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## A Smart Barcode Identifier & Recovery System for Lost Individuals in Mass Gatherings

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| Peer Review Information                                                                                                                                                                                                                                                                                                                              | Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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| <p><i>Submission: 08 Dec 2025</i></p> <p><i>Revision: 25 Dec 2025</i></p> <p><i>Acceptance: 10 Jan 2026</i></p> <p><b>Keywords</b></p> <p><i>Biometric Identification, Face Recognition, Artificial Intelligence, Machine Learning, Computer Vision, Smart Barcode, QR Code, Crowd Management, Emergency Recovery, Real-Time Identification.</i></p> | <p>Mass public events such as pilgrimages, festivals, and large community gatherings frequently lead to individuals—especially children and elderly people—becoming separated from their families. Conventional recovery methods are often slow, inefficient, and emotionally distressing. To overcome these challenges, this paper proposes an <b>AI-driven Smart Barcode-Based Identification and Recovery System</b> that integrates machine learning, computer vision, and facial recognition for real-time and automated identification. Each participant is provided with a barcode or QR code-embedded wristband linked to a secure digital profile containing personal details, emergency contacts, and medical information. Authorized personnel can scan the codes using a mobile application enhanced with AI-based identity verification and deep learning techniques. Machine learning pipelines improve identification accuracy through pattern recognition, anomaly detection, and predictive matching, thereby minimizing human error. The proposed intelligent recovery framework ensures fast, secure, and scalable operations by integrating cloud computing, data analytics, and automated decision-making. Predictive AI models and automated alert mechanisms significantly enhance response time, improve crowd management, strengthen emergency coordination, and provide a reliable, data-driven safety infrastructure for mass public events.</p> |

### Introduction

Mass gatherings such as religious pilgrimages, cultural festivals, and community events bring together thousands to millions of individuals at a single location. While these events promote social interaction, cultural identity, and community engagement, they also introduce significant challenges related to crowd management, public safety, and emergency response coordination. One of the most critical issues during such events is the separation of individuals from their families or groups—

particularly children, senior citizens, and persons with disabilities. Delays in locating, verifying, and identifying lost individuals often result in emotional trauma, increased safety risks, and, in extreme cases, fatalities.

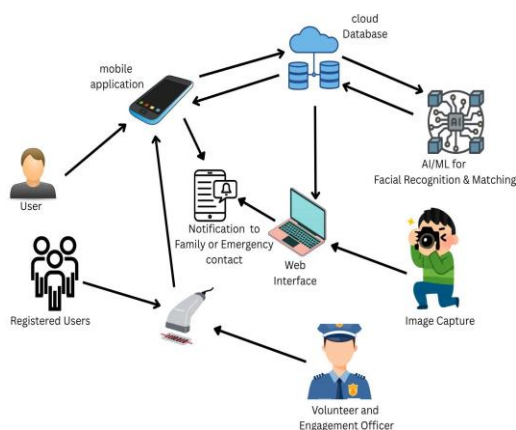
Traditional recovery methods, including manual announcements, temporary shelters, and physical identity verification, are often slow, error-prone, and inefficient, especially in high-density environments. As the scale and frequency of mass gatherings continue to increase, these conventional approaches become increasingly

inadequate, highlighting the need for intelligent, automated, and scalable solutions.

To address these challenges, this research proposes an **AI-driven Smart Barcode-Based Identification and Recovery System** that integrates artificial intelligence (AI), machine learning (ML), and computer vision technologies to enable faster and more accurate identification of individuals. Each participant is issued a unique barcode or QR code-enabled wristband linked to a secure, cloud-based digital profile containing essential personal details, emergency contacts, and medical information. When a lost individual is located, authorized personnel can scan the wristband using an AI-powered mobile application to instantly retrieve the registered details and notify family members or guardians. Furthermore, the integration of AI-based facial recognition, deep learning image matching, and predictive analytics significantly enhances identification accuracy and automates the verification process. This intelligent, data-driven approach improves operational efficiency, strengthens real-time decision-making, enhances safety measures, and reduces the workload on event organizers and law enforcement agencies—ensuring a faster, safer, and more organized response during mass public events.

### Methodology

The proposed system follows a structured workflow to ensure accurate identification and rapid recovery of lost individuals during mass gatherings.



*Fig 1: Flow diagram of the AI-driven Smart Barcode-Based Identification and Recovery System.*

### User Registration

Each participant registers through a mobile application by providing personal information such as name, age, address, emergency contact details, and relevant medical information. During registration, a unique barcode or QR code is

generated and securely linked to the participant's digital profile.

### Cloud Database Storage

All collected data are securely stored in a centralized cloud database. This enables real-time access, scalability, and efficient data retrieval during large-scale events.

### AI/ML Processing

AI and machine learning algorithms process and validate the stored data to eliminate duplicate registrations, verify identities, and optimize the system for fast search and matching operations.

### Barcode Scanning by Volunteers and Officers

Authorized volunteers and event officers use the mobile application to scan the barcode or QR code embedded on the wristband of a lost individual. The scan provides immediate access to the registered profile.

### Image Capture and Identification

If required, volunteers or officers capture an image of the lost individual using the mobile or web interface. The system then applies AI-based facial recognition and deep learning image-matching techniques to identify the individual by comparing the image with the stored database.

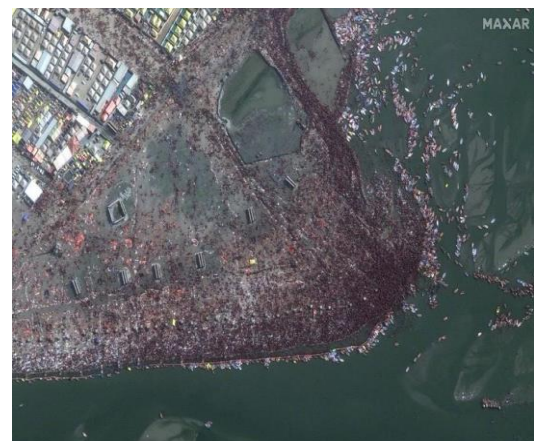
### Notification System

Once identification is confirmed, automated notifications are sent to the individual's family members or emergency contacts. The notification includes details regarding the person's current location and condition.

### Recovery and Assistance

After successful identification, the individual is safely reunited with their family or guardians. This structured process significantly reduces response time, improves accuracy, and ensures safer recovery during large-scale events.

### Case Data and Illustrations



*Fig 2: Maha Kumbh Mela*

During the 2025 Maha Kumbh Mela, more than

20,000 individuals who were separated from their families were successfully reunited through digital lost-and-found centers. These centers employed AI-based facial recognition, machine learning techniques, and multilingual support systems. Notably, 8,725 devotees were reunited with their families during the major bathing event on Mauni Amavasya, demonstrating the effectiveness of technology-driven recovery systems.

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### Deadly stampede at religious event

More than 100 people have been killed and many others injured during a stampede at a Hindu gathering in Hathras district of northern India's Uttar Pradesh state, about 200km (125 miles) southeast of New Delhi.



Fig 3: Hathras Religious Gathering

At the Hathras religious gathering, extreme crowd density resulted in widespread separation of individuals from their families, particularly women, children, and socially vulnerable groups. Many missing individuals were later reunited through coordinated efforts involving hospitals, police camps, and volunteer teams. Identification and tracking were challenging due to overcrowding in makeshift tents, limited exit routes, muddy conditions caused by rain, and inadequate on-site medical and disaster management resources. These challenges highlight the urgent need for automated, AI-based identification and recovery mechanisms.

### Conclusion

The proposed **AI-driven Smart Barcode-Based Identification and Recovery System** offers an efficient and reliable solution for locating and reuniting lost individuals during mass gatherings such as pilgrimages, festivals, and community events. By combining barcode or QR code wristbands with cloud storage and AI-based facial recognition, the system enables rapid and accurate identification while significantly reducing response time and emotional distress

for affected families. Real-time notifications and mobile application support enhance coordination between authorities and guardians, thereby improving public safety and crowd management. Future enhancements, including real-time tracking, multilingual support, and Internet of Things (IoT) integration, can further strengthen the system and contribute to safer and more organized mass public events.

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