A comprehensive survey On Real Time Crowd Detection And Management Using Vineland Social Maturity Scale : Deep Learning Study

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***Abstract*:**
Nowadays crowd Management is big issue for public safety. By using deep learning methodology the behavior of big crowd can be managed easily. The goal of the paper is to review deep learning methodologies for crowd detection and management. The system involves the use of cameras, sensors, and other technologies to monitor and analyze the movement and behavior of large groups of people in public spaces, such as airports, railway station, stadiums, and shopping malls. The goal of crowd detection and management is to improve safety, security, and efficiency in these spaces by identifying potential crowd- related problems, such as congestion, stampedes, and suspicious behavior, and providing timely updates to prevent or mitigate them. The objective of this study is to survey a existing system which will be Effective solution for crowd detection and management. To build this application requires a multidisciplinary approach that integrates knowledge from computer science, engineering, psychology, and sociology .In this paper existing deep learning methodology Vineland Social Maturity Scale (VSMS) approach can be used or implementation of the application which will be used for public safety, event planning and public transportation. This paper is organized in different sections. Section 1 consists of Introduction. Section 2 gives Literature Survey of the research papers which are referred for study. Section 3 consists of algorithms used in papers, Section 4 is proposed architecture of the system. Sec-tion 5 is Implementation framework. Section 6 is Methodology.

***Keywords*:** Crowd, Detection, Camera, VSMS Technique;

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I. Introduction

Public safety has grown to be a major concern over the holiday season in locations like malls, train stations, and streets. Large-scale disasters happen all throughout the world, and frequently in places where a lot of people are gathering. To effectively control the crowd count, an automated method is required. A method for locating people in a location, obtaining their motion mark, and maintaining their identities is provided by human tracking. Identifying. Individual people in a crowd that has different densities demands detecting technology. Inter-object occlusion makes it difficult for computer vision to detect and track people in a high density crowd, making it difficult to do so [18]. Due to the complexity of background modeling, current tracking algorithms face difficulties. Crowding occurs when an extremely large number of individuals gather in a defined, significantly smaller space. They frequently gather, though frequently in larger numbers, where certain events or activities, such sporting contests, political rallies, religious gatherings, and Melas, take place [15]. The occasion is regarded as "the largest religious pilgrim congregation in the world" and is one of the most tranquil gatherings in the world. Densities of 2-3 individuals per square meter and an overall appropriate flow of 82 people per meter and minute can be used to estimate typically secure crowd conditions. There is a significant risk of people falling or becoming stuck when there are four or five per-sons or more per square meter of space. With so many regular visitors to the Rail-way Station, analytics and AI were utilized to forecast crowd behavior and an opportunity for an attack run. Insight into the varied activities taking place across a number of platforms is provided by the analysis of streams from more than 100 security cameras and monitors. In the past ten years, crowd analysis techniques have greatly advanced, and now it is possible to count people using pixel-level, texture-level, or object-level analysis, as shown in figure 1. To avoid crowd influence, people counting is used to assess the size of the crowd and to send out an alarm if the crowd size exceeds a set limit. The study of crowds also involves tracking individuals and analyzing their actions. The two primary categories of behavior understanding are object level to address issues with small crowds and holistic approach to assess situations involving medium to large crowds. Because a crowd shows both dynamics and behavioral characteristics, which frequently involve goals, the mechanism of human crowds is complicated. Determining a suitable level of granularity to represent the dynamics of a crowd is therefore quite difficult. Several vital applications for smart cities, including visual surveillance and intelligent environmental control, are made possible by advances in crowded scene analysis. The current study use thorough behavior analysis approaches to identify any unusual behavior in crowded environments in order to prevent accidents in crowded public spaces. If any deviant behavior is accidentally or purposefully displayed, exceeding crowd limits in public places could have disastrous effects. Several tragic incidents happened when high-level crowds and abnormal behaviors coincided, as in the Hillsborough football accident disaster the Love display disaster in 2010, and the Al-hajj disaster in 2017[17]. We could stop fatal accidents from occurring if we could identify any odd behavior in crowds in crowd sites like stadiums, malls, and even holy places.

II. Literature survey

The mobile-based Crowd Abnormal Behavior Detection and Management System used IP surveillance cameras to identify abnormal crowd behavior and crowd densities at entrance gates is discussed in this paper[1]. This system uses IP surveillance cameras to identify abnormal crowd behavior and crowd densities at access gates. In the event of an increase in crowd size or unusual movement, the system notifies users via a mobile application, offering a quick and efficient way to warn all system users and stop any danger brought on by unusual crowd behavior. The article presents a framework for anomalous crowd behavior and crowd size detection methodology based on a mobile implementation to give an efficient method for instantly connecting and informing all system users. The system has been evaluated using interface, unit, and usability tests to assess whether it is likely to work. The test results reveal that the outcome was satisfactory. In this paper [3], a study on crowd detection and management utilizing ARMv8 and OpenCV Python's Cascade classifier is presented. The authors suggest utilizing a Raspberry Pi 3 board with an ARMv8 CPU to monitor the crowd size and utilize that data to control it. They clarify that the Opens-Python package, which offers an intuitive user interface for computer vision tasks like object identification and tracking, is the foundation of their solution. The authors describe how they trained the cascade classifier for head detection using Haar features and the Adaboost method. Then they go into depth on how they created their system, using an ARMv8-powered Raspberry Pi 3 board and the OpenCV-Python library to record video from a camera connected to the Raspberry Pi 3 board and their technology to process it. The authors conclude by presenting their findings, which show that their system can precisely understand and track human heads in the image and count the number of persons there. The authors point out that any region with a large density of people can utilize their method to manage crowds. Efficient Anomaly Detection in Crowd Videos is a research paper [4]. A cheap method for detecting crowd anomalies uses pre-trained 2D convolutional neural networks. The proposed method does away with the pricey optical flow calculations by using a pre-trained 2D convolutional neural network (CNN) for motion information and a lighter form of the 2D CNN to obtain high recognition accuracy at minimal processing cost. Three open datasets—the UMN, Hockey Fights, and Violent Flows datasets—were utilized to evaluate the effectiveness of the proposed technique. The two broad categories of crowd anomalies discussed in this work, namely escape panic and violent confrontations, were taken into consideration when choosing these datasets. The text proposes a novel method for identifying unusual behaviors in crowded settings, which can be quite useful for surveillance activities. Several approaches now in use have been successful in identifying a variety of anomalous crowd behaviors utilizing geographical and temporal data extracted from movies. But in order to enable real-time anomaly detection, greater attention must be paid to lowering model complexity, which increases computational and memory demands. The recommended approach leverages a streamlined 2D CNN to achieve great recognition accuracy at minimal computational expense while avoiding expensive optical flow calculations. This method can be adjusted for a variety of video data types and has potential uses outside of surveillance. The paper [5] titled "Video Analysis for Crowd and Traffic Management" addresses the value of video classification methods in analyzing video sequences from diverse scenarios involving crowds and traffic jams. The importance of improving road and transport infrastructure is emphasized in the report in order to lessen rush-hour traffic congestion in large gatherings. The recommended automatic video scene detection system provides a video classification technique to evaluate video sequences from various crowd and traffic jam situations. The importance of classification technique may be seen in a variety of applications, including crowd monitoring, traffic control analysis, and video surveillance [18]. The development of object identifi-cation techniques is also covered in the study, which has had a major impact on video analysis research. The video analysis can be divided into two groups based on the object: traffic and crowd. Data used to create traffic scenes shows how many light and heavy cars are on the road, whereas data used to create crowded scenes shows how many people are present in a given physical space. Preprocessing methods like binary conversion, edge detection, and others have enhanced this system's performance. Histogram of Oriented Gradients (HOG) contour. The five components of the study are: related work, system approaches, experiments and findings, conclusion, and future work [19]. Overall, this report offers insightful information about the use of video analysis for crowd and traffic management. A video-based crowd stability analysis model for emergency evacuation is presented in this paper [6]. The management of public safety requires a thorough understanding of crowd stability during emergency evacuation, and this model seeks to do just that. The model determines pedestrian movement trajectory and crowd velocity by using the Mean Shift method and the Hough Circle Transform, respectively. The stability of the crowd flow in the video is then examined using the Green Guide's stability criterion for crowd evacuation. The effectiveness of the plan recommended in this research is demonstrated by a case study analysis of the crowd footage taken at the passenger arrival exit channel of Shanghai Hongqiao airport. The findings demonstrate the crowd's stability [20]. Over-all, this model offers a fresh method for examining crowd stability in public spaces and introduces video image processing technologies to the subject of crowd evacuation. It might be used in a variety of situations, including stadiums or shopping centers, where crowds need to be controlled for the sake of public safety. The paper[7] covers motion-based machine vision strategies for crowd control [21]. Due to the rising frequency of large-scale events and the potential security risks connected with crowded surroundings, the authors stress the growing necessity for efficient crowd management solutions. The study emphasizes the value of applying machine vision technology to crowd control. These methods, which include crowd monitoring, density estimation, and aberrant behavior identification, analyze video sequences acquired by security cameras to extract pertinent data regarding crowd behavior. The authors provide a summary of various motion-based machine vision techniques used in crowd control systems. They cover methods that make it possible to extract useful crowd data from video recordings, including background modelling, object tracking, and trajectory analysis .Additionally, the report discusses the difficulties in crowd control, such as occlusion, shifts in lighting, and complicated crowd dynamics. The authors suggest approaches to overcome these difficulties, including the use of several cameras, adaptive backdrop modelling, and sophisticated object tracking algorithms. The advantages of motion-based machine vision approaches for crowd control are discussed, including greater security measures, improved situational aware-ness, and improved crowd movement [22]. The authors also go over possible uses for these methods in fields including urban planning, transportation, and public safety. The paper's conclusion highlights the value of motion-based machine vision approaches for efficiently controlling big crowds. It sheds light on the many approaches and difficulties involved in crowd analysis and draws attention to how they might be used in practical situations. This paper [8, 10] focuses on the detection of abnormal crowd behavior using image processing techniques [23]. The writers talk about the necessity of reliable surveillance systems to keep an eye on busy areas where unusual behaviors can point to potential threats or emergencies. The study suggests using image processing to analyze video data and find unusual crowd behavior. Back-ground subtraction, motion analysis, and crowd density estimation are just a few of the image processing algorithms and methods covered by the authors. The research also provides a framework for abnormal crowd behavior detection, which includes steps like preprocessing, categorization and feature extraction. The implementation specifics and settings applied in the authors' suggested system are described. The outcomes of the trials carried out by the authors show how successful their method is at properly identifying aberrant crowd behavior. When it comes to recognizing actions like brawls, stampedes, and abrupt crowd dispersal, the algorithm performs admirably. The report concludes by emphasizing the image processing techniques have the potential to improve crowd surveillance systems by making it possible to spot unusual behavior. The suggested strategy offers useful insights into enhancing security precautions and emergency response in busy regions.

III. EXISITNG APPROCH

Table1: Summary of Algorithms used in literature survey with accuracy

Sr.no	Machine Learning Algorithm	Technique/Method for Crowd Management	Accuracy	Description
1	Support Vector Machines (SVM)	Density-based clustering, anomaly detection, trajectory analysis.	90%	Supervised learning algorithm that classifies data by finding hyperplanes.
2	Random Forest	Density-based clustering, anomaly detection, trajectory analysis.	92%	Ensemble learning method that combines multiple decision trees.
3	Convolutional Neural Networks (CNN)	Real-time surveillance systems, object detection.	95%	Deep learning algorithm designed for image analysis.
4	Recurrent Neural Networks (RNN)	Trajectory analysis, behaviour prediction, anomaly detection.	85-90%	Deep learning algorithm used for sequential data analysis.
5	Long Short-Term Memory (LSTM) Networks.	Trajectory analysis, behaviour prediction, anomaly detection.	87-92%	Type of RNN capable of learning long-term dependencies.
6	Gaussian Mixture Models (GMM)	Density-based clustering, anomaly detection, behaviour analysis.	80-85%	Unsupervised learning algorithm for clustering and density estimation.

***A.** Exisiting Algorithm:*

These cameras are designed to perform crowd management analytics such Line Count, which counts the number of people crossing the line in either direction to evaluate entry and exit at a specific targeted region, as well as crowd density evaluation at all targeted sites that are considered to be notable routes. Artificial intelligence has been around for more than 50 years, but the Deep Learning subfield of AI is just now becoming widely available due to high performance GPUs' (graphic processing unit) ability to render large-scale matrix convolutions quickly. A deep neural network is first created, then trained using multiple iterations on huge quantities of data sets, and high-end GPUs are used for this learning step by step. Photos of a dense

crowd from L&T Smart World collected data from surveillance systems, and CSRNet was chosen as a Deep learning algorithm for the crowd management solution framework because to its accuracy of more than 80%. In order to complete the implementation, 1500 high resolution images collected,700 selected images were annotated, an average of over 600 headcounts per image was analyzed, over 400 heads were annotates and training.

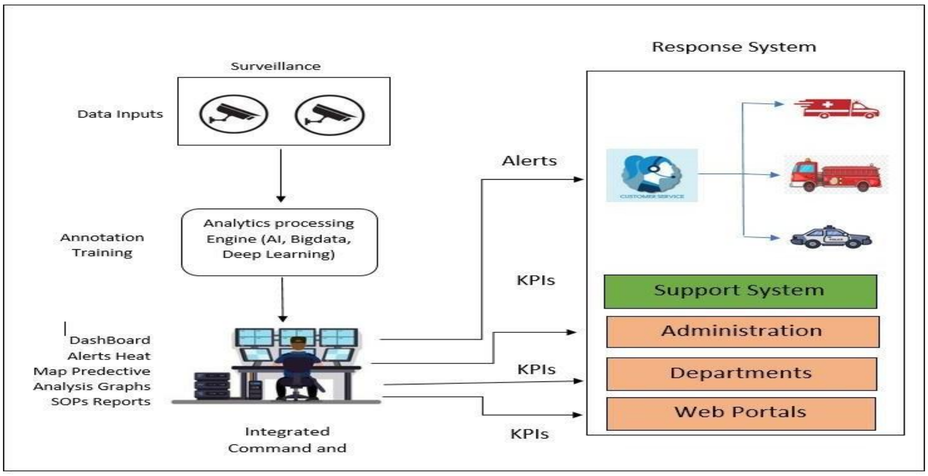

Fig1:Proposed Architecture of system

***B.** Praposed Implementation:*

It's not always the case that there is a lot of density in the crowd. Given the coexistence of low- and high-density populations, Jiang et al. observed that while the detection-based crowd counting technique could more effectively finish the task of counting low-density crowds, it has significant drawbacks for high-density populations. Although the density map-based approach for crowd counting may accurately estimate the size of a high-density crowd, it exhibits significant mistakes when dealing with low-density crowds. To integrate the best features of these two approaches, they suggested [12].The ICCC has big data analytics and AI-based algorithms that provide timely updates and warnings during specific crises. The framework is composed of three major subsystems on a broad size:

- Management system for video surveillance
- Real-time Analytics processing system
- System of Integrated Command and Control

3.1 Management System for video surveillance: An efficient instrument for crowd control in a variety of scenarios, including public gatherings, transportation hubs, and commercial establishments, is a video surveillance management system (VSMS). By monitoring crowds and identifying potential security 9 20 risks or safety dangers, VSMS technology enables swift reactions to any problems that may emerge. Here are some ways that VSMS can help with crowd control:

Crowd Monitoring: Crowd monitoring is the process of observing and tracking large groups of people in order to assess their behavior and safety. It is often used in public places such as stadiums, concert venues, and transportation hubs to prevent overcrowding, identify potential hazards, and respond to emergencies. Crowd monitoring systems can use a variety of technologies, including CCTV cameras[17], thermal imaging, and facial recognition software. The data collected by these systems can be used to track crowd density, movement patterns, and other metrics. This information can then be used to make real-time decisions about crowd management, such as closing off areas, redirecting traffic, or deploying security personnel. Crowd monitoring systems can play an important role in ensuring public safety and security.[19]By providing real-time information about crowd behavior, these systems can help to prevent accidents, disasters, and other incidents. They can also be used to improve crowd management and optimize the flow of people in public spaces

Here are some of the benefits of crowd monitoring:

Prevention of accidents and disasters: Crowd monitoring systems can help to identify potential hazards and take steps to mitigate them. For example, a system could be used to track crowd density and identify areas that are at risk of overcrowding. This information could then be used to close off these areas or deploy security personnel to prevent accidents.

Improved crowd management: Crowd monitoring systems can help to improve crowd management by providing real-time information about crowd behavior. This information can be used to make decisions about traffic flow, security deployment, and other aspects of crowd management.

Optimized flow of people: Crowd monitoring systems can be used to optimize the flow of people in public spaces. For example, a system could be used to track crowd movement patterns and identify areas where people are bottlenecking. This information could then be used to make changes to traffic flow or signage to improve the flow of people

VSMS: The Vineland Social Maturity Scale (VSMS) can be used in crowd detection and management in a few ways. First, the VSMS can be used to identify individuals who may be at risk of becoming separated from their group or who may have difficulty navigating a crowd. This information can then be used to deploy security personnel or provide additional assistance to these individuals. Second, the VSMS can be used to track the movement of individuals within a crowd. This information can be used to identify areas where people are bottlenecking or where there is a risk of overcrowding. This information can then be used to make changes to traffic flow or signage to improve crowd flow. Third, the VSMS can be used to assess the overall social climate of a crowd. Here are some specific examples of how the VSMS can be used in crowd detection and management:

A security team can use the VSMS to identify individuals who may be at risk of becoming separated from their group, such as children or elderly people. This in-formation can then be used to deploy security personnel to keep an eye on these individuals and ensure their safety. A transportation authority can use the VSMS to track the movement of individuals within a crowd at a stadium or transportation hub. This information can be used to identify areas where people are bottlenecking or where there is a risk of overcrowding. This information can then be used to make changes to traffic flow or signage to improve crowd flow. A government agency can use the VSMS to assess the overall social climate of a crowd at a protest or political rally. This information can be used to identify potential conflicts or tensions within the crowd. This information can then be used to deploy security personnel or provide additional resources to prevent or de-escalate conflicts.

Traffic Control: Traffic control is an important aspect of crowd detection and man-agement. By managing the flow of traffic, authorities can help to prevent accidents, overcrowding, and other problems that can occur when large crowds gather in a single area. There are a number of ways that traffic control can be used to improve crowd management. One common approach is to use barriers or cones to create designated pathways for pedestrians. This can help to prevent people from bottlenecking in certain areas and can also help to direct people to safety in the event of an emergency. Another approach is to use traffic lights or signs to control the flow of vehicles. This can help to keep traffic moving and can also help to prevent vehicles from blocking pedestrian pathways. In some cases, authorities may also need to use more drastic measures, such as closing off roads or restricting access to certain are-as. This may be necessary in cases where there is a high risk of overcrowding or where there is a need to protect public safety. Traffic control is an essential tool for crowd detection and management. By using a variety of strategies, authorities can help to keep large crowds safe and orderly. Here are some specific examples of how traffic control can be used in crowd detection and management: A security team can use traffic control to prevent vehicles from entering a restricted area, such as a stadium or concert venue. This can help to prevent potential security threats and can also help to keep the crowd safe. A transportation authority can use traffic control to manage the flow of vehicles around a large event, such as a sporting event or a political rally. This can help to prevent traffic congestion and can also help to keep the crowd safe. A government agency can use traffic control to divert traffic away from an area that is experiencing a large crowd, such as a protest or a natural disaster. This can help to keep the crowd safe and can also help to prevent traffic congestion.

Planning and Evacuation: Planning an evacuation in crowd detection and management involves a systematic approach to ensuring the safe and efficient movement of people during emergency situations. It requires a thorough understanding of crowd dynamics, behavior, and the layout of the environment. The process typically includes identifying potential evacuation routes, establishing assembly points, implementing clear signage and communication systems, and providing trained personnel to guide and assist the crowd. Crowd detection technologies, such as video surveillance and sensors, can play a crucial role in monitoring crowd density, identifying congestion points, and triggering timely evacuation alerts. Effective planning also involves considering factors such as crowd demographics, disabilities, and potential bottlenecks to ensure an inclusive and well-coordinated evacuation process that minimizes panic and maximizes the safety of individuals.

Fig2:Calculatingpeople using model

3.2 Realtime Analytics Process System: Through the timely and accurate delivery of insights into crowd dynamics and behavior, a real-time analytics processing system can play a significant part in crowd management. This technology enables crowd management professionals to quickly identify and address any emerging safety or security issues, enhancing the safety of crowd members. Real-time analytics processing systems can help with crowd control in the following ways: Crowd Density Monitoring: Systems for real-time analytics processing can employ video data to identify and keep track of crowd density. In order to avert potential safety concerns, crowd management professionals can take action by identifying locations that are becoming overcrowded. Crowd density monitoring is a vital component of crowd detection and management, focusing on the measurement and analysis of the number of people in a given area or space. It involves the use of various technologies, such as video surveillance cameras, sensors, or even mobile applications, to capture real-time data on crowd density. By continuously monitoring crowd density, authorities can assess the level of congestion, identify areas prone to over-crowding, and take proactive measures to prevent potential safety risks. This information helps in managing crowd flow, optimizing space utilization, and ensuring compliance with safety regulations. Crowd density monitoring also enables authorities to make informed decisions regarding crowd control measures, such as adjusting entry or exit points, redirecting people to less crowded areas, or implementing crowd management strategies to maintain a safe and comfortable environment for every-one.

3.3 Realtime Crowd Flow Monitoring: Is possible with analytics processing systems, which can also spot any bottlenecks or congestion. By doing this, it may be possible to avoid crowding and guarantee a steady flow of pedestrian traffic. Real-time crowd flow monitoring is an essential aspect of crowd detection and management that focuses on tracking and analyzing the movement patterns of individuals within a crowd in real-time. It involves the use of technologies such as video surveillance, sensors, and advanced analytics to capture and process data on crowd behavior and movement.

3.4 System of Integrated command and control: By offering a centralized platform for controlling multiple aspects of crowd control and security activities, an Integrated Command and Control (IC2)system can be an effective tool for efficient crowd management. In order to provide real-time monitoring, decision-making, and response to any accidents or emergencies that may happen, IC2 systems integrate multiple technologies and data sources. The following are some ways that an IC2system can help with crowd control:

Situational Awareness: Situational awareness is a critical component of crowd detection and management that involves obtaining and maintaining a comprehensive understanding of the current state of a crowd environment. It encompasses the col-lection, analysis, and interpretation of real-time data and information to assess the overall situation and make informed decisions. Situational awareness in crowd man-agement involves monitoring various factors, including crowd density, movement patterns, behavior, potential risks, and external influences such as weather conditions or nearby events. By leveraging technologies such as video surveillance, sensors, social media monitoring, and data analytics, authorities can gather valuable insights to enhance their understanding of the crowd dynamics and potential threats. Real-time situational awareness allows authorities to identify and respond to developing situations promptly. It enables them to detect crowd congestion, bottlenecks, or areas of high risk and take immediate action to ensure public safety. For example, if crowd density reaches critical levels in a specific area, authorities can redirect the flow of people or implement crowd management strategies to alleviate congestion. By monitoring crowd behavior, they can identify signs of unrest, agitation, or other abnormal activities that may require intervention or de-escalation techniques. In addition to monitoring the crowd itself, situational awareness also involves considering external factors that could impact crowd management. This includes staying informed about local events, potential protests, traffic disruptions, or any other incidents that could affect crowd behavior and safety. By being aware of these external influences, authorities can adapt their crowd management strategies accordingly and make proactive decisions to maintain order and minimize risks.

Collaboration between several agencies: Collaboration between several agencies is crucial in crowd detection and management to ensure a coordinated and effective response. Managing large crowds often requires the involvement of multiple entities, such as law enforcement agencies, emergency services, event organizers, public transportation authorities, and local government bodies. These agencies must work together and share information, resources, and expertise to ensure the safety and security of the crowd. Collaboration enables the pooling of resources and capabilities from different agencies, leading to a more comprehensive approach to crowd detection and management. Each agency can contribute its specific knowledge, skills, and resources to address different aspects of crowd management. For example, law enforcement agencies can provide security expertise, event organizers can contribute insights into crowd behavior and logistics, and emergency services can bring medical assistance and response capabilities. Sharing information and maintaining open communication channels is crucial for effective collaboration [24]. Timely exchange of information about crowd size, potential risks, and ongoing incidents allows agencies to make informed decisions and take coordinated actions. This can be achieved through shared communication platforms, regular meetings, joint trainings, and the establishment of standard operating procedures. Collaboration also helps in optimizing resource allocation. Agencies can coordinate their efforts to strategically deploy personnel, equipment, and technology in areas where they are most needed. For instance, law enforcement agencies can work with transportation authorities to ensure smooth crowd flow and manage traffic during large events or emergencies. Furthermore, collaboration enhances situational awareness. By sharing data from different sources, agencies can gain a comprehensive understanding of the crowd dynamics, identify emerging patterns, and assess potential risks. This shared situational awareness allows for a more proactive and coordinated response to any crowd- related incidents or issues.

Resource Distribution: Resource distribution in crowd detection and management refers to the strategic allocation of personnel, equipment, and other resources to effectively address the needs and challenges of managing large crowds. It involves identifying and assessing the requirements of crowd management, such as crowd control barriers, signage, communication systems, medical facilities, and trained personnel, and distributing them in a manner that optimizes safety, efficiency, and response capabilities. To ensure effective resource distribution, a thorough under-standing of the crowd dynamics and potential risks is necessary [8]. This understanding can be gained through crowd monitoring technologies, data analysis, and collaborative information sharing among relevant agencies. By analyzing data on crowd density, movement patterns, and behavior, authorities can identify areas of potential congestion, high-risk zones, or points of vulnerability. Based on this information, resources can be strategically positioned to manage and mitigate these challenges. Personnel deployment is a critical aspect of resource distribution. Trained personnel, such as security personnel, law enforcement officers, and crowd management teams, play a crucial role in maintaining order, guiding crowd flow, and responding to emergencies. They can be strategically positioned at entry and exit points, congested areas, and high-security zones to ensure smooth crowd movement and timely intervention if needed. Additionally, the distribution of physical resources is essential for effective crowd management [10]. This includes crowd control barriers, signage, first aid stations, and communication systems. By strategically placing barriers and signage, authorities can guide the flow of the crowd, designate specific areas for different purposes, and provide clear instructions to individuals. First aid stations and medical facilities should be distributed throughout the crowd area to ensure quick access to medical assistance if required. Communication systems, such as public address sys-tems, two-way radios, or mobile applications, enable effective communication be-tween personnel, enhancing response capabilities and situational awareness.

IV. METHODOLOGY

The proposed approach for crowd detection and management using YOLOv3 involves several steps, as described below:

Data gathering: To train and assess the suggested approach, publicly accessible crowd datasets are gathered, including those from UCSD and Shanghai Tech.

Data preprocessing: Data preprocessing involves reducing the photos to a fixed size and restoring the pixel values to the range [0, 1] for the collected datasets.

The YOLOv3 architecture was selected as the object detection method for crowd detection and control because to its real-time performance and exceptional accuracy in object identification tasks.

YOLOv3 adaptation: By changing the output layer to forecast crowd density maps rather than object bounding boxes, the YOLOv3 method is modified for crowd detection and management. More contextual data, such as the time of day and the weather, are also now included in the input layer.

Training procedure: The modified YOLOv3 algorithm is trained using a mean squared error loss function and a stochastic gradient descent optimizer on the pre-processed datasets. The datasets are split into training and validation sets throughout the training process, and the network parameters are subsequently optimized repeatedly depending on the results of the validation set [16].

Measures utilized for evaluation: A number of measures, such as mean absolute error, mean squared error, and peak signal-to-noise ratio, are used to judge the suggested approach's accuracy and computational effectiveness.

Experimental setup: The proposed method is implemented and assessed using a PC with an Intel Core i7 CPU and an NVIDIA GTX 1080 Ti GPU.

Comparison with cutting-edge techniques: The proposed method is compared to a number of cutting-edge techniques for crowd detection and management, including Faster R-CNN and Multicolumn Deep Neural Network (MCDNN), in order to assess its performance. The process involves changing the YOLOv3 algorithm for crowd identification and management and testing the results using datasets that are available to the general public. The suggested method uses YOLOv3's advantages in real-time object detection tasks to address the drawbacks of existing approaches [15].

Dataset for train stations

The train station dataset was gathered by Helia Farhood et al. [63] using a publicly accessible CCTV camera on a train station platform. The 62581 individuals in 2000 photos, varying in number from 1 to 53 in each image, make up the dataset. But as Figure 3e illustrates, due to the constraints of the camera and the high ratio of image compression, the image size is only 256 × 256, indicating very low image resolution and quality. Each head is just 45 pixels wide on average, and some heads are so small that it is difficult for the human eye to identify them, which is a significant difficulty for crowd counting algorithms. In addition, the passenger density on the platform will fluctuate significantly over time.

Indoor dataset

Miaogen Ling et al.'s collection of interior scenes is the subject of the interior dataset [13]. Three distinct scenes are included in this dataset: a bus, a canteen, and a classroom. The sequences depicting classrooms are taken from four Closed-Circuit Television (CCTV) recordings of three distinct classes, while the scenes depicting canteens are taken from two distinct canteens. Three of the classroom videos were made during the day, and the fourth was made at night. The indoor dataset has an enormous amount of samples, containing 148243 740 × 576 pictures. With a range of 0 to 49 annotations per image, the dataset has a total of 1834770 annotations.

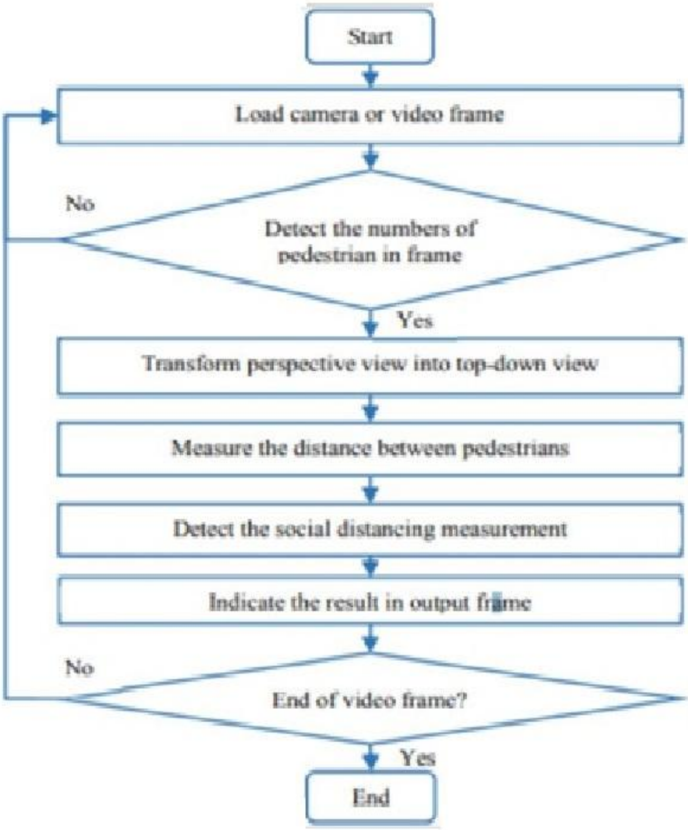

Fig 3: Flow chart of proposed system

V. CONCLUSION AND FUTURE WORK

In conclusion, managing crowds and detecting them are essential components of maintaining safety and security in crowded settings. In order to increase the effectiveness and efficiency of crowd management and detection, technology-based solutions including video surveillance, real-time analytics processing, and integrated command and control systems have showed promise. However, it's crucial to strike a balance between the advantages of these technologies, respect for each person's right to privacy, and the necessity of human judgment and intervention in crowd man-agement. The accuracy and effectiveness of crowd management and detection may be further improved in the future with the continued development and integration of technology-based solutions, data analytics, and predictive modelling, but it will be crucial to address privacy concerns and potential data misuse. In the end, efficient crowd detection and management require a multifaceted strategy that combines technology, human intervention, and effective communication and collaboration between many stakeholders involved in managing crowds. In future this application plays important role for public safety in crowd management. In the future, it's ex-pected that crowd control and detection will depend heavily on the further development and integration of technology-based solutions like artificial intelligence, ma-chine learning, and Internet of Things (IoT) technologies. These systems could im-prove crowd detection and management's accuracy and effectiveness, enabling quicker responses to possible security or safety problems. Predictive modelling and data analytics may also receive more attention in order to better predict and plan for crowd dynamics and behavior. To preserve individual privacy rights and address worries about potential data misuse or abuse, it is essential that any new technologies and solutions be created and put into use in this way.

REFERENCES

[1] Wafaa Mohib Shalash, Azzah Abdullah AlZahrani, Seham Hamad Al-Nufai, "Crowd Detection Management System", Information Technology Department, Collage of Computers and Information Technology, King Abdul-Aziz University, Jeddah, KSA.

[2] Shubham Lahiri, Nikhil Jyoti, Sohil Pyati, Jaya Dewan," Abnormal Crowd Behavior Detection using Image Processing ", Information Technology Pimpri Chinchwad College of Engineering Pune, India.

[3] Dr.S.Syed Ameer Abbas,b Dr.P.Oliver Jayaprakash,c M. Anitha,c X.Vinitha Jaini 2017," Crowd Detection and Management using Cascade classifier on ARMv8 and OpenCV-Python ", Students, Electronics and Communication Engineering Mepco Schlenk Engineering College, Sivakasi.

[4] ABID MEHMOOD 2021," Efficient Anomaly Detection in Crowd Videos Using Pre-Trained 2D Convolutional NeuralNetworks ", Department of Management Information Systems, College of Business Administration, King Faisal University,Al-Ahsa31982,SaudiArabia.

[5] S.Jothi Shri, S. Jothilakshmi ," Video Analysis for Crowd and Traffic Management ", Department of Information TechnologyAnnamalaiUniversity,Annamalainagar.

[6] Rongyong Zhao1 , Daheng Dong1 , Cuiling Li2 , Qiong Liu1 , Qianshan Hu1 , Yunlong Ma1 , Qin Zhang3 2019," Videobasedcrowdstabilityanalysisusedinemegencyevacuation",1.CIMSResearchCenter,TongjiUniversity,Shanghai,201804.

[7] B.A.Boghossian and S.A.Velastin,"MOTION-BASED MACHINE VISION TECHNIQUES FOR THE MANAGEMENT OF LARGE CROWDS",Department of Electronic Engineering,King's College London Strand,London WC2R 2LS,England,UK

[8] Raykar, N., Khedkar, G., Kaur, M. et al. A novel traffic load balancing approach for scheduling of optical transparent antennas (OTAs) on mobile terminals. Opt Quant Electron 55, 962 (2023). https://doi.org/10.1007/s11082-023-05201-0

[9] BruceD.LucasandTakeoKanade,1981,"AnIterativeImageRegistrationTechniquewithanApplicationtoStereoVision",in International Joint ConferenceonArtificial Intelligence, pages 674-679.

[10] Nagesh Raykar, Prashant Kumbharkar, Dand Hiren Jayatilal. Hybrid LSTM technique for phonetic. Int J Adv Electr Eng ;4(1):18-22. DOI: 10.22271/27084574.2023.v4.i1a.3 2023

[11] R. T. Ionescu, F. S. Khan, M.-I. Georgescu, and L. Shao 2019, ''Object- centric auto-encoders and dummy anomalies forabnormaleventdetection invideo,''inProc.IEEE/CVFConf.Comput.Vis.PatternRecognit.(CVPR),pp.7834–7843.

[12] W. Lin, J. Gao, Q. Wang, and X. Li 2021 , ''Learning to detect anomaly events in crowd scenes from synthetic data,''Neurocomputing,vol. 436, pp.248–25.

[13] Nagesh Raykar, Dr. Prashant Kumbharkar, Dr. Dand Hiren Jayatilal. De-duplication avoidance in regional names using an approach based on pronunciation. Int J Adv Electr Eng ;4(1):10-17. DOI: 10.22271/27084574.2023.v4.i1a.32 (2023)

[14] B.Georgievski, "Object detection and tracking in 2020," 2020, https://blog.netcetera.com/object-detection-and-tracking- in-2020-f10fb6ff9af3.View at: Google Scholar

[15] W. Pitts and W. S. McCulloch, "How we know universals the perception of auditory and visual forms," Bulletin ofMathematicalBiophysics, vol.9,no.3,pp. 127–147, 1947.

[16] Z.-Q.Zhao,P.Zheng,S.-T.Xu,andX.Wu,"Objectdetectionwithdeeplearning:areview,"IEEETransactionsonNeuralNetworksandLearningSystems, vol.30,no.11,pp.3212–3232,2019.

[17] E. N. Kajabad and S. V. Ivanov, "People detection and finding attractive areas by the use of movement detection analysisanddeeplearningapproach,"ProcediaComputerScience,vol.156,pp.327–337,2019.

[18] A.Brunetti,D.Buongiorno,G.F.Trotta,andV.Bevilacqua,"Computervisionanddeeplearningtechniquesforpedestriandetectionand tracking:asurvey,"Neurocomputing,vol.300,pp.17–33,2018.

[19] M.Manfredi,R.Vezzani,S.Calderara,andR.Cucchiara,"Detectionofstaticgroupsandcrowdsgatheredinopenspacesbytextureclassification," PatternRecognitionLetters, vol. 44, pp.39–48, 2014.

[20] Raykar, N., Kumbharkar, P., Jayantilal, D.H. (2023). Structured Demographic Data De-duplication in Indian Names. In: Kumar, A., Ghinea, G., Merugu, S. (eds) Proceedings of the 2nd International Conference on Cognitive and Intelligent Computing. ICCIC 2022. Cognitive Science and Technology. Springer, Singapore. https://doi.org/10.1007/978-981-99-2746-3_50

[21] A. Alahi, M. Bierlaire, and P. Vandergheynst, "Robust real-time pedestrians detection in urban environments with low-resolution cameras," Transportation Research Part C: Emerging Technologies, vol. 39, pp. 113–128, 2014.

[22] G. Kaur, P. Tomar, and P. Singh, "Design of cloud-based green IoT architecture for smart cities," Internet of Things andBigDataAnalyticstowardNext-GenerationIntelligence,Springer,Cham,pp.315–333,2018.Viewat:PublisherSite|GoogleScholar

[23] Sonali Purnaye and Sunil Rathod, " A REVIEW OF ARTIFICIAL INTELLIGENCE TECHNIQUES USED WITH RENEWABLE ENERGY SYSTEMS"VOLUME 8, ISSUE 4 (2023, APR) (ISSN-2455-6300)

[24] Raykar, N., Kumbharkar, P., Jayantilal, D.H. (2023). Assembled LSTM Technique Used for Phonetic-Based Algorithm for Demographical Data. In: Singh, S.N., Mahanta, S., Singh, Y.J. (eds) Proceedings of the NIELIT's International Conference on Communication, Electronics and Digital Technology. NICE-DT . Lecture Notes in Networks and Systems, vol 676. Springer, Singapore. https://doi.org/10.1007/978-981-99-1699-3_36 2023