



Specifying the Effective Use of Artificial Intelligence for Crowd Management in Prayag Maha Kumbh Mela

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Abstract

The management of significant events, such as the Maha Kumbh Mela, and the growing complexity of public security provide substantial obstacles for real-time crowd AI surveillance and security detection by better utilization of Information and Communication Technology. The incapacity of traditional surveillance systems to manage and assess the vast volumes of real-time data generated in spiritual environments usually limits their capacity to prevent or reduce security events. To get over these limitations, this study recommends developing an AI-powered crowd monitoring system that can swiftly examine AI powered video feeds and provide real-time alerts. The system can identify potential dangers, identify unusual crowd behaviors, and provide situational awareness in real time by using advanced artificial intelligence, machine learning, and computer algorithm programs.

Through faster and more accurate threat identification, improved crowd control, and proactive response to potential security risks, an AI-powered technology enhances public safety with best planning, organizing, controlling and directing in this concerned. The system's agility and accessibility make it a great tool for huge events and people's safety, resulting in a safer atmosphere for all devotees. Maintaining devotee security at major events like the Maha Kumbh Mela has become much more difficult due to the expanding number of devotees and the heightened potential for disruption. To overcome the limitations of traditional methods and enhance the ability to monitor, assess, and respond to crowd management in real-time by considering both functional and non-functional criteria, artificial intelligence (AI) is being used extensively in the current Maha Kumbh Mela. To get over these limitations in the current Maha Kumbh, a strong AI-powered crowd

surveillance system that can offer proactive threat alerts, anomaly identification, and real-time monitoring is needed.

Keywords: AI Camera; AI drone; AI Technology; Crowd Management; Real-time analysis; Maha Kumbh Mela; Pilgrims security; ICT.

I. Introduction

Special challenges arise during large events like the Kumbh Mela in terms of crowd control and public safety. Since millions of people often attend major events, meticulous preparation and constant attention to detail are required to prevent potentially dangerous situations. The enormous volumes of data generated in real time by surveillance equipment are beyond the scope of standard crowd control and monitoring tactics, notwithstanding their potential for some degree of effectiveness. Therefore, government must ensure the safety of the devotees, using advanced AI technology with management dynamics principles of planning, organizing, controlling, budgeting and directing through Information and Communication Technology. The authors have been mentioned a scientific literature survey regarding use of Artificial Intelligence for Crowd Management in Kumbh Mela in this concerned. In such international spiritual events of Kumbh Mela of India, pilgrims' security is the need of hour in the modern era.

Liu, Z., et al. Water, (2022)., In this regard “Weighted Multi-Function Effectiveness and Site Suitability in GI Layout Decision-Making Framework: A Case Study in Beijing Sub-Center” has been discussed. It is sometimes difficult for these traditional systems to detect and respond timely to critical events such as traffic jams, security breaches, or potential stampedes. It becomes imperative in this scenario to implement an advanced AI-powered surveillance system. Authorities can significantly improve real-time hazard detection, crowd monitoring, and behavioral pattern analysis by integrating AI and machine learning technologies with their existing infrastructure.

M. Hoseinpourfard et al. (2017)., In this regard “Hajj trauma centers can learn from the rise of Hajj stampedes” has been discussed. Therefore, by simultaneously analyzing video streams from many AI cameras, this AI-powered system can detect odd crowd movements or behaviors and immediately notify users if any risks are detected. The strategy has numerous advantages for events like the Kumbh Mela, where the sheer number of people could lead to dangerous situations.

Weppner, J., et al. (2014)., “Participatory Bluetooth scans serving as urban crowd probes” in the IEEE Sensors Journal have been discussed. It can detect early signs of congestion, allowing security personnel to act before the situation becomes unmanageable. The AI systems may also identify suspicious behavior by individuals or trends that could indicate a potential stampede, which could be problematic for security. Along with enhancing public safety, this also ensures a more orderly flow of people and lessens disruptions. In addition to its safety applications, this AI technology can improve the whole experience of event attendees. By analyzing crowd movements, it can help organizers better manage the distribution of participants and avoid crowding in any one place.

Singh, U., et al., (2021)., “Crowd monitoring: State-of-the-art and future directions. IETE Technical Review” has been discussed. Bottlenecks can be avoided and emergency response teams, who could otherwise be overworked in catastrophic situations, can feel less pressured by adopting this preventive approach. Ultimately, the application of AI-driven crowd monitoring systems at events such as the Maha Kumbh Mela places intelligent crowd management at the forefront of public safety campaigns. Modern technology makes it feasible to create more secure environments during high-density events, ensuring everyone's safety and well-being while allowing authorities to respond swiftly and effectively to any emerging threats.

Manish Kumar, Ajay Zad, S Ajitha, Jagannatha S, and Prakash B R, (2023)., "Virtual Mouse Using Face Gesture and NLP", The IEEE North Karnataka Subsection Flagship (NKCon) is an international conference. To perform mouse operations on a computer system without a real mouse, this paper presents a method that makes use of voice instructions and facial motions.

Kumar Ravindra, and Kumar Pavnesh(2024)., “Brics FDI Policies: An Empirical Analysis of Foreign Direct Investment of India with Brics Economies in Covid-19.”, According to the authors, BRICS must do investment for better crowd management in Kumbh Mela of India for fruitful result in the welfare and security of pilgrims in this concerned. Regulations must be strengthened, and public support must be increased to overcome additional regulatory challenges within the framework of the BRICS nations' agreement on investment protection and promotion. In another dimension of Investment, BRICS must be able to enter into a trade agreement and obtain funding from the federal budget, which has deposited 39 trillion Rubles for these purposes (Tinbergen, 1962), if they satisfy the requirements for the ratio of cumulative FDI investments in fixed assets until the year 2024 of per Ruble of state support. With the implementation of 1st April-2020, of Federal Law No. 69, "On Protection and Encouragement of Investment in the Russian Federation," the economy of the nation was given a legal framework for fostering improved investment conditions and expediting public-private FDI collaboration (UNCTAD, 2018). Therefore, BRICS Investment in crowd management is also needed in Kumbh Mela of India by using Artificial Intelligence and space satellite with the help of BRICS government for security of pilgrims in this concern.

Chen et al.,(2021)., in this regard “Risk assessment and early warning for large group activities using the random forest algorithm for Pattern Recognition Letters” has been discussed. An internal microphone is used to receive verbal commands, while an internal webcam is used to identify face gestures. Natural language processing (NLP) and facial gestures are used to give the virtual mouse the ability to accomplish simple tasks like "click," "right-click," "double-click," "scroll-up," "scroll-down," "minimize," and "close." By utilizing your facial movements to control the movement of the pointer on the screen, you can navigate in various directions. "Machine Learning-Based Automatic Help System for Efficient Crowd Control Management (2020) ". The author have presented an autonomous assistance system in this study that manages crowds efficiently by utilizing machine learning techniques. The proposed method makes real-time predictions about potential issues and evaluates crowd dynamics using machine learning approaches.

Deng, L., et al. (2023)., in this regard “Hospital crowding assessment and in-hospital resource distribution using image recognition technology, by Scientific Reports” has been discussed. The system combines data from several sources, including video surveillance and sensor inputs, to identify and manage crowd trends, identify unusual behavior, and provide valuable insights to enhance safety and control during significant

events. The paper provides detailed information on the system's architecture, the machine learning models used, and its effectiveness in real-world scenarios.

Lokesh Boominathan, R. Babu and Srinivas Kruthiventi (2016)., " Crowd Net : Artificial Intelligence-Powered Crowd Density Categorization Modeling for Intelligent Communities." This study investigates an artificial intelligence-based crowd density classification technique with the goal of improving smart community management. With the use of data from several sensors and video feeds, the suggested model uses AI algorithms to analyze and categorize crowd density levels in real-time. This method makes it easier to control and respond to urban situations by precisely calculating crowd density. The paper discusses the AI model's design, implementation, and efficacy in several smart community scenarios.

In another study entitled "**An automated assistance system based on machine learning for effective crowd control Management (2015)**", a detailed Investigation has been described. A thorough analysis of an automated help system based on machine learning that is intended to effectively manage crowds is presented in this research. Technology uses cutting-edge machines learning algorithms to successfully manage big gatherings by analyzing crowd behavior. Through the integration of real-time data from sensors and surveillance cameras, the system can anticipate and prevent possible crowd-related problems including crowding and safety violations. An in-depth examination of the system's design, the machine learning techniques used, and its useful applications in diverse crowd management scenarios are provided in this present study.

II. Research Methodology

This research article makes use of secondary data. Determining the problem and its scope is the first step in implementing an AI-powered crowd surveillance management system for large events like the Maha Kumbh Mela. The major objective is to enhance crowd control and public safety by employing artificial intelligence to detect traffic, potential stampedes, and security risks in real time. This system has been concentrated on high-risk locations, such as gathering spots, entry and departure points, and crowded areas like riverbanks, Sangam nose and temples. Next are data collection and infrastructure setup. A system of HD surveillance AI cameras has been set up at strategic points throughout the event.

The AI system will do real-time data analysis using the continuous video inputs from these AI cameras and AI drones. Sensors such as motion and heat detectors have been placed at various points in addition to camera feeds to better monitor crowd density and movement patterns scientifically. The AI algorithms are taught to analyze sensor data and video feeds once the infrastructure for data collection has been set up. Crowd behavior trends, strange motions, and potential threats are all detected by machine learning algorithms. As the event progresses, the accuracy of these AI powered drones, security data models increases because they are constantly improved using real-time data. Additionally, the system is designed to alert security personnel to risks instantaneously, allowing them to take preventative action and effectively manage the crowd of devotees. This proactive strategy ensures that crowd flow and public safety are maintained at their optimal levels during the event.

III. Objective of the Study

- To combine big data analytics and artificial intelligence (AI) for effective management and predictive analysis of surveillance data
- To improve public safety by giving security guards real-time alerts for crowd management during Prayag Maha Kumbh Mela

IV. Statement of the Problems

Events that attract millions of devotees, like the Kumbh Mela, government provides significant crowd control and public safety challenges. It can be difficult to recognize and respond promptly to significant events since traditional crowd control and monitoring methods are usually unable to handle the enormous scale such as crowds, crushes, or security lapses. The inability to monitor crowd behavior in real time and foresee potential threats could lead to dangerous situations that put devotees' lives at jeopardy and put too much strain on security personnel. The main problem is the lack of an intelligent, real-time system that can simultaneously evaluate vast amounts of data from several sensors and security cameras, spot odd crowd patterns, and alert authorities before things get out of control.

There is a greater chance of accidents and poor crowd control because traditional technologies cannot provide timely insights and preventative measures. Adding to the complexity is the unpredictable nature of crowd behavior. Although planners can predict specific traffic patterns based on event schedules and attractions, panic attacks, bottlenecks, and unexpected surges can occur at any time. Due to the limited predictive power of manual surveillance techniques, preventive measures may be too late by the time a harmful scenario is detected. This calls for automated, intelligent AI technologies solutions. Traditional surveillance systems often rely heavily on human oversight, which can be slow and prone to errors in emergency situations. Conventional systems are reactive rather than proactive because they are unable to forecast crowd behavior or issue early warnings. As a result, the current public safety and crowd management methods are inadequate for managing major events like the Kumbh Mela, which is the root of the problem for devotees' security, severely compromising security, safety, and the entire event experience. To ensure public safety, optimize crowd flow, and enhance security staff's capacity to react swiftly and efficiently in preventing and managing emergencies, a more advanced, real-time, AI-powered solution have been required.

V. Management Dynamics of the Real Time Quick Response

The government have been implemented Artificial Intelligence Technology system to determine crowd density in real time using AI sensor data and video feeds by the help of AI satellite provided by the Indian Space Research Organization (ISRO) for better planning, organizing, directing and controlling during the entire event. To monitor flow and density, it is essential to count people in the crowd precisely and follow their movements. Let us see in the figure-1, crowd management strategies are described below.

Figure-1: Crowd management strategies

Crowd Management Strategies



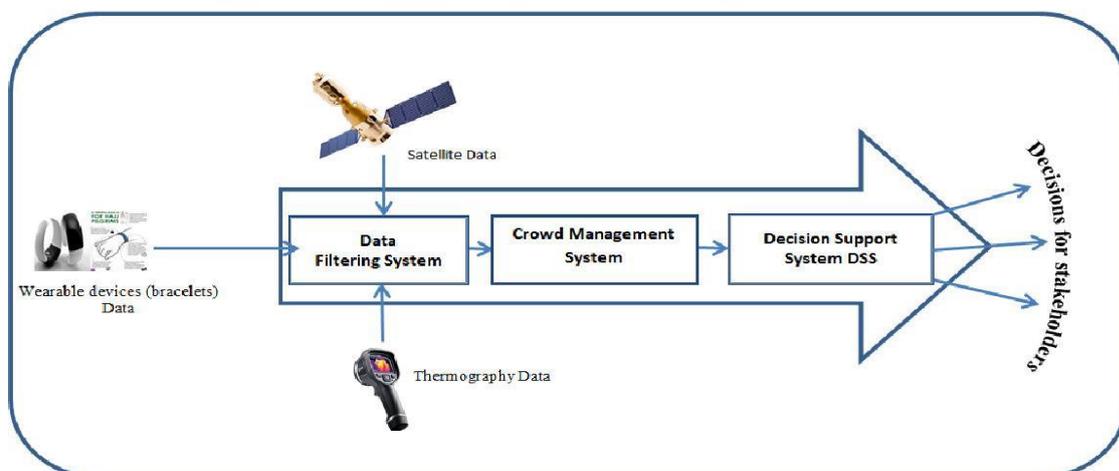
Data Source: <https://fastercapital.com/topics/crowd-management-strategies-for-busy-areas.html>

How to make Kumbh Mela event safe and secure with crowd management techniques and spiritual event security. In this regard, when the system notices unusual activity or overcrowding, it needs to immediately send out alerts. Integration of Facial Recognition: For security purposes, if required, turn on facial recognition AI software to identify individuals. Analysis of Behavioral Patterns: Analyze and predict potentially hazardous behaviors, such as an abrupt increase in people that could indicate a stampede. A dashboard that allows security personnel to monitor crowd measurements and notifications in real time should be made available to them. Incident logging is keeping a record of events and incidents for analysis and decision-making in the future. Crowd Flow Management: Assists in crowd distribution by offering the most efficient routes or points of entry and departure. To provide timely answers, such as directing paramedics in an emergency, connect to emergency systems. Several AI cameras feed Processing: To effectively cover large regions, manage data simultaneously from several camera sources and AI drones' data.

VI. Response by Professional Management Team

Scalability: The system ought to have the capacity to handle more AI video feeds and bigger data sets as an event's magnitude rises. Let us see in the **figure-2**, crowd management challenges in real time data have been discussed below. As stated by **A. M. Al-Shaery et. al. (2020)** in the "In-Depth Survey to Detect, Monitor and Manage Crowd," have been discussed in figure-2.

Figure-2: Crowd Management Challenges in real time data measurement



DataSource:

https://www.google.com/search?q=crowd+management+model&oq=crowd+management+model&aqs=cchrome.#vhid=eiMTxS6ffG06FM&vssid=_vj-rZ6v3NumWjuMPmr2s4AU_40

Therefore, the government must have implements all types of effort of the challenges as indicated in the figure -2, and figure-1, discussed in this concerned. **Reliability:** Make sure the system runs continuously and has a high up time to avoid failures during critical time. **Management Performance:** Real-time data processing and minimal latency enable quick resolution of crowd problems. **Dynamic Security:** Restrict access and encrypt data to prevent unauthorized access to private surveillance data. **Usability:** The AI system is so user-friendly that non-technical staff should have no trouble utilizing it.

Conclusion

In conclusion, the government have to better use of Information and communication technology resources by the help of administration with better planning, organizing, directing, budgeting and controlling the installation of a surveillance system driven by AI for large events like the Prayag Kumbh Mela represents a significant advancement in crowd management system and public safety as author has discussed in the **figure-1, and figure -2**, in this concerned. This system aims to address both functional and non-functional criteria to increase the ability to track, assess, and respond to crowd dynamics in real-time, thereby overcoming the limitations of traditional methodologies. Real-time data collecting, statistical analysis and quick alarm production are all features of the AI technology system that provide timely response and effective risk management. Its design, which prioritizes scalability, stability, performance, security, usability, reliability, interoperability, data privacy, and cost-effectiveness, makes it a powerful choice for managing the complexity of big spiritual events. The use of this cutting-edge AI technology will ultimately improve the safety and security of devotees while also improving the event's efficiency and planning, which will pave the way for future developments in crowd control and management.

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