

# STAMPEDE DETECTION SYSTEM

## Team:

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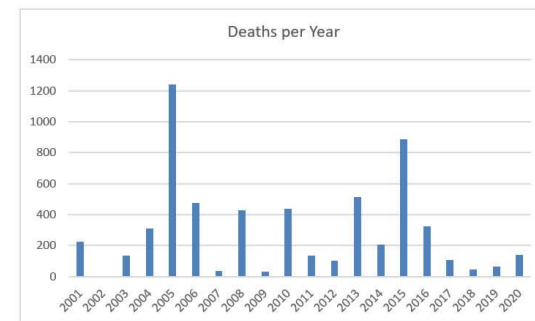
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# Why?

- In huge crowd gatherings, stampedes pose a huge threat to human lives. Our aim was to apply what we've learnt to solve a social problem. The advancements in hardware technology offer great potential to this model that can be used to predict a stampede and alert the concerned authorities.
- From 1980 to 2022, approximately 440 crowd surge incidents were documented, leading to over 13,700 deaths and 27,000 injuries.
- In January 2025, during the Maha Kumbh Mela festival in Prayagraj, India, a crowd crush led to at least 30 fatalities and 60 injuries.
- A few hours ago, a tragic stampede occurred at New Delhi Railway Station, resulting in at least 15 fatalities as people rushed to board a special train heading to the same Maha Kumbh Mela festival.



# How?

- Stampede Detection Criteria

1. **Crowd Density:** Identifying high congestion levels in a given area.
2. **Sudden Change in Direction:** Detecting abrupt shifts in movement patterns.
3. **Motion Patterns:** Recognizing irregular movement and acceleration.



# Implementation

## 1. Data Collection & Processing

- **Real-time Video Input:** Surveillance cameras, drones
- **Preprocessing:** Frame extraction, noise reduction, and stabilization.

We used FiftyOne library for frame extraction and labelling.

## 2. AI-based Crowd Analysis

### 1. Crowd Density Analysis

- Detect people per square meter using object detection (YOLO).
- Predict trends using historical data and time-series analysis.


### 2. Sudden Change in Direction

- **Optical Flow Analysis** (Lucas-Kanade, Farneback) to track movement vectors.
- **Anomaly Detection:** Identify rapid directional shifts.
- Correlate with **audio signals** (if available) for external disturbances.

### 3. Motion Patterns & Erratic Behavior

- Track **acceleration spikes** using trajectory analysis.
- Identify **unnatural clustering** with density-based clustering (DBSCAN).

## 3. Alert Mechanism & Visualization

- **Risk Flags:** High & Critical levels based on predefined thresholds.
  - **Live Dashboard:** Real-time alerts, risk zones.
  - **Automated Notifications:** Alerts sent to security teams via SMS/IoT integration.
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# Conditions for Risk Detection

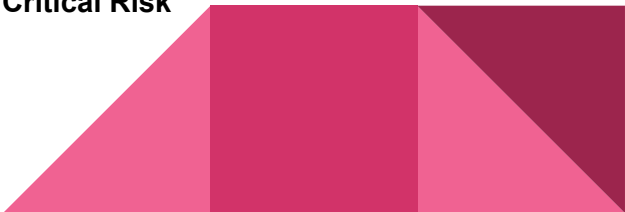
## Crowd Density Conditions

- If density > 4-5 people per square meter → **Flag as High Risk**
- If density > 6 people per square meter → **Flag as Critical Risk**
- If density increases by >20% in 30 seconds → **Trigger Alert**

## Sudden Direction Change Conditions

- If >30% of individuals change direction within 2-3 seconds → **Potential Risk**
- If movement shifts from orderly to chaotic → **High Risk**
- If directional change coincides with loud noise/disturbance → **Critical Risk**

## Motion Pattern & Erratic Behavior Conditions

- If many individuals accelerate beyond 1.5× normal speed → **Potential Risk**
  - If clustering occurs abnormally → **High Risk**
  - If multiple irregular movements (stopping, pushing, turning) happen simultaneously → **Critical Risk**
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# Conclusion and Future Work

- Implement the proposed framework.
- Add prediction algorithms for early risk detection.

