KumbhRakshak - Policing Framework for Safety and Surveillance at Kumbh Mela

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ABSTRACT – *Managing large crowds without proper organization is challenging and essential to prevent accidents like trampling and overcrowding. Crowds can be structured (moving in one direction, like in Kumbh Mela or Hajj) or unstructured (moving in different directions, like in stations or city centres. By tracking individual movement, speed, and direction, potential risks can be detected early. The proposed KumbhRakshak system uses AI-powered cameras and computer vision to monitor crowd density, detect unusual activities, and generate real-time alerts. It also uses CNN-based facial recognition to identify missing persons and stores all event data securely in a MySQL database. With instant notifications, safer route suggestions, and predictive analysis, the system ensures better coordination, faster emergency response, and improved safety during large-scale events like the Kumbh Mela.*

Additionally, the system supports real-time communication between administrators, police help centers, and emergency teams to improve response efficiency. Detailed logs and analytics help authorities plan resource allocation and manage crowd flow effectively. Overall, Kumbh-Rakshak provides a scalable, intelligent, and reliable solution for enhancing public safety and crowd management in mega events.

Key Words: Kumbh Mela, Person Identification, AI Surveillance, CCTV Monitoring, Web Application, Computer Vision, Missing Person Finder, Public Safety.

1. INTRODUCTION

KumbhRakshak is an AI-powered crowd management and safety system designed for large-scale events like the Kumbh Mela. It helps manage challenges such as overcrowding, stampede risks, missing persons, traffic congestion, and delayed emergency response by using real-time surveillance, computer vision, and predictive analytics. High-angle cameras monitor crowd density and generate heatmaps to detect congestion, while automated alerts are triggered when safety limits are crossed. Facial recognition technology assists police in quickly identifying and locating missing individuals, with detection logs maintained for accurate tracking.

The system includes dedicated modules for administrators, police help centers, and pilgrims, ensuring smooth coordination and communication. Pilgrims can check real-time crowd status and receive navigation guidance through web or mobile interfaces. By providing early warnings, instant notifications, secure data storage, and intelligent decision support, KumbhRakshak enhances public safety, improves emergency response time, and ensures efficient management of massive gatherings.

1.1 Problem Statement

Managing large crowds at events like the Kumbh Mela is highly challenging due to issues such as overcrowding, missing persons, traffic congestion, delayed emergency response, and lack of real-time monitoring. Traditional methods rely heavily on manual supervision and basic surveillance, which are often slow, inefficient, and prone to errors. This increases the risk of stampedes, panic situations, and poor coordination among authorities. Additionally, without predictive monitoring systems, it becomes difficult to identify high-risk areas before they turn into emergencies. Therefore, there is a strong need for an AI-driven, automated solution that can monitor crowd movement in real time, estimate density levels, track missing individuals, provide navigation guidance, and generate instant alerts to improve safety, coordination, and overall crowd management efficiency. Such a system would also enable better resource allocation, faster communication between departments, improved decision-making through data analytics, and proactive risk prevention to ensure a safer and more organized event experience for all participants.

1.2 Objectives

The objectives of the proposed KumbhRakshak are as follows:

1] Develop an AI-powered system capable of real-time crowd density detection and monitoring to prevent overcrowding and ensure public safety during massive events like the Kumbh Mela.
2] Implement an intelligent Person Finder module using facial recognition and uploaded data to quickly identify and locate missing individuals.
3] Provide instant alerts and notifications through a centralized dashboard and mobile app to enable faster and smarter decision-making by authorities.
4] To enable quick emergency response triggers for deploying medical and security support when needed.

5] To create a user-friendly web and mobile interface for control panel, police help centers, and pilgrims for smooth interaction and communication.

6] Maintain a centralized and secure database system to store crowd logs, missing person records, detection history, and emergency reports for future analysis and decision-making.

1.3 System Architecture

The proposed Kumbh-Rakshak system is structured into three primary modules: Control Panel, Police Help Center Module, and User Module, each designed to ensure efficient crowd management and coordinated response during large-scale events
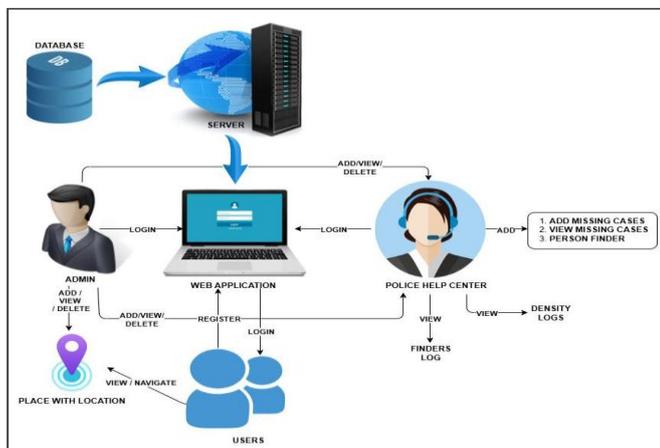
Fig.1.1 System Architecture Diagram

The Control Panel serves as the administrative core of the system. Authorized administrators can securely log in to manage overall operations. This module allows admins to add, view, and delete Police Help Centers along with their detailed information and geographical locations. It also enables the management of key places of interest and major crowd gathering points within the event area. Additionally, administrators can monitor real-time system status, manage the centralized database, and supervise alerts and crowd analytics through an integrated dashboard to ensure smooth and continuous functioning of the platform.

The Police Help Center Module is designed for authorized police personnel responsible for on-ground safety and emergency handling. Police staff can log in securely to manage missing person cases by adding and viewing detailed records along with photographs. Officers can review logs of previous person detections as well as crowd density detection records for better situational awareness. Automated alerts related to overcrowding, unusual crowd behavior, or successful person identification are instantly delivered to help police respond quickly and effectively.

The User Module is developed for pilgrims and visitors attending the event. Users can register and log in through web or mobile applications to access essential features. They can view important locations and check real-time crowd status to avoid congested areas. The system also provides navigation assistance by suggesting safer routes based on live crowd analysis. Through access to live data and web-based information, pilgrims can plan their movement efficiently, ensuring a safer and more organized experience during the event.

2. LITERATURE REVIEW

1] **Smart Way of Tracking and Assistance of Pilgrims Using Android – Sowmya & Kumar (2014):**
This paper presents an Android-based application designed to enhance pilgrim safety during large religious events. The system integrates GPS, Google Maps, and SMS services to track pilgrims' locations in real time. Pilgrims can share their position with family members or authorities, request emergency help, and receive event-related notifications. The solution reduces the risk of people getting lost and lowers family anxiety by enabling continuous location visibility.[1]

2] **A Study and Estimation of Lost Person Behaviour in Crowded Areas Using Accelerometer Data from Smartphones – Balfas et al. (2018):**
This paper proposes a mobile-based safety management system aimed at improving security during large-scale religious gatherings. The application utilizes GPS tracking, real-time location mapping, and cloud-based data storage to monitor pilgrim movement effectively. It allows users to send distress signals, access nearby help centers, and receive instant safety alerts through push notifications.[2]

3] **A Model for Tracking People in Crowds – Alsubhy et al. (2020):**
This paper introduces a hybrid tracking system that combines RFID tags, GPS, and sensor technologies to monitor both individuals and their belongings in crowded environments. The system provides continuous real-time tracking to prevent loss or theft and enables faster emergency response. It is particularly designed for large religious gatherings like the Hajj pilgrimage, where crowd density is extremely high. By integrating multiple technologies, the proposed model improves tracking accuracy, reliability, and overall safety in complex and challenging crowd conditions.[3]

3. EXISTING SYSTEM

Existing personality prediction systems mainly rely on traditional psychological assessments such as the Myers-Briggs Type Indicator (MBTI) and the Big Five Personality Test, where individuals answer structured questionnaires and results are interpreted manually or through predefined scoring techniques. Although scientifically validated, these approaches are time-consuming and require active human involvement.

In recent years, some digital platforms have attempted to automate personality analysis. However, most systems depend on basic statistical methods rather than advanced machine learning algorithms, limiting their ability to adapt, learn from new data, and improve accuracy. They also struggle with handling large datasets and identifying complex behavioral patterns. Additionally, traditional and semi-automated systems lack real-time processing capabilities, making them less suitable for dynamic environments. Therefore, there is a need for a more intelligent, scalable, and automated system that uses advanced machine learning techniques, particularly unsupervised learning algorithms, for accurate and efficient real-time personality prediction.

4. PROPOSED SYSTEM

KumbhRakshak, is an AI-powered crowd monitoring and safety management platform designed to ensure public safety during large-scale gatherings such as the Kumbh Mela. The system integrates computer vision, deep learning, predictive analytics, and centralized monitoring to manage crowd density, detect unusual activities, and assist in locating missing persons in real time.

It uses strategically placed high-angle and low-angle surveillance cameras to capture live video feeds across major event locations. These feeds are processed using Convolutional Neural Networks (CNNs) for human detection, crowd density estimation, and facial recognition. When overcrowding or abnormal movement patterns are detected, the system automatically generates alerts to notify authorities through a centralized dashboard.

The system also includes an AI-powered Person Finder module that matches uploaded photographs of missing individuals with live camera feeds to enable quick identification and tracking. Detection logs and case details are stored in a secure centralized database for monitoring and reporting.

To improve movement efficiency, the system incorporates a Predictive Route Suggestion feature that analyzes crowd flow patterns and recommends safer, less congested routes to pilgrims through web and mobile applications. Real-time notifications and emergency triggers allow quick deployment of medical and security teams when necessary. The platform operates through three role-based modules: the Control Panel for administrators, the Police Help Center Module for law enforcement personnel, and the User Module for pilgrims. By combining intelligent surveillance, predictive guidance, and coordinated communication, Kumbh-Rakshak provides a scalable, reliable, and efficient solution for safe crowd management during massive religious events.
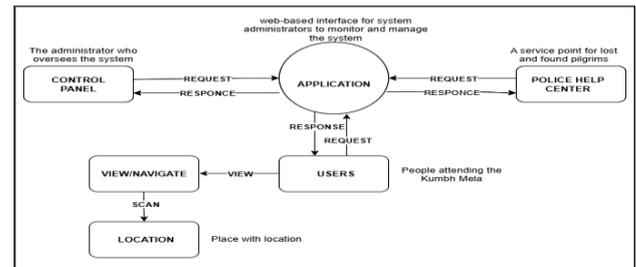

Fig.2.1 DFD Level 1

5. ALGORITHM USED

The Convolutional Neural Network (CNN) Algorithm is used in Kumbh-PATH-AI for real-time crowd analysis and missing person detection from CCTV or webcam feeds. The algorithm works by first converting input video frames into a series of images, which are then passed through multiple convolutional layers to automatically extract spatial features such as edges, textures, and shapes. Each convolutional layer is followed by pooling layers that reduce dimensionality while preserving essential information. The extracted feature maps are then flattened and fed into fully connected layers, which perform classification tasks, such as identifying individuals or estimating crowd density. The CNN model is trained on annotated datasets of faces and crowd scenarios to learn patterns and variations in real-world conditions. Finally, the trained model outputs predictions, including bounding boxes for detected persons and crowd density levels, which are used to generate real-time alerts and assist authorities in monitoring and safety management during large gatherings.
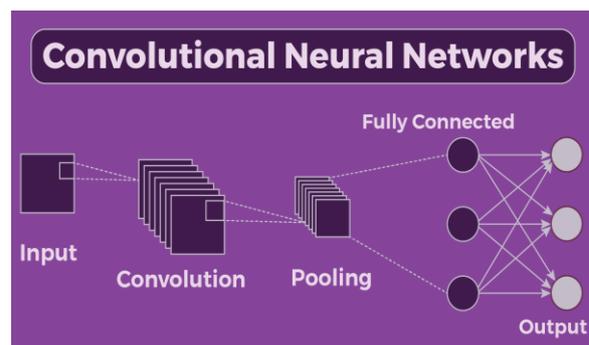
6. RESULT AND ANALYSIS

The **KumbhRakshak System** was successfully developed and tested for managing crowd safety during large gatherings like the Kumbh Mela. The system effectively monitored crowd density, detected individuals using AI-based facial recognition,

generated real-time alerts, and helped authorities respond quickly to emergencies. Features like the Admin Module, View Logs, User Detection by Branch, and View Location & Density worked efficiently, improving coordination, reducing congestion, and enhancing overall public safety.

Fig.6.1. Welcome page

The Welcome Page of the KumbhRakshak system provides options such as Admin Login, Police Help Center Login, and User Login. It allows administrators to manage and monitor the system, police staff to handle missing person case and crowd alerts, and pilgrims to access navigation, crowd updates, and important event information.
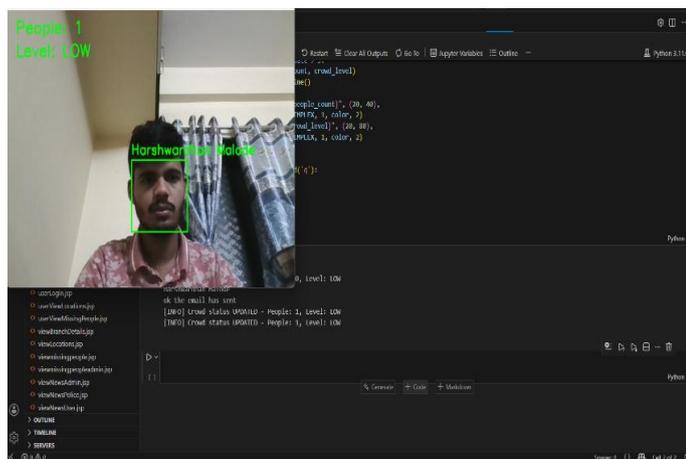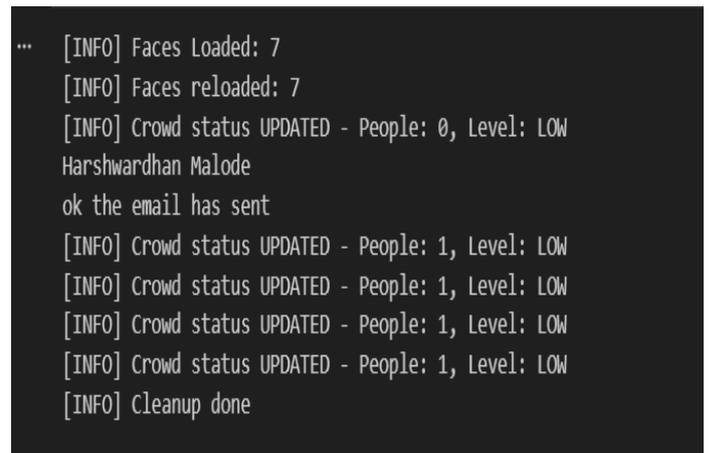

Fig.6.2. Person Detected

Fig.6.3. User Detection by Branch

The User Detection by Branch feature allows police help center staff to identify and verify individuals detected through the AI-based surveillance system. When a person is captured via camera feeds, the system uses facial recognition technology to compare the image with stored missing person records. If a match is found, the relevant branch is immediately notified with details such as location, time, and identification status.Branch officers can then take quick action, contact concerned authorities or family members, and facilitate faster resolution of missing person cases. Additionally, the system provides real-time crowd status updates, enabling officers to monitor crowd density and movement at different locations. This helps in proactive crowd management, preventing overcrowding or potential hazards. By combining person detection and crowd monitoring, the feature ensures both public safety and rapid response to emergencies.

Fig.6.4. Graph showing people found vs location

The above graph represents the number of missing people found at major locations during the Nashik Kumbh Mela. The highest number of missing individuals was reported at Ramkund (Godavari Ghat), followed by Trimbakeshwar Temple Area and Nashik Road Railway Station, indicating that areas with heavy footfall and religious importance experience higher crowd-related challenges. Comparatively lower cases were observed at Sadhugram and CBS Bus Stand, suggesting relatively better crowd distribution or lower density in those zones. The data highlights the importance of real-time monitoring and AI-based crowd management systems to quickly detect and respond to missing person cases in high-density areas.
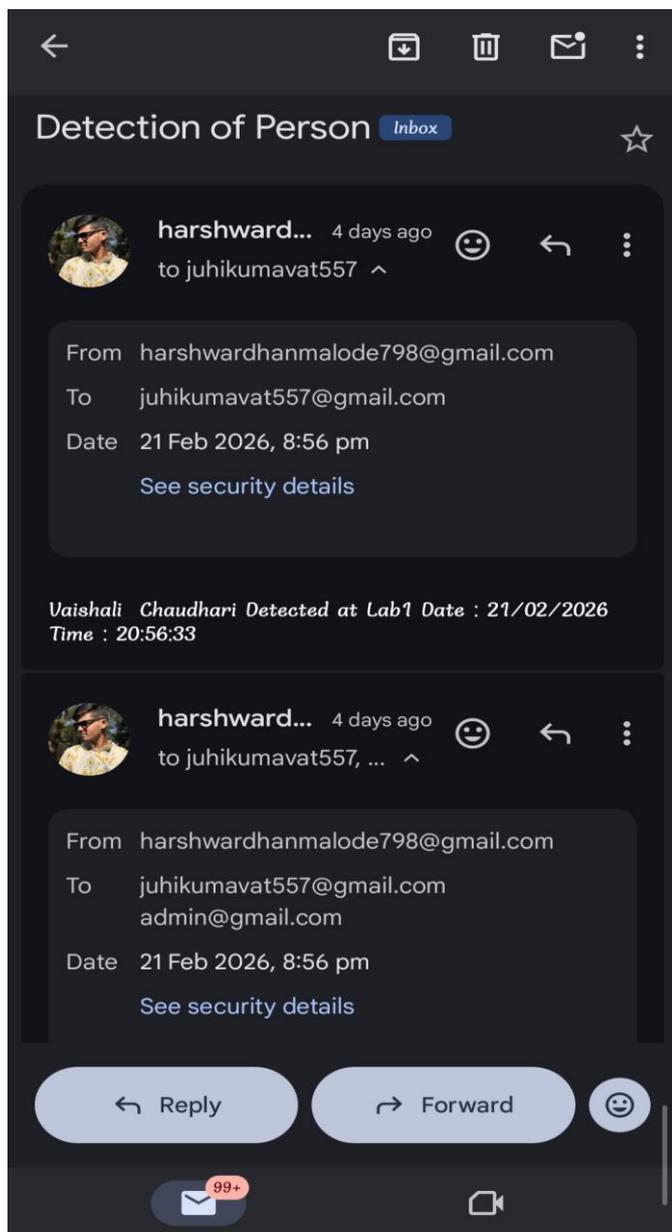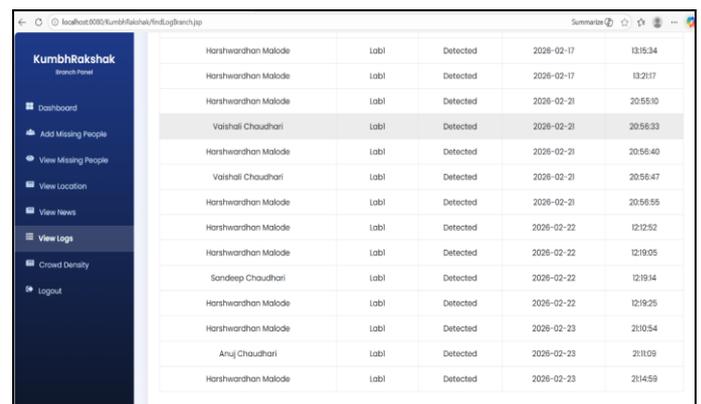

Fig.6.5. Email of User found

The **User Found – Email Received** feature notifies registered users or family members immediately when a missing person is successfully identified by the system. Once facial recognition confirms a match, an automated email is sent containing details such as the person's name, detected location, date and time of detection, and the concerned help center information. This instant communication reduces panic, improves coordination, and ensures faster reunification. The feature enhances transparency, builds trust in the system, and significantly improves response efficiency during large-scale events like the Kumbh Mela.

Fig.6.6. Branch View Logs

The View Branch Logs feature allows branch officials to access detailed records of all activities performed within their respective help center. It includes logs of missing person registrations, found cases, Person Finder detections, and crowd density alerts. Each log entry contains relevant details such as date, time, location, and action taken, ensuring proper documentation and traceability. This feature helps in reviewing past operations, analyzing response effectiveness, and maintaining

7. FUTURE SCOPE

1] **Advanced AI and Deep Learning Integration:**
Future versions can incorporate more advanced deep learning models to improve crowd density estimation and facial recognition accuracy. These models can perform better in highly congested areas, poor lighting conditions, and low-visibility environments such as night-time events.

2] **Real-Time Mobile Alert System:**
The system can be enhanced with instant mobile notifications for pilgrims. Users can receive alerts about overcrowded areas, emergency situations, safe routes, and important announcements directly on their smartphones.

3] **GPS-Based Smart Navigation:**
Integration of GPS technology can provide live navigation support, suggesting safer and less crowded

routes to pilgrims. This can help in better crowd distribution and prevent congestion in specific areas.

4] Predictive Crowd Behavior Analysis:
Using AI-based predictive modeling, the system can forecast crowd build-up before it becomes critical. Authorities can then take preventive actions such as route diversion or controlled entry.

8. CONCLUSION

The KumbhRakshak project is an intelligent, technology-driven solution for managing safety and crowd control during large gatherings like the Kumbh Mela. It integrates AI, computer vision, and real-time surveillance to monitor crowd movement, identify congestion, and generate early alerts, reducing the risk of stampedes. The face recognition module helps quickly locate missing persons, improving response and recovery rates. The system ensures smooth coordination among Admins, Police Help Centers, and Pilgrims, providing location management, crowd monitoring, alerts, navigation guidance, and safety updates. Secure data storage, role-based access, and structured reports allow authorities to analyze crowd patterns and improve planning. Overall, KumbhRakshak demonstrates how AI-driven monitoring can enhance public safety, operational efficiency, and emergency response. Its scalable design makes it suitable for other large events, smart city projects, and public gatherings.

9. REFERENCES

1] M. Alsubhy, A. A. A. Sen, B. A. Alahmadi, N. M. Bahbouh, and H. A. A. Sen, ``A model for tracking people and property in crowds,'' in Proc. 7th Int. Conf. Comput. Sustain. Global Develop. (INDIACom), Mar. 2020, pp. 244_248.
https://www.researchgate.net/publication/341152820_A_Model_for_Tracking_People_and_Property_in_Crowds

2] Sharley Kulkarni and S. K. Shah, "Monitoring and Safety of Pilgrims Using Stampede Detection and Pilgrim Tracking", IJAREEIE, vol. 4, no. 7, pp. 6642-6648, July 2015.
http://www.ijareeie.com/upload/2015/july/106_Monitoring.pdf

3] K. Sreenivasa Ravi, Mohammed Abdul Aziz and B. Venkataramana, "Pilgrims Tracking and identification Using RFID Technology", Advances in Electrical Engineering Systems (AEES) World Science Publisher United States 96, vol. 1, no. 2, 2012, ISSN 2167-633X.
https://www.researchgate.net/publication/287596037_PILGRIM_IDENTIFICATION_SYSTEM_BASED_ON_RFID