Crowd Monitoring And Visualisation

A Synopsis of Research

Submitted in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Technology
in
Computer Science and Engineering

by

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DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

We also declare that the intellectual content of this synopsis is the product of our own work, even though we may have received assistance from others on style, presentation, and language expression.

In accordance with the project rubric's emphasis on **Academic Integrity**, we commit to using plagiarism detection tools like Turnitin for self-checking throughout the writing process to ensure the originality of our work.

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CERTIFICATE

This is to certify that the work which is being presented in the B.Tech Synopsis entitled **"Crowd Monitoring And Visualisation"**, in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering and submitted to Ajay Kumar Garg Engineering College, Ghaziabad, affiliated with Dr. A.P.J. Abdul Kalam Technical University, Lucknow, is an authentic record of our own work carried out under my supervision.

The matter presented in this synopsis has not been submitted by us for the award of any other degree of this or any other University.

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Chapter 1

Introduction

1.1 Background and Motivation

Need for Real-Time Crowd Monitoring and Visualization

Effective crowd management is crucial for ensuring public safety in a variety of environments, including concerts, sporting events, public gatherings, spiritual gatherings, and transportation hubs. While these events are vital for social and cultural life, they also present a substantial public safety challenge. It induces risks , such as panic , stampedes and overcrowding which leads to fatal consequences or life threatening situations. These environments can be a source of deep psychological agony for a growing number of people and two specific fears , **Demophobia** which refers to a broad or general fear of being in crowds, whereas **ochlophobia** is a more specific and extreme fear of mobs or chaotic, uncontrollable gatherings .It navigates the public spaces an overwhelming and often impossible task.

Crowd management has always been an issue raised in descriptive analysis and has always been a labor-intensive process . Security staff manually monitor surveillance footage, and transmit updates by radio and guide people on the ground. In current high traffic scenarios, depending on manual intervention is often slow and vulnerable to errors especially when events escalate across multiple sites. So the rise of AI-powered video analytics has provided a compelling alternative but a critical gap still exists. Mostly descriptive and diagnostic purposes are already in existence - but they lack intelligence to provide guidance and automate the system. The intervention of AI-powered systems with computer vision can analyze vast amounts of data from surveillance cameras in real-time, identifying patterns, detecting anomalies, and providing insights that would be impossible for a human to process. This capability has already shown significant promise in urban security, traffic management, and emergency response. Our project is motivated by the need to close this gap and provide a solution that mainly focuses on safety for everyone , including those who struggle with demophobia and ochlophobia. [1] [2]

1.2 Problem Statement

Challenges in Managing and Visualizing Crowd Data

In current scenario, the crowd monitoring systems which are available in the market are mainly capable of doing the diagnostic and descriptive analysis (means that they are only able to tell us what is happening) but they are not able to demonstrate or tell us the steps which we should take after a scenario like stampede have occured. In short, all the **current approaches are reactive but not proactive** and this was the most important problem we found with the current research on this topic of crowd management. This is a huge and very critical gap where humans must be able to interpret the data provided by AI systems (in form of alerts, notifications, etc) and be able to immediately decide what to do at that point of time, leading to avoiding potential delays and inefficiencies in important situations. [3] [4]

1.3 Research Questions and Objectives

Key Objectives for Crowd Monitoring and Visualization

Primary Research Questions:

How can a video-based system be used to generate a prescription based on the status of the crowd? What techniques can be considered reliable methods for identifying the difference between the normal gathering of people and a stampede or other intense crowd situation? What machine learning models are most effective for predicting the escalation of crowd pressure, congestion, or panic?

Objectives:

1. Create a prescriptive analytical tool that is able to generate a set of prescriptions based on the current situations of the crowd and their pattern of movements.
2. Develop a simple and efficient user interface based on a model that accurately classifies crowd status (e.g., normal, dense, overcrowded) from the data of video feeds.
3. Implement and verify the consistency and reliability of this tool in a real-world scenario.
[5] [6]

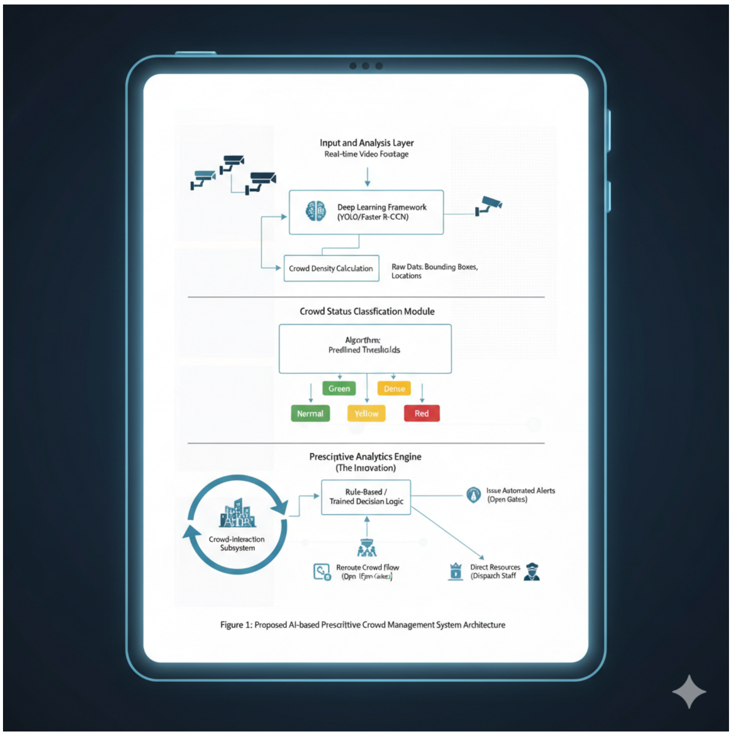

Figure 1.1: Workflow of the Research

1.4 Novelty and Originality

Innovative Aspects of the Proposed Crowd Monitoring System

The novelty and the originality of our idea lies in the fact that we are solely focused on giving prescriptions, not on the fact of just giving diagnosis of the events that have occurred, as already done in the previous research papers and project ideas. We are focused on creating an engine which can be used to fulfill a gap in this field ,i.e. **Prescriptive Analytics and Automated Intervention**, and using that for decision making based on the current situation of the crowd. [1] [7]

1.5 Scope of the Project

Scope and Potential Applications of Crowd Visualization

The scope of this project is limited to developing a software-based system that uses video data for crowd monitoring and management(if needed in that scenario).It will not incorporate other data sources such as social media feeds, network data, or GPS tracking. The primary output will be automated intervention and recommendations, rather than a physical control system.

Chapter 2

Literature Review

2.1 Historical Overview

Evolution of Crowd Management and Visualization Systems

The field of crowd management has evolved significantly from basic methods to highly advanced and enhanced technology driven approaches. Historically these approaches were slow and reactive and were insufficient in dynamic situations. It often led towards life threatening situation and severe risks Then after some time the cctv systems marked a significant role in the industry by centralising the monitoring, but it served as a post-incident tool for analysis rather than a Proactive Approach to Crowd Safety that Integrates Video Analytics and Automated Intervention. [8] [9]

2.2 Current State-of-the-Art

Recent Technologies in Crowd Monitoring (AI, IoT, and Visualization)

AI and computer vision drive have modernised or transformed crowd management. The current technology landscape resides with this technology for public tasks, which include:

- **Crowd counting and density estimation:** Systems can now count the number of people in a scene accurately, outputting heatmaps which visualise individual people density, usually with (deep learning) models such as convolutional neural networks (CNNs).
- **Anomaly and behaviour detection:** AI algorithms provide detection of anomalous activities including having people suddenly run, hostile behaviours or a stampede, considering motion patterns and motion/textures.
- **Predictive analytics:** The areas of research has moved towards predictive modelling, where systems consider the analysis of historical datasets and the real-time streaming of data to predict risk or congestion before they occur.

The evolution of these systems is now capable of scanning the immediate environment, and providing alerts to authorities in real-time enhancement of situational awareness. However, when considering these technologies, there is a key constraint. [10] [11] [12]

2.3 Identification of Research Gap

Gaps in Existing Crowd Monitoring and Visualization Solutions

As pointed out before, while there is development in crowd analysis, we have not transitioned from providing diagnosis function, to prescriptive function. Currently, systems can assess crowd density or hazards, but they do not offer any sort of automated, actionable, intervention in real time. The dependency on a ”human-in-the-loop” for decision making might represent a single point of failure and add delay to an emergency which could be hazardous. This is the gap that our project is addressing. We aim not only classify the status of the crowd, but work towards a prescriptive analytics framework that will suggest or automate control actions in real time. This technical gap is not only addressing an analytics function, but establish the need to transition from advanced monitoring to effective autonomous proactive interventions, therefore providing the foundational framework for a truly proactive crowd management solution. [13] [14] [15]

Chapter 3

Societal Impact and SDG Alignment

3.1 Primary SDG Relevance

How Crowd Monitoring Supports Public Safety and Sustainable Cities (SDG 11)

This project is in full accordance with the United Nations SDGs(Sustainable Development Goals), like-
SDG 11 : Sustainable Cities and Communities The main aim of our research and project is to make the human settlements safer and giving a proactive alternative to resolve issues related to the crowd monitoring and visualization.
Our project will enhance safety for the people by reducing the risks of injuries and deaths as happened in the stampede caused in MahaKumbh and RCB trophy celebrations. We aim to make this technology that much efficient so that it can work nicely and efficiently both for rural and urban settings .

3.2 Breadth of SDG Linkages

Linkages to Emergency Response, Urban Planning, and Smart Cities

The project has impacts that extend beyond a single SDG. By fulfilling the SDG 11 it also extends its cascading impacts on some other SDGs that supports the advancement of multiple global goals. Some of these other SDGs are :

- **SDG 9: Industry, Innovation and Infrastructure:** Our research is focused to address the necessity of the use of new technologies like leveraging Ai and using Machine Learning.
  The most common and impactful example of using AI for crowd management is the use of **AI powered systems to manage crowd at Tokyo Olympics in 2020**.

- **SDG 3: Good Health and Well-being:** History is itself the evidence that how the technology helps to prevent accidents , human life, their well being and health as well. so through this research we are also headed to do the same, like Through our proactive approach we are focused to prevent the issue not to resolve it when it had already occurred,just like **Noise Detection system in Dublin Park** has prevented many people from the risks of fluctuation in BP and sudden Heart Attack.
- **SDG 16: Peace, Justice and Strong Institutions:** Having a proactive approach towards managing the crwod will make our institutions, cities and safer and more peaceful spot to survive. This approach can become as efficient as the current system for traffic management using video analytics are and it can also give a proper evidence tracking which will lead the victim to get justice . Thus, it makes the institutions a more safer place to live and help them to maintain the public order.

Chapter 4

Universal Human Values & Harmony with Nature

4.1 Impact on Material & Plant/Bio Orders

The project has a primarily positive effect on the Material Order (inanimate objects) from the perspective of operational and resource efficiency. The camera-based system controlling crowd flow will limit the need for physical barriers, multiple signs, and lights - all of which require energy and operate using other resource use. The system is also likely to help limit damage to infrastructure and public property by controlling crowd density during a large gathering. The effects on the Plant/Bio Order are much more indirect, in that the system can help manage events and urban spaces and ensure that humans do not access uncontrolled areas such as parks or green spaces that are often adjacent to large urban gathering areas. Limiting human disruption will have the effect of limiting physical impact on plant life and the ecosystem in that area while maintaining a relationship with human activity.

4.2 Impact on Animal & Human Orders

The positive impact of your project is the Human Order. The purpose of your system is to improve public safety by preventing stampedes, crushing dangers, and other crowd-related emergencies. The system automated any intervention, which will improve the ability to react quickly and efficiently, saving lives, and preventing injury. It will give people a sense of security in crowded public situations. Additionally, there is a positive impact on the Animal Order. In urban environments and at events, uncontrolled behavior among crowds can put animals at risk. Uncontrolled behavior caused by a panicked crowd can put working animals like police dogs or animals in wildlife at risk. By promoting order, and preventing panic, you are benefitting animals who are in close range or proximity to humans or events enjoyed by humans.

4.3 Overall Mutual Fulfillment

In the end, your endeavor further fulfills the ideal of mutual fulfillment - human development that co-evolves with nature and the other orders of existence. Increasing multi-faceted and human-centric technology ensures spaces are safer and more effective. More effective and pressure-free environments alleviate the burdens felt by the natural environment and its resources. The technical capability to guarantee a safer and more predictable environment for human or animal alike illustrates how innovation can contribute to meaningful coexistence. This mirrors the idea that human needs can be achieved without significant adverse impact to other orders in the system, moving toward a balanced and sustainable relationship.

Chapter 5

Research Methodology

5.1 Research Approach

Methodology for Developing and Testing the Crowd Monitoring Systemn

An applied research approach will be employed in this study, as the primary purpose of the research is to address a real-world issue (particularly, ineffective crowd management) through a useful technology-based practice. An applied research approach is more concerned with the design of a functioning system as opposed to creating solely theoretical knowledge. The research will collect and follow a systematic and iterative process, incorporating aspects of an agile development cycle to allow for ongoing design, development, and testing to be able to easily revise and modify and refine based on outcomes, findings, and results in each stage.

5.2 Proposed System/Algorithm/Framework

AI-Based Crowd Detection and Visualization Framework

The new framework, ”AI-based Prescriptive Crowd Management System,” has a model consisting of three levels:

Input and Analysis Layer

The system inputs real-time video footage from a monitoring camera. The footage can run through a deep learning framework (for example, YOLO (You Only Look Once) or Faster R-CNN) to go through an object detection process and creates outputs for both location and number of people in the footage. The raw human detection data will be used to calculate crowd density within designated areas.

Crowd Status Classification Module

The status classification module is the basis for the system algorithmic capabilities. It takes the density data provided from the input and processes it for classifying the status of the crowd as the thresholds have been defined. The outputs from this module are about the status classification of the scene–"Normal", "Dense", or "Overcrowded" status–and this is the classification which enables the system to move from surveillance to analysis.

Prescriptive Analytics Engine

This is the innovative aspect of the framework. This assumes either rule-based or trained decision making about the status classification. The input of the status classification will invoke a prescriptive capability, depending on available rules.

5.3 Data Collection and Analysis

Data Sources, Processing, and Visualization Techniques

In order to assess and train the models used in the proposed framework, a multi-step process of data collection and analysis will be implemented.

Preparing Data: Obtained videos are to be processed in three steps :

- Requires resizing of frames to a common size,
- Normalization of pixel values,
- Using YOLO(You Only Look Once) for real-time object detection
- Transforming the data for deep learning models in a structured format.
- **Data Annotation and Labeling:**
  Although pre-annotated datasets will be used, any other data will be annotated manually or semi-automatically. In systems where object detection is enabled, colonized reads are used as a proxy for individuals and when training crowding counting models, density maps will be used. Categorizing crowd states as "normal", "dense", and "over-crowded", will rely on established thresholds of crowd density and may even assist in training the prescriptive engine.
- **Code Performance Assessment:** The system will be assessed by comparative performance metrics and performance codes including object detection (Mean Average Precision - mAP), crowd counting (Mean Absolute Error - MAE) and classification accuracy. The assessment of the prescriptive engine will rely on the density models.

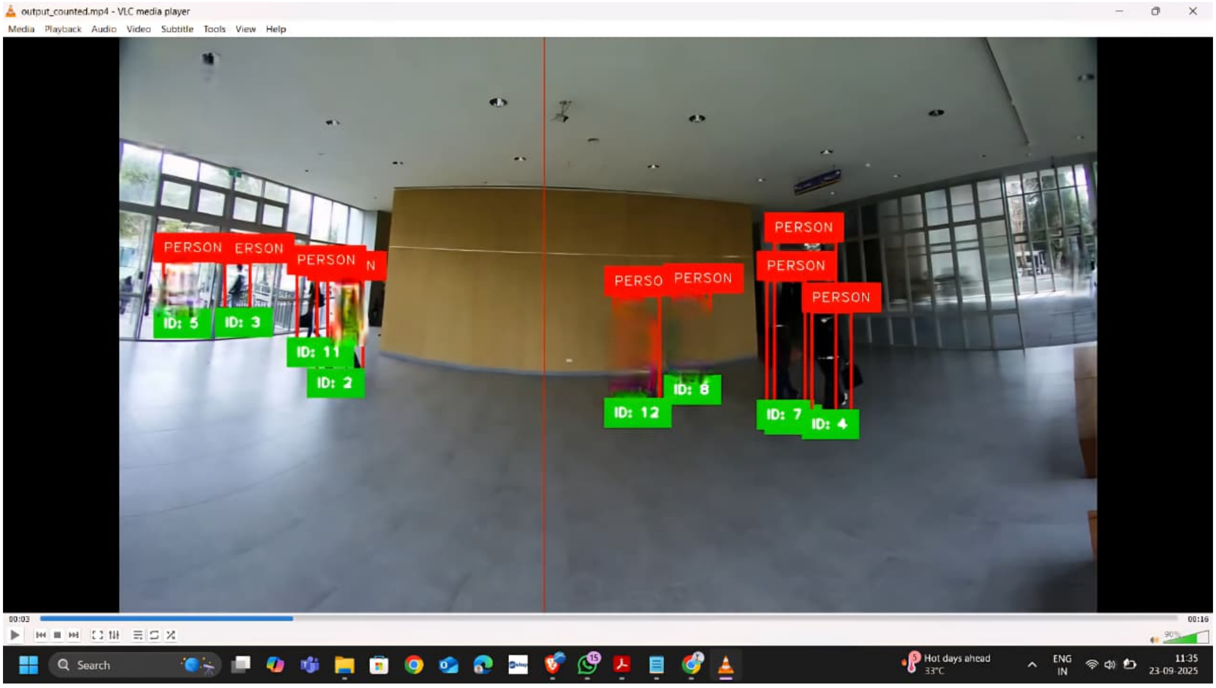

Figure 5.1: YOLO model

Comparison of various Object Detection Models

Model Name	**Architecture Type**	**Primary Strength**	**Key Weaknesses**	**Recommended Use Case**
YOLO	One-stage Detector	High-speed inference, suitable for real-time applications	Potential accuracy issues with small, occluded targets in dense crowds	Real-time crowd flow monitoring and initial anomaly detection
Faster R-CNN	Two-stage Detector	Higher accuracy, especially for small objects	Slower inference speed	Offline analysis, or real-time deployment in less latency-sensitive scenarios
Proposed System	Hybrid	Utilizes strengths of both via a streamlined data pipeline	Requires careful balancing of speed and accuracy	Real-time crowd status classification with automated

Chapter 6

Project Plan and Professional Practices

6.1 Timeline and Milestones

Project Timeline and Key Deliverables

Table 6.1: Project Timeline

Month	**Milestone**
Sep-Oct 2025	Finalize Literature Review & Methodology
Nov-Dec 2025	Initial Design & Prototyping
Jan-Feb 2026	...
Mar-Apr 2026	...

6.2 Collaboration and Documentation

Team Roles, Data Sharing, and Documentation Practices

6.3 Required Resources

Hardware, Software, and Data Requirements

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