networks ,IEEE,2018
[3] Nitish Ojha,Shivali Choudhary ,Dr. Vrijendra Singh ,Real-Time Crowd Behavior Detection using SIFT Feature Extraction Technique in Video Sequences ,ICICCS,2017
[4] N. Patil , Prabir Kumar Biswas , Global Abnormal Events Detection in Surveillance video – A Hierarchical approach ,IEEE,2016
[5] Amanpreet kaur , Navjot kaur ,Xinhua Liu , Image Segmentation Techniques Networks ,IRJET,2015
[6] Xu-gang Zhou, Li-qing Zhang , Abnormal Event Detection using Recurrent Neural Network ,IEEE,2015
[7] G.Santhiya,K.Sankaragomathi,S.Selvarani,A.Niranjil Kumar,Abnormal Crowd Tracking and Motion Analysis ,IEEE,2014
[8]Habib Mahi, Hadria Isabaten,Chahira Serief,"Zernike Moments and SVM for Shape Classification in Very High Resolution Satellite Images " IAJIT 2014
[9]P. Bhaskara Rao,D.Vara Prasad,Ch.Pavan Kumar,"Feature Extraction Using Zernike Moments",IJLTET 2013
[10] Hongtao Wei,Yao Xiao,Ruifang LiXinhua Liu , Crowd abnormal detection using two-stream Fully Convolution Neural Networks ,NNSFC
[11] Muthukrishnan.R,M.Radha, EDGE DETECTION TECHNIQUES FOR IMAGE SEGMENTATION,IJCSIT,2011

[12] Teng Li, Huan Chang, Meng Wang, Bingbing Ni, Richang Hong,and Shuicheng Yan, Crowded Scene Analysis: A Survey, IEEE
[13] Nilam Nur Amir Sjarif1, Siti Mariyam Shamsuddin2, Siti Zaiton Mohd Hashim3, and Siti Sophiayati Yuhaniz4," Crowd Analysis and Its Applications", Springer-Verlag Berlin Heidelberg 2011.