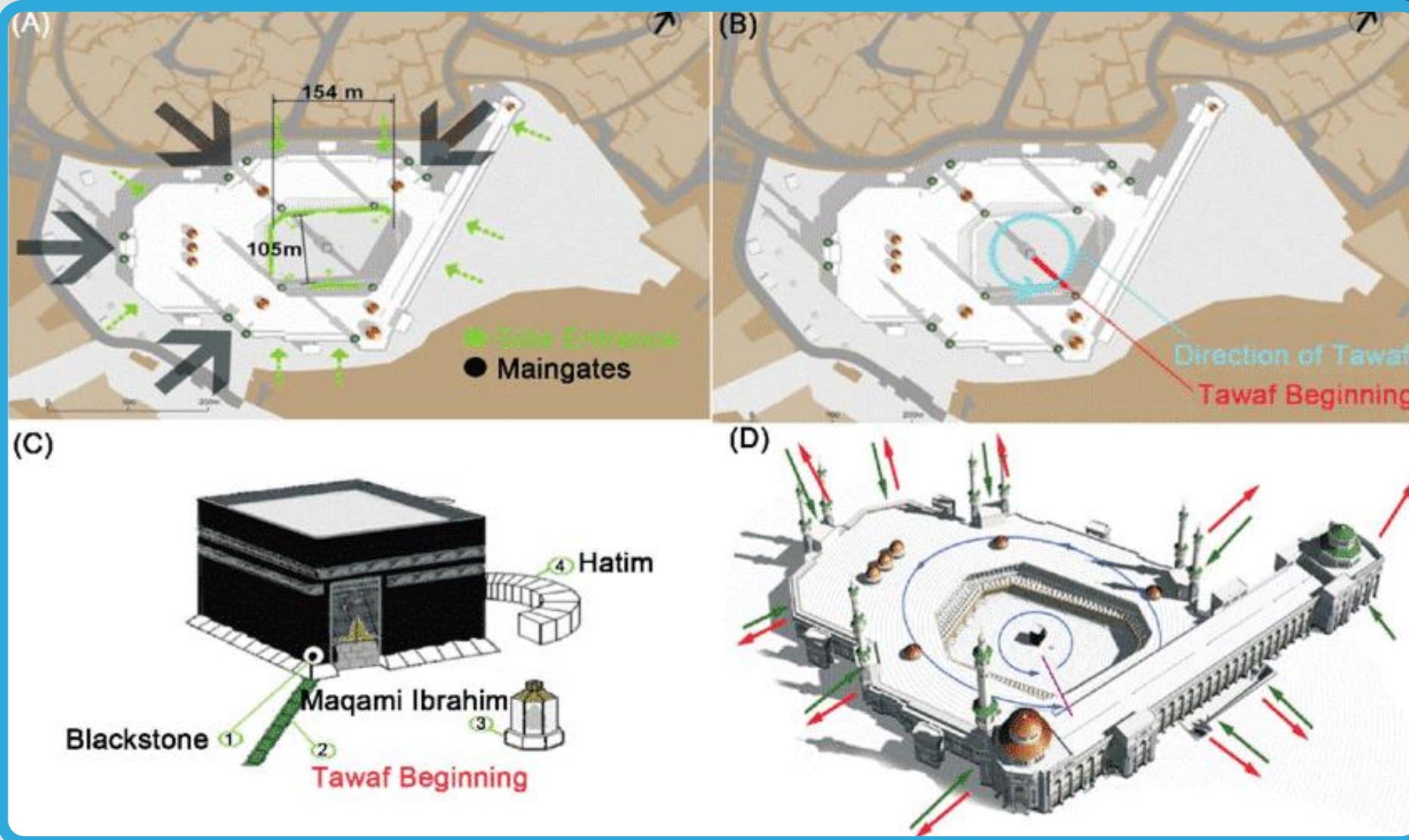




CROWD CRISIS MANAGEMENT IN HAJJ USING ARTIFICIAL INTELLIGENCE

Abdullah Alburithen & Amjad Alharbi

Master's Students of Science in Artificial Intelligence

Supervision by

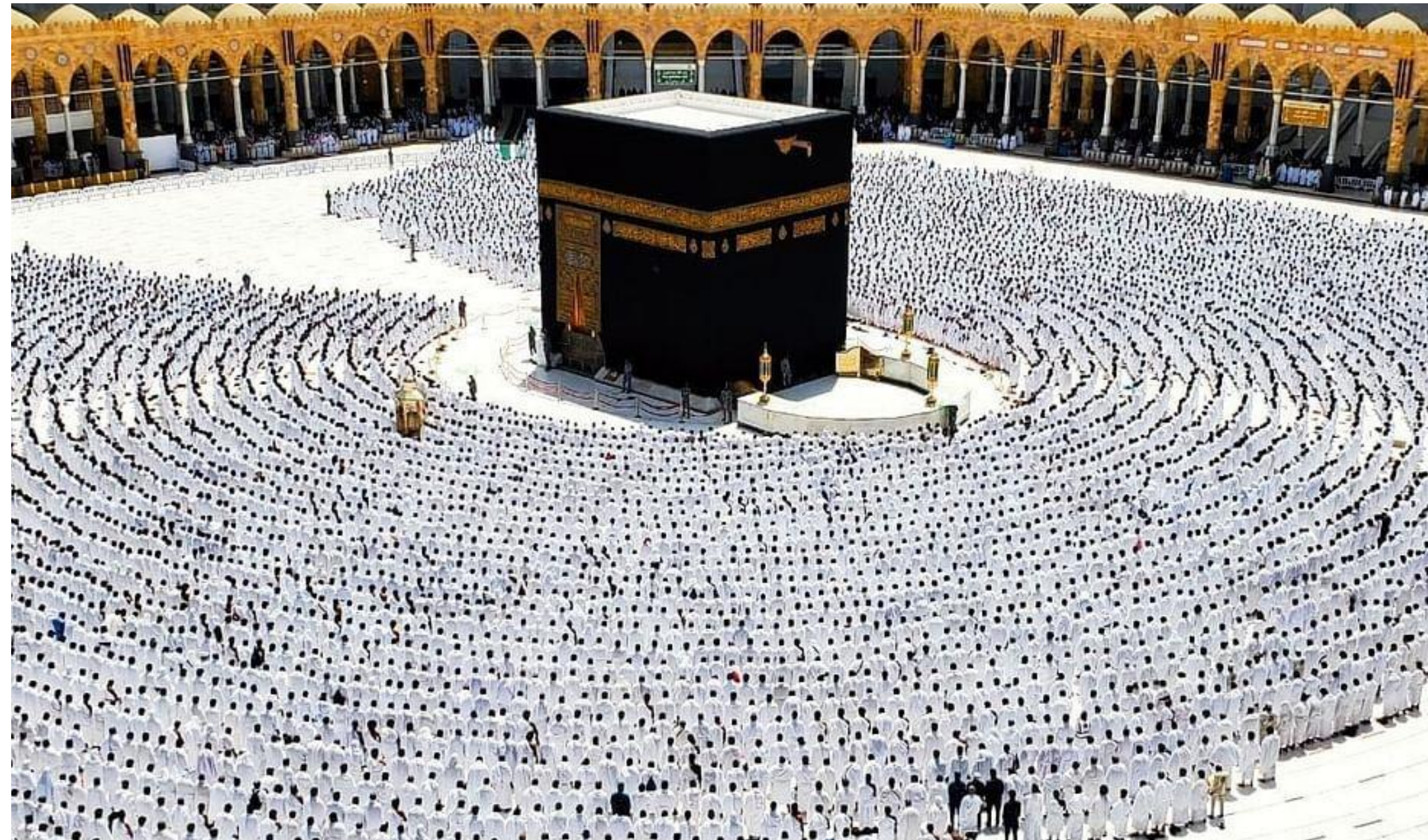
**Prof. Dr. Yasser
Abdelhamid**

- 03. Introduction
- 04. Problem
- 05. Research Objective
- 06. Related Work
- 07. Research Plan
- 08. Implementation
- 09. Discussion of Results
- 10. CONCLUSION

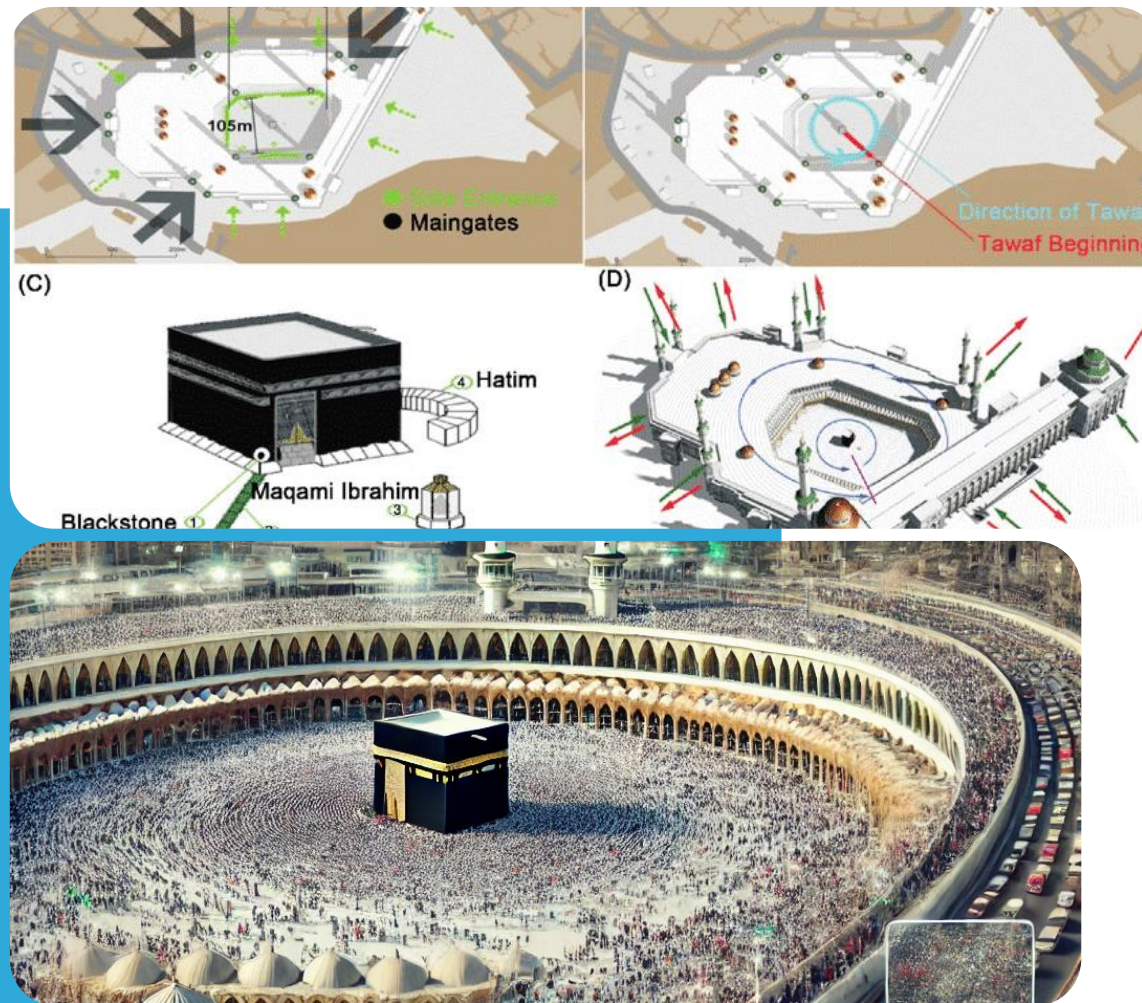


Research Area

- Artificial Intelligence
- Crowd Management
- Safety and Security



INTRODUCTION



- **Hajj** is one of the largest annual gatherings worldwide, with millions of pilgrims performing rituals in confined spaces.
- Managing such large crowds poses challenges, including overcrowding, congestion, and medical emergencies.
- Traditional methods, such as human monitoring, are insufficient for real-time decision-making.
- Artificial Intelligence (AI) offers innovative solutions for monitoring and managing high-density crowds.
- This research integrates AI techniques to improve crowd flow, predict emergencies, and enhance safety during Hajj.

PROBLEM DEFINITION

01 High Crowd Density

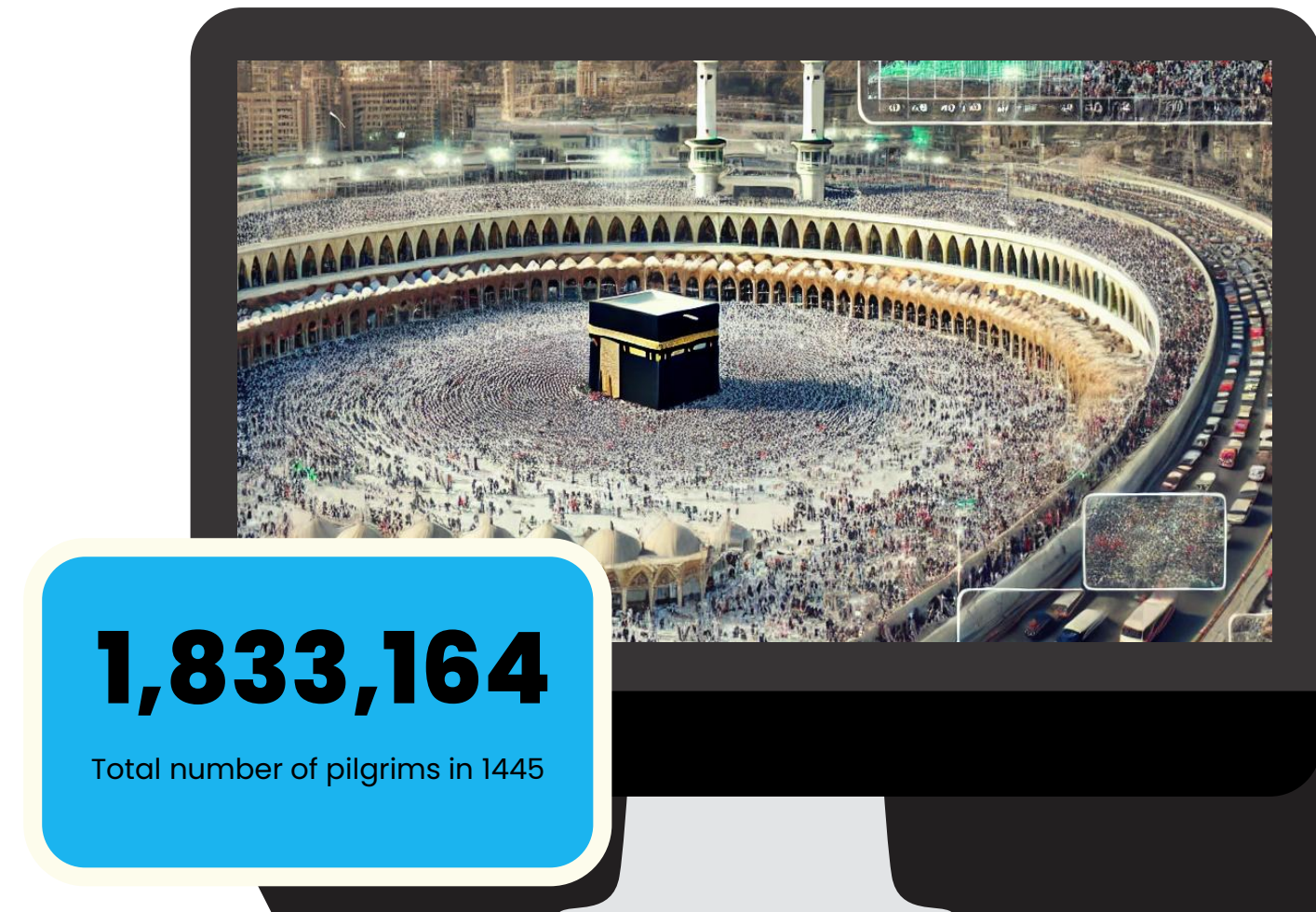
Millions gather in limited spaces, increasing risks of stampedes and bottlenecks.

02 Limited Space

Key rituals occur in restricted areas (e.g., Mina, Arafat, Jamarat Bridge)

03 Emergency Risks

Delayed reaction to medical or behavioral anomalies due to lack of real-time data.
Traditional methods fail to adapt dynamically to the evolving nature of crowd behavior



RESEARCH OBJECTIVES

01.

Real-Time Monitoring

Monitor crowd density using AI-based techniques like CNN and YOLO.

02.

Crowd Flow Optimization

Predict high-density zones

03.

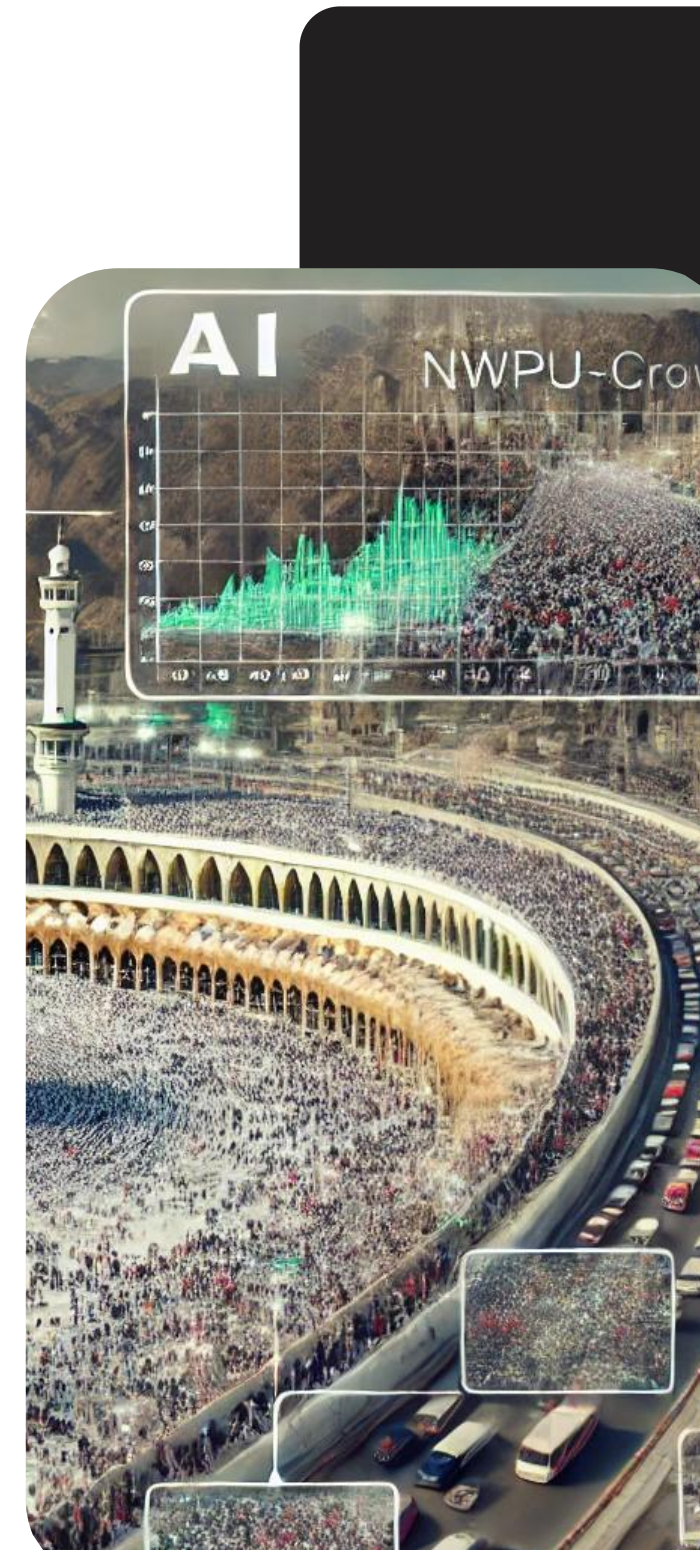
Implement Emergency Alerts

Notify authorities of or abnormal crowd behavior.

04.

Improve Pilgrim Experience

Reduce risks and enhance safety.



RELATED WORK

Crowd Density Estimation:

Studies using CNN models focus on generating real-time heatmaps to estimate and monitor crowd density.

Example: CSR Net model applied for high-accuracy crowd density prediction.

Behavior Prediction:

LSTM models predict sequential movements of crowds, enabling early identification of congestion points.

Example: LSTM integration for dynamic crowd behavior forecasting.

Object Detection and Tracking:

YOLO models provide real-time detection and tracking of individuals in dense environments.

Example: Using YOLO for anomaly detection in pilgrimage settings.

Dataset Utilization:

NWPU-Crowd dataset, with over **5,000 images and 2.1 million** annotations, has been widely adopted for training AI models in high-density scenarios.

This dataset supports robust training and benchmarking for real-world applications.

RESEARCH PLAN

01.

Data Collection

High-resolution images, IoT sensors, and NWPU-Crowd

02.

Data Preprocessing

Cleaning, normalization, and augmentation

03.

Model Development

CNN for density analysis.

04.

Validation

YOLO for anomaly detection.

05.

Deployment

Test models using real-time data.

06.

Integrate

with existing Hajj surveillance systems.

IMPLEMENTATION

System Components:

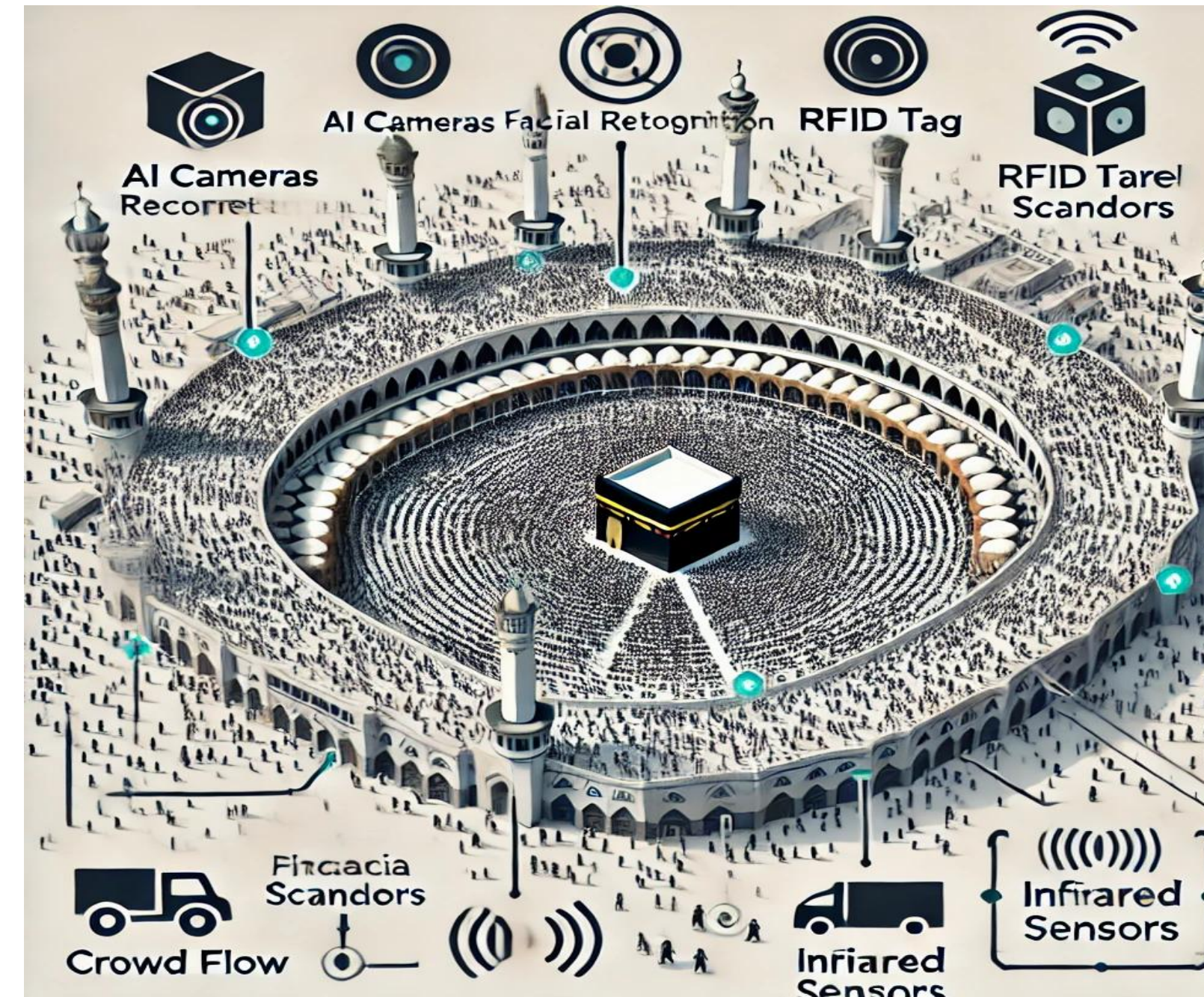
Surveillance cameras, IoT sensors, and AI models.

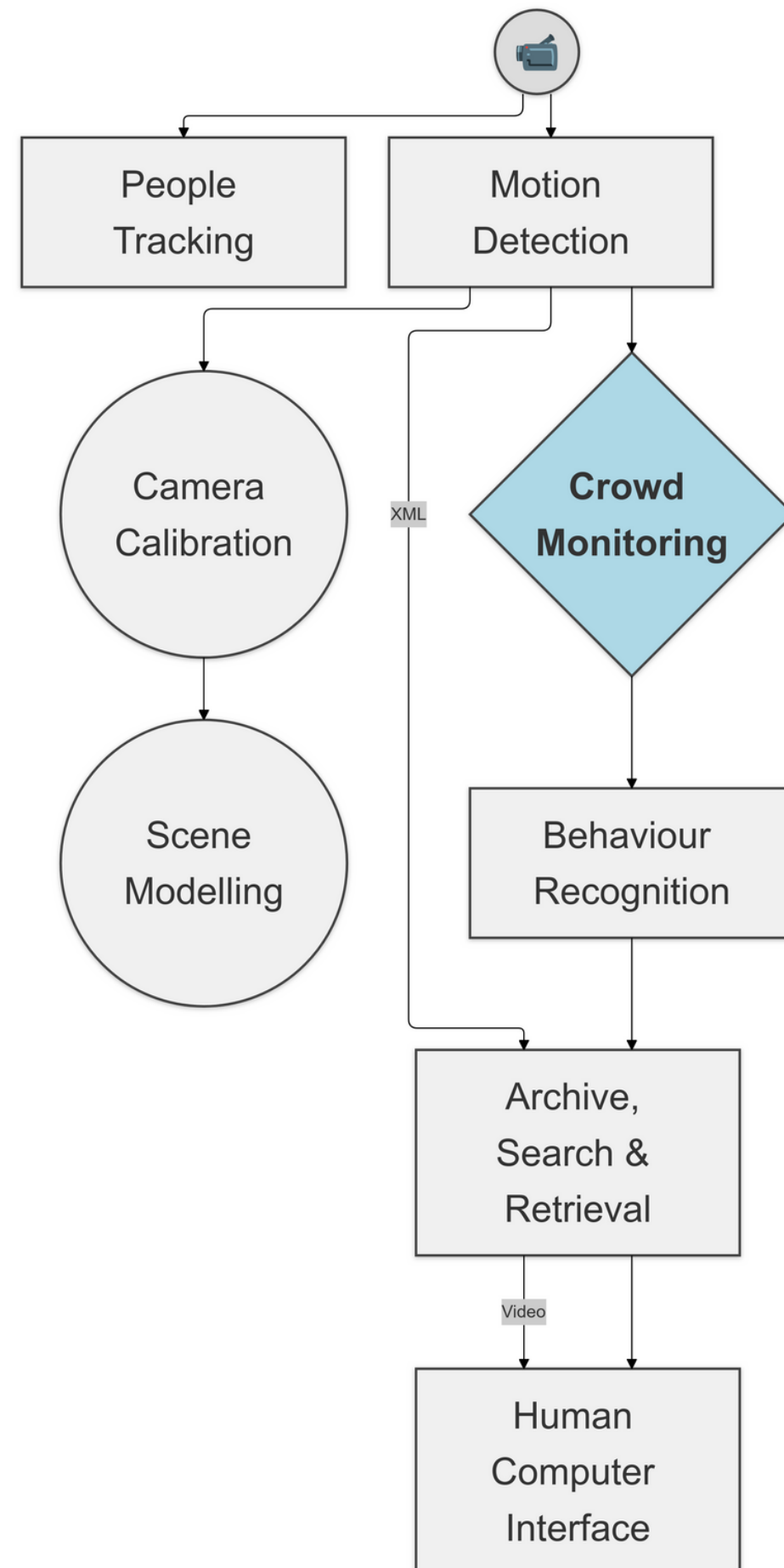
Real-Time Analysis:

Heatmaps for density, flow optimization.

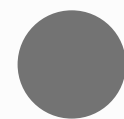
Alert Mechanism:

Automated notifications for emergencies.



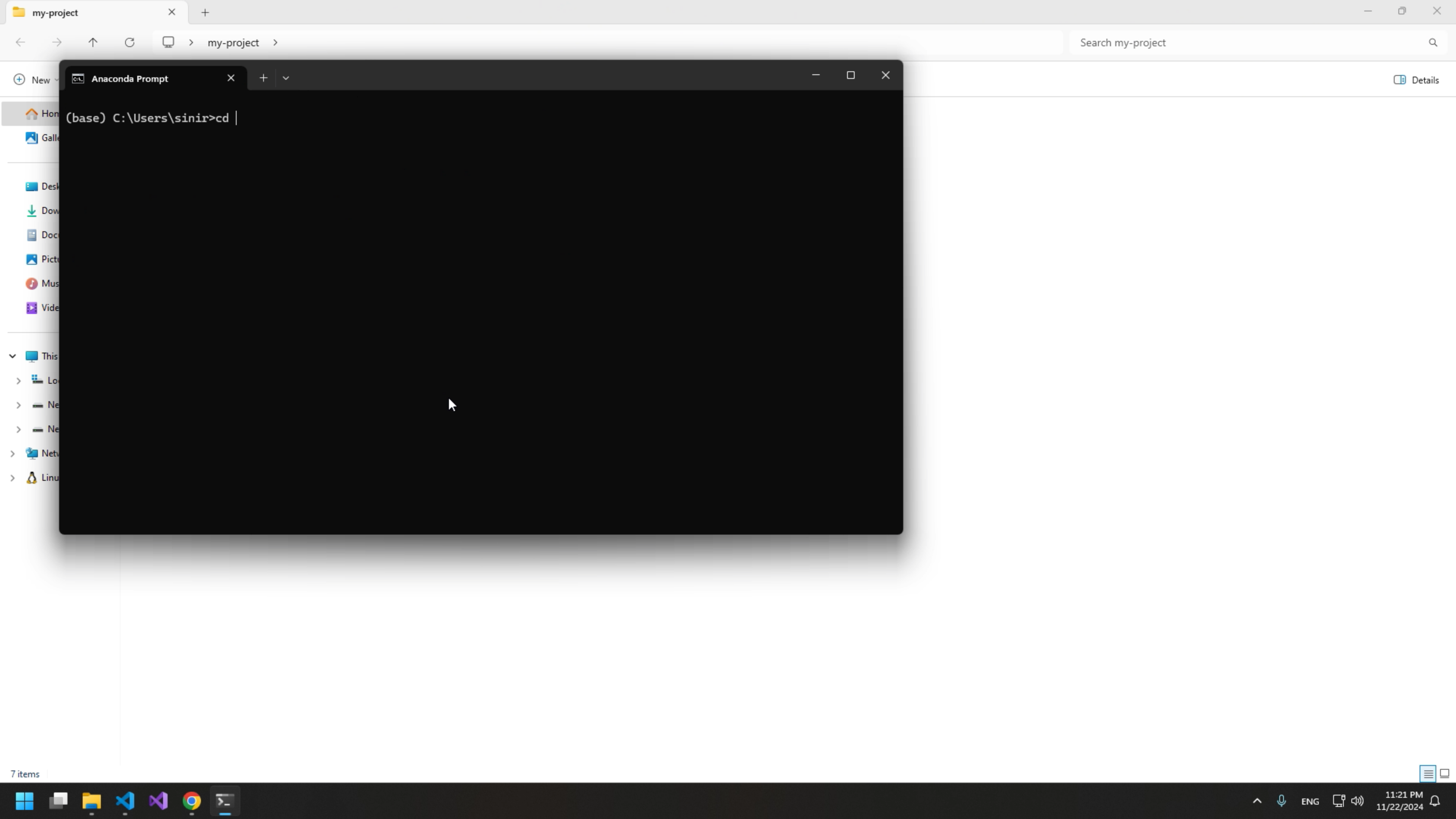


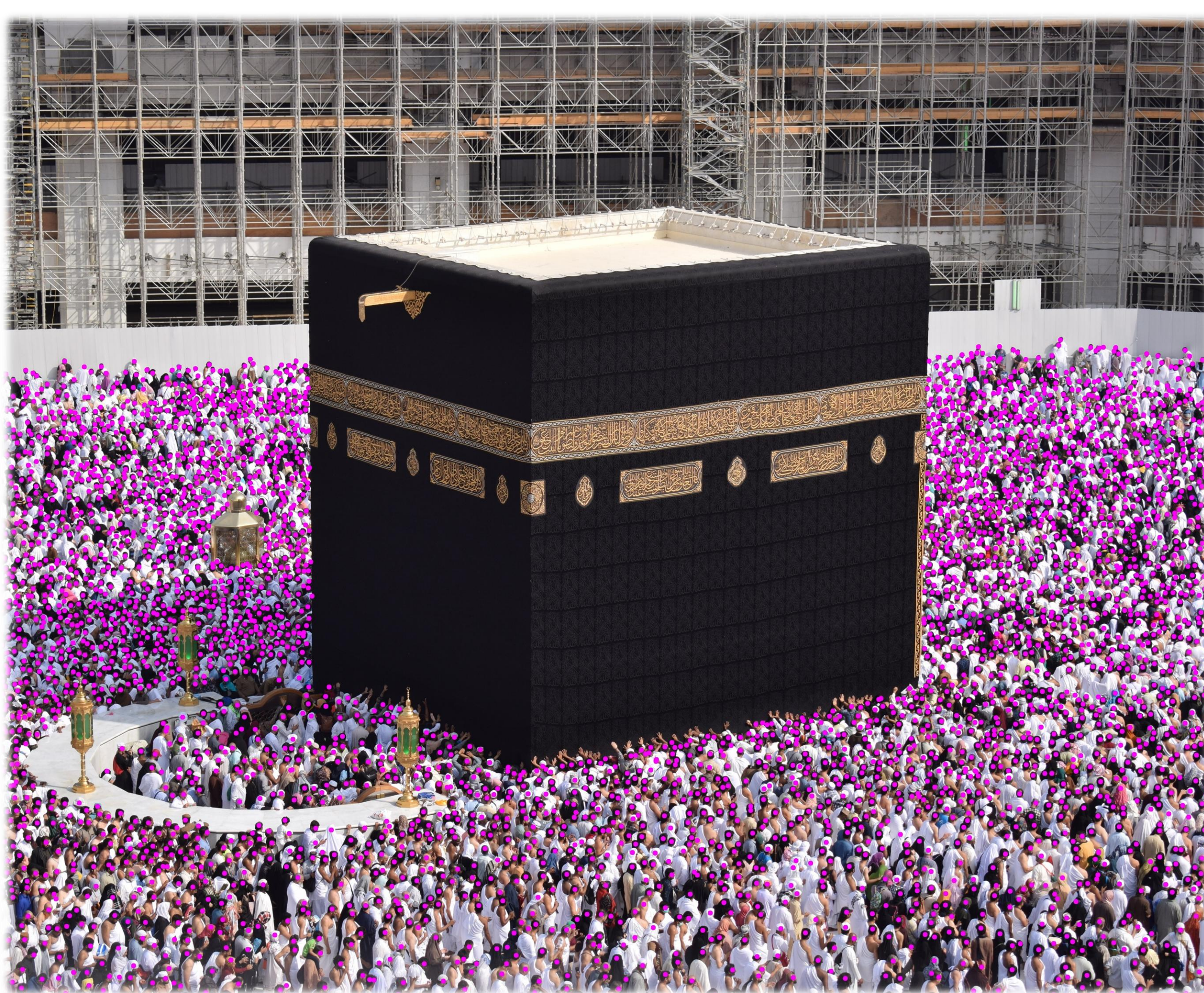
Key

-  Offline
-  Current Module
-  Main Module

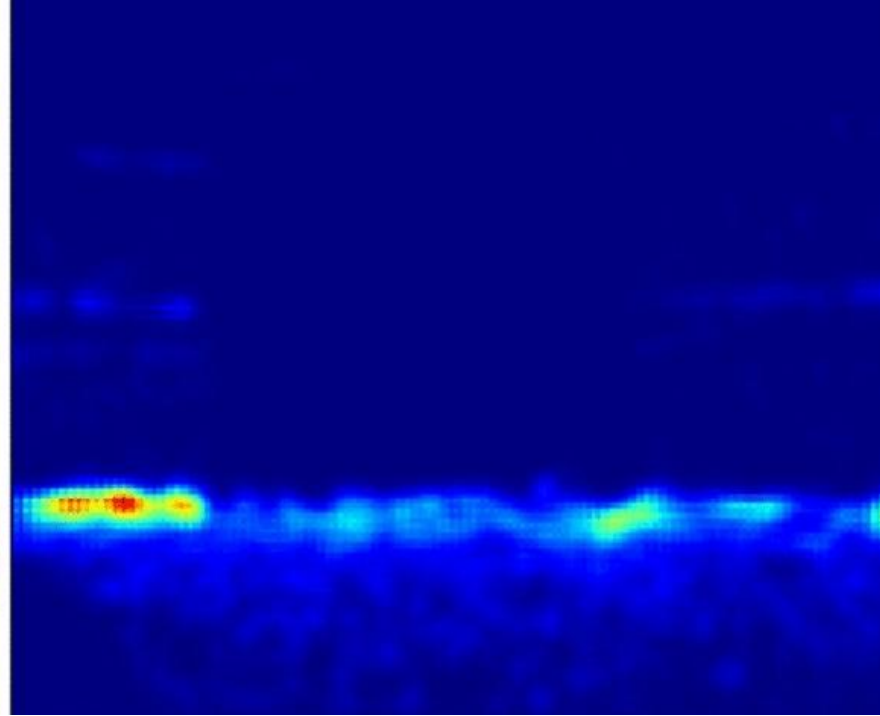
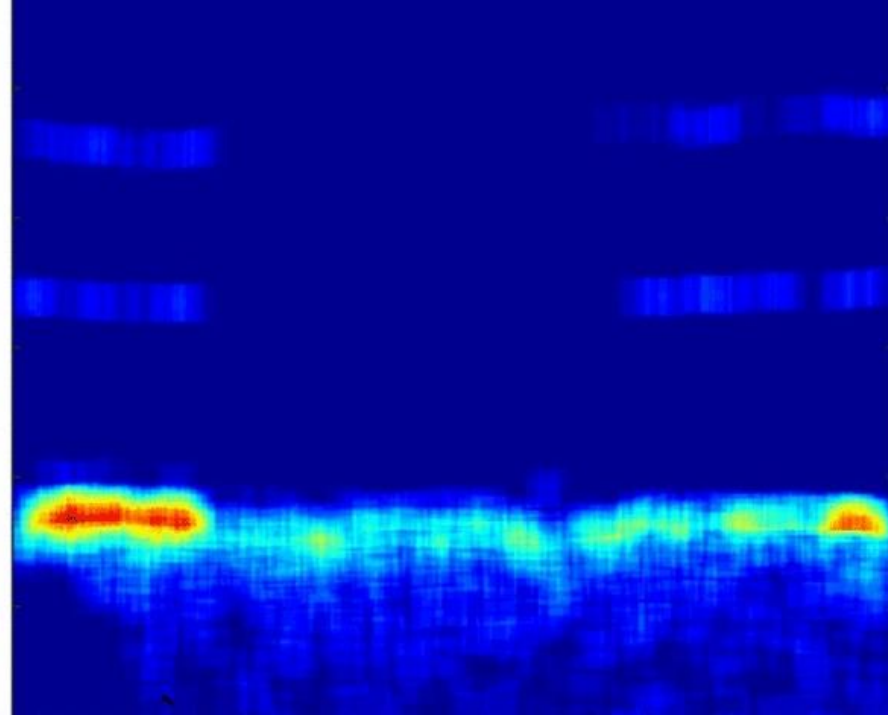
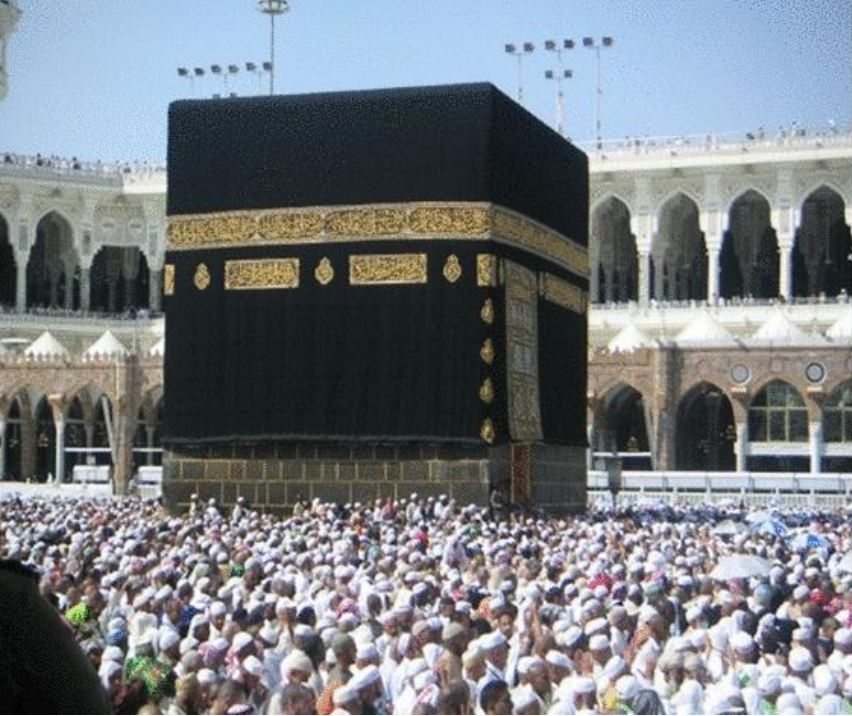
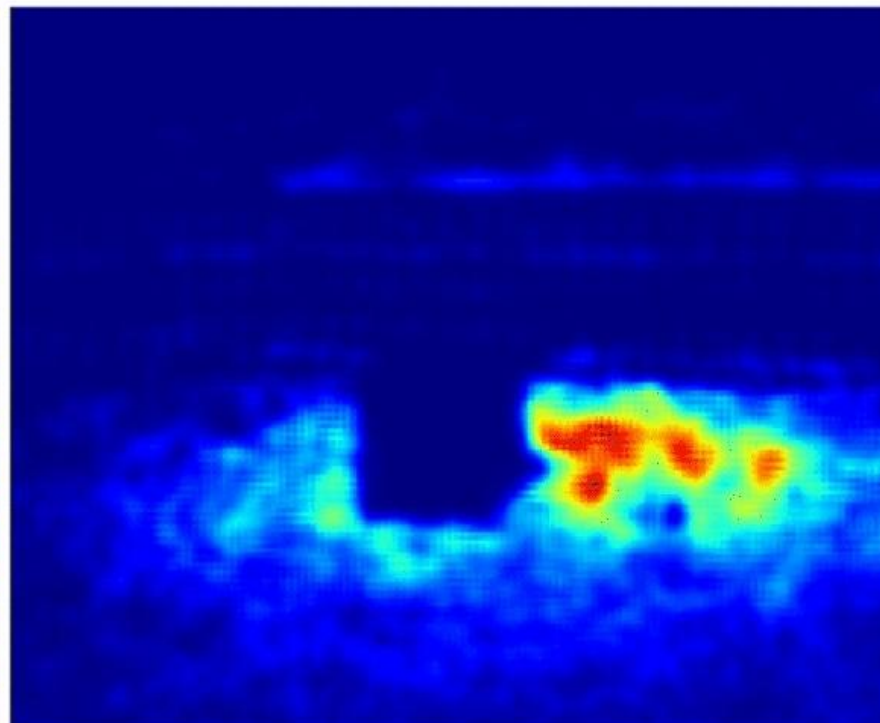
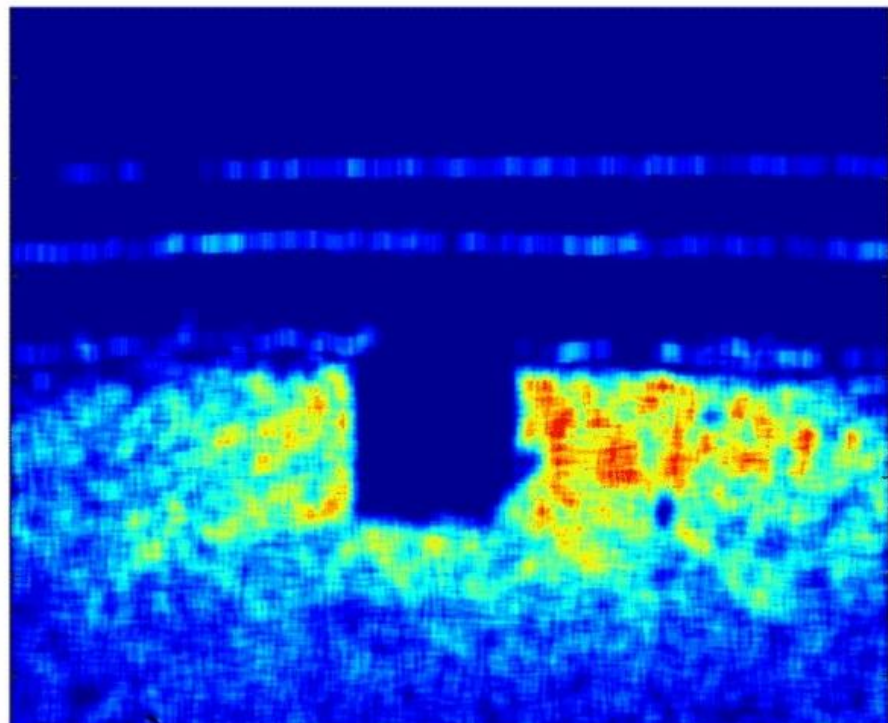
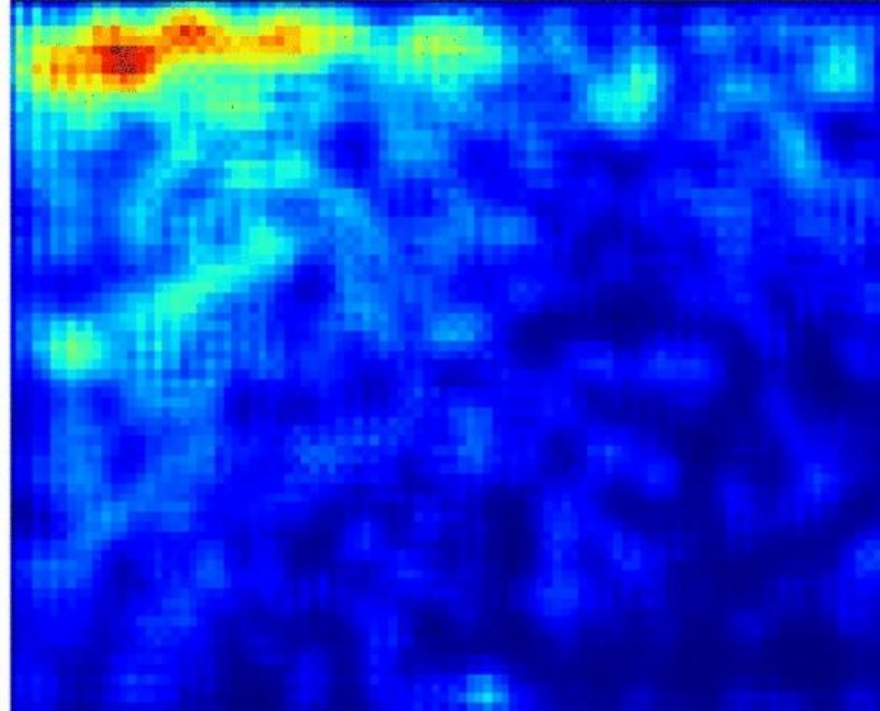
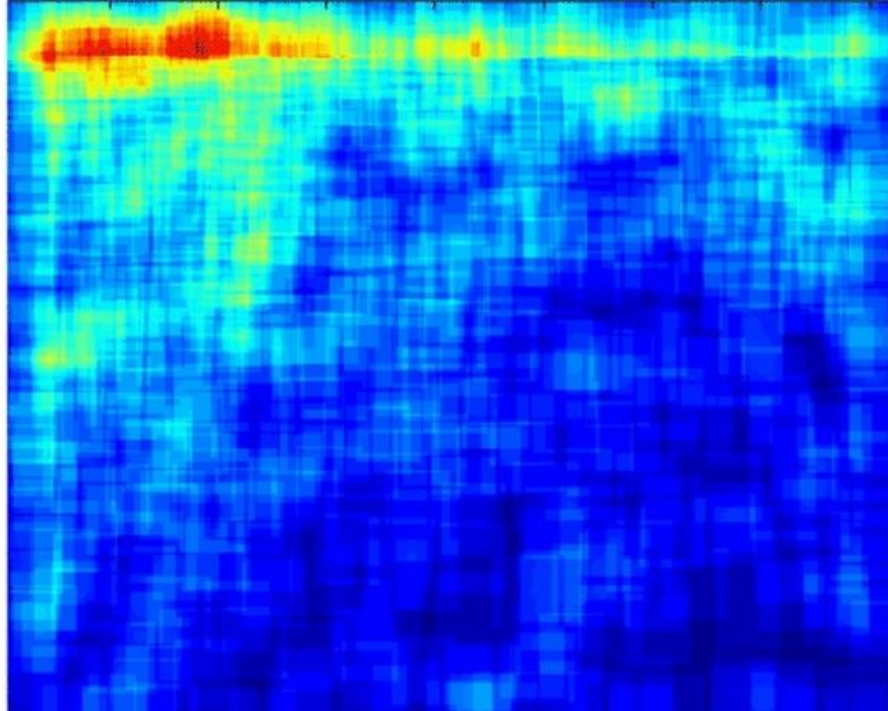
Flowchart illustrating a crowd monitoring system with motion detection, people tracking, and behavior analysis.

**A VIDEO ILLUSTRATE THE WHOLE
OPERATION OF REAL TIME
COUNTING**





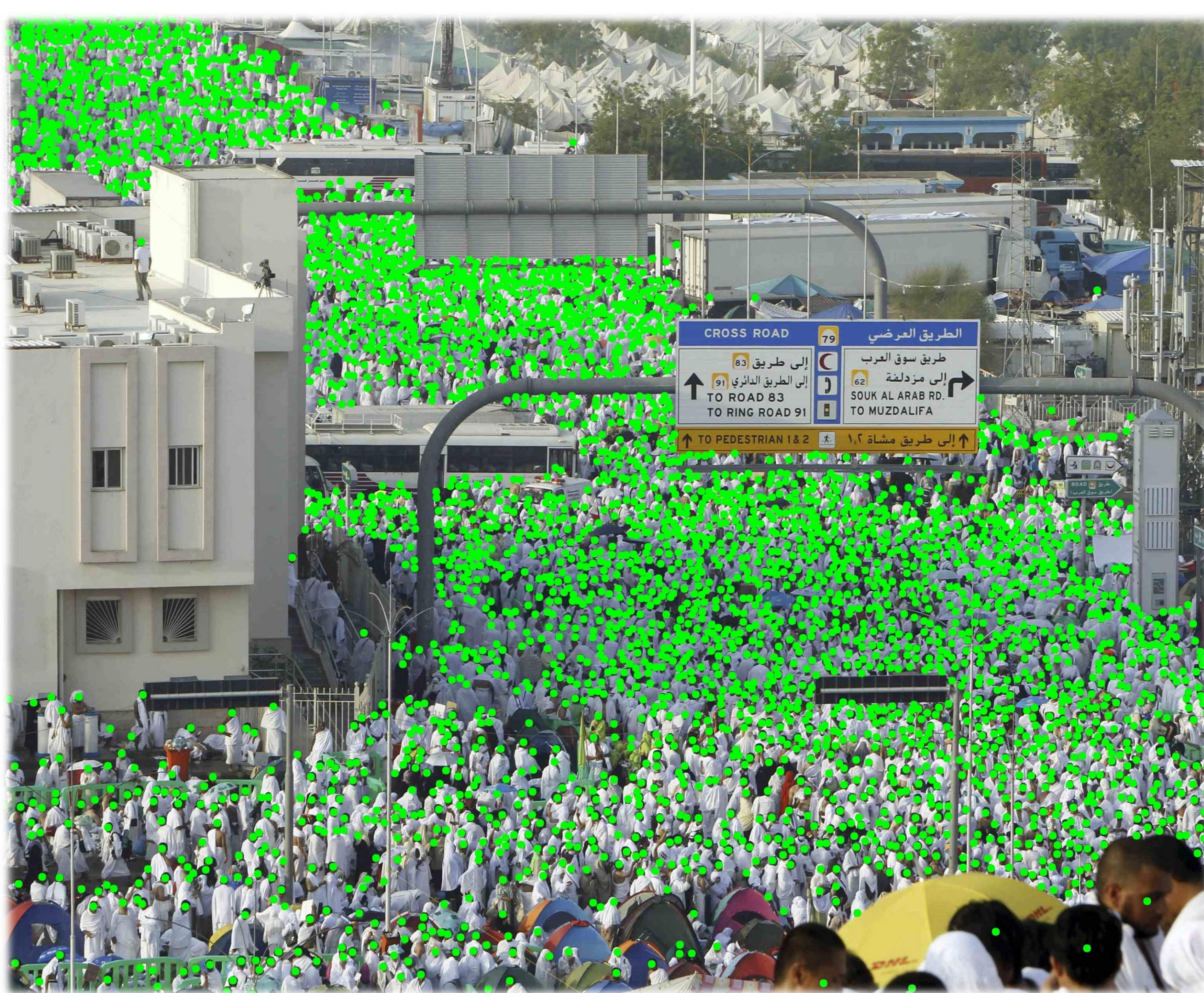
Crowd around the Kaaba with
individual tracking markers



Crowd **Density** Analysis: Heatmaps visualize high-density (red) and low-density (blue) areas during the Hajj pilgrimage for efficient crowd management."



Example of detection and
monitoring the head markers using
AI-based detection techniques



High-density crowd monitoring
with head detection markers for
real-time crowd analysis and
management.



Example of Preprocessing
this photo after Cleaning,
normalization, and augmentation

DISCUSSION OF RESULTS

The system detected abnormal crowd patterns, including stagnation, sudden surges, and reverse flows.

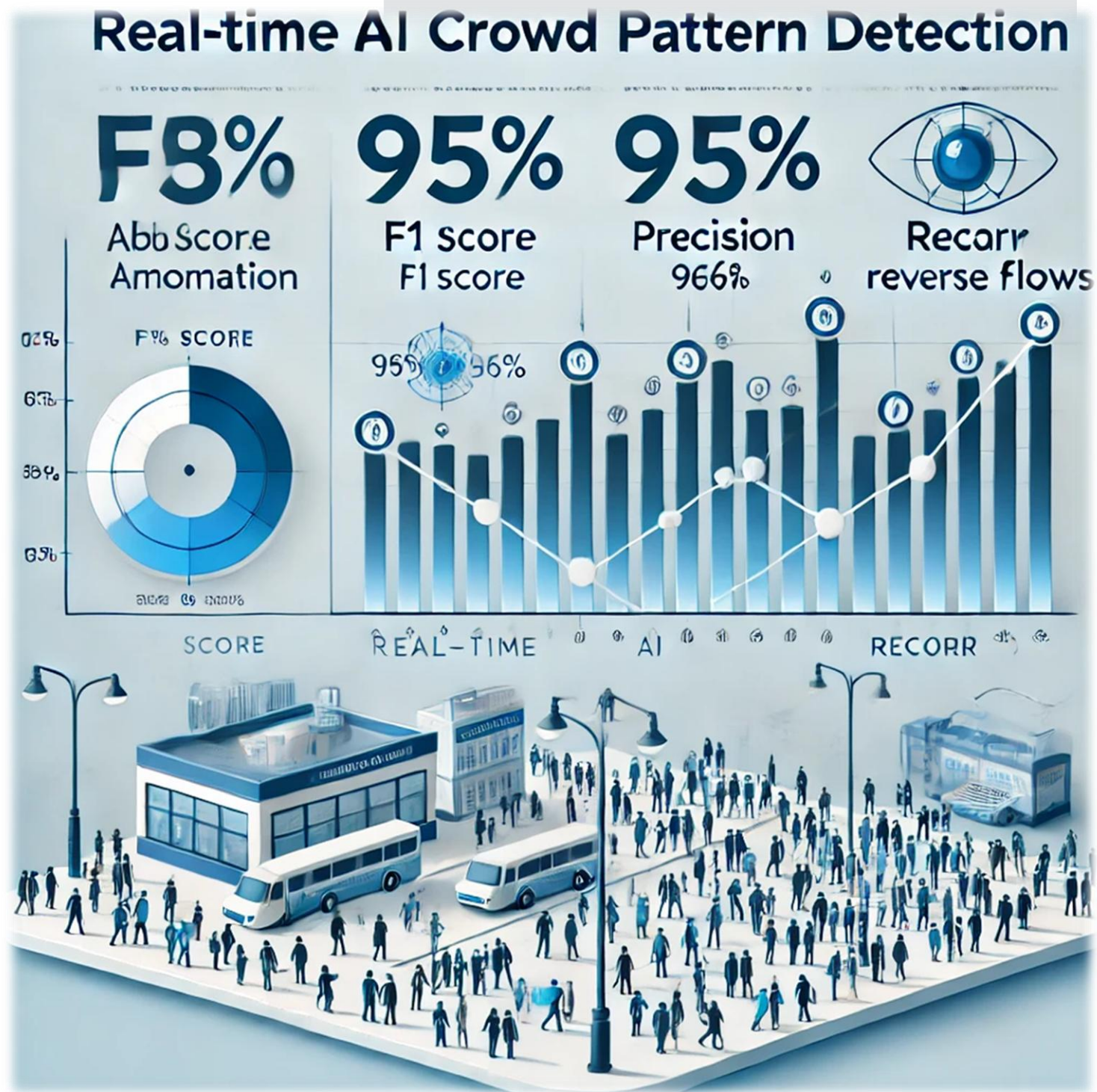
Key Metrics:

F1 Score: **95%**

Precision: **96%**

Recall: **93%**

The system outperformed existing anomaly detection methods by combining CNN for feature extraction and LSTM for predicting crowd behavior over time.



DISCUSSION OF RESULTS

Improvements
Over Traditional
Methods

Performance Comparison

Metric	Existing Systems	Proposed System
Detection Accuracy (%)	85%	97%
Response Time (minutes)	14 minutes	9 minutes
Adaptability	Limited	Real-time

Aspect	Existing Systems	Proposed System
Crowd Density Estimation	Basic object detection	CNN-based heatmap generation
Anomaly Detection	Limited precision	High-precision anomaly detection
Emergency Alerts	Manual identification	Automated IoT-based detection
Predictive Analysis	Absent or limited	LSTM-based congestion prediction

DISCUSSION OF RESULTS

Comparison with Existing Systems

THANK YOU
FOR LISTENING