

Introduction

Large venues such as stadiums and concert halls concentrate thousands of people in a confined area, which makes them prone to medical emergencies, crowd incidents, and deliberate security threats. Existing systems combine surveillance cameras, access control, and intrusion detection, yet identifying a specific individual in real time remains the bottleneck: matching a captured face against a database of hundreds of thousands of records is computationally expensive and may take minutes. A monitoring architecture is therefore needed that couples facial recognition with a search fast enough for agents to intervene while the incident is still unfolding.

Objectives

The objective of this invention is to identify, in real time, an attendee involved in an abnormal or sensitive action inside a venue. The system minimizes identification latency through a progressive neighbor-based search, scales to venues with tens of thousands of seats, and delivers the identity and the location of the flagged attendee to security assets.

Methods

Each attendee is registered before entering the venue through a self-service kiosk or remotely. Personal details and the assigned seat are recorded, a facial image is captured, and an alignment method extracts the facial landmarks that are converted into a facial embedding using models such as ArcFace or FaceNet. Embeddings, seat identifiers, and precomputed neighbor relationships are stored in an encrypted centralized database. During the event, a surveillance module analyses the camera feeds, flags abnormal behavior, and passes the captured embedding to the matching module (Fig. 1).

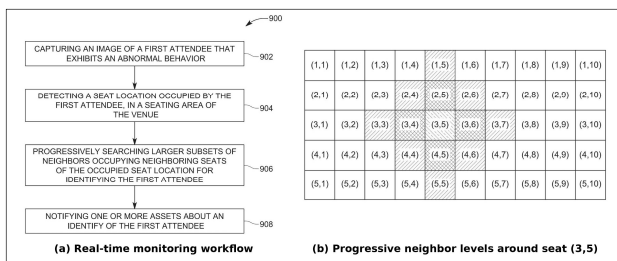


Figure 1 shows (a) the main steps of the real-time monitoring method and (b) the seat chart of a venue section, in which the shaded seats form the progressive levels of neighbors searched around the flagged seat (3,5).

Results and Discussion

The system comprises five cooperating modules: registration, surveillance, matching, live tracking, and notification. When abnormal behavior is detected at a seat, the matching module first compares the captured embedding with the one registered for that seat. If they disagree, which happens whenever attendees have moved, a progressive neighbor-based search replaces the brute-force scan of the database.

The search expands in levels: level 1 covers the four adjacent seats, level 2 their direct neighbors, and so on, driven by a queue of candidate seats and a marked list that prevents repeated checks. FAISS or HNSW compare embeddings within each level, so a match is usually found early and the response time drops sharply.

Conclusion

This invention delivers a practical route to real-time identification in crowded venues by linking seat-aware registration with a progressive neighbor-based search. Restricting each stage of the search to a small, spatially motivated subset of the stored embeddings avoids the latency of exhaustive database matching while preserving accuracy, and the approach scales from arenas to large stadiums. The resulting identity and location data reach security and medical teams quickly enough to support a timely intervention.

References

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Acknowledgements

The inventors acknowledge the support of the University of Jeddah and the Deanship of Research and Innovation for their continuous support of innovation, research, and intellectual property development.