Project Synopsis Presentation On

"Stampede Avoidance System For KumbhMela-2025 Using Drone Technology"

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- Kumbh Mela is one of the largest religious gatherings in the world attracting millions of pilgrims to sacred riverbanks in India.

- However, overcrowding during the event poses significant safety challenges, especially the risk of stampedes.

- This project aims to address this issue by using drones for crowd management and stamped avoidance during the Kumbh Mela which will also be helpful for police management.

Problem Statement

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The problem to be addressed is the risk of stampedes and overcrowding during the Kumbh Mela, which can lead to loss of lives and injuries.

Traditional crowd management methods are often insufficient to handle such massive gatherings efficiently.

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Aim & Objective Of Project Work

❑ **Aim:**

To enhance crowd safety, management, and pilgrim experience during the Kumbh Mela through the development and implementation of innovative technologies, including a drone-based real-time crowd monitoring system.

❑ Objectives:

- To develop a drone-based system for real-time crowd monitoring and management during Kumbh Mela 2025.

- To mitigate the risk of stampede in Kumbh Mela.

- To improve the safety and overall experience of pilgrims attending the Kumbh Mela.

Grand Maha Kumbh 2025: Yogi Government Allocates Whopping Rs 2500 Crore For Event

The Yogi Adityanath-led Uttar Pradesh government in its budget allocated Rs 2,500 crore for the preparations of Maha Kumbh Mela 2025

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By Victor Dasgupta | Edited by Victor Dasgupta

Around 40 crore rupee's arranged for the integrated development of Prayag raj[10].

- A case study for dense crowd counting and modeling this model applied to Kumbh Mela and other gatherings. The model employs orthographic projection to ensure uniform representation of individuals, minimizing occlusion. Utilizing a CNN for head counting, this simple yet effective model offers superior performance compared to 23 state-of-the-art approaches across 7 datasets, including a new Kumbh Mela dataset[1].

- Another systematic review, following PRISMA guidelines, investigated surveillance drones' role in smart cities up to August 2021. Among 323 records, 43 met the criteria, revealing seven key application areas, including transportation, environmental monitoring, and disaster management, with air pollution and traffic monitoring[2].

- The cognitive and psychological perspectives of crowd behavior a vision-based analysis. focuses on the importance of smart and proactive surveillance of crowds, especially in urban areas with increasing population and the risk of crowd disasters. It aims to do analysis of crowd behavior from cognitive and psychological perspectives using vision-based analysis techniques[3].

- Stampede Events and Strategies for Crowd Management The paper examines incidents and related documents as references, and uses Simulex software to simulate stampede events during evacuation[4].

Literature Survey

Sr. No	Title of Paper	Author's Name	Publication Year & Details	Advantages / Salient Remarks	Drawback / Future scope
1.	KUMBH MELA: a case study for dense crowd counting and modeling	Anurag pandey	23 feb2020	Drone surveillance and data capture, CNN modelling for data counting.	Can extend the work over the images having low illumination.
2.	Involvement of surveillance drone in smart cities	Adel Gohari	2022	Object, people detection , disaster management.	Apply vision based approach to asses multiple air pollutants.
3	Towards the cognitive and psychological perspectives of crowd behavior: a vision-based analysis	Elizabeth B. Varghese	2021	Addresses the importance of smart and proactive surveillance of crowds in urban areas .	Develop smart crowd management systems that can handle huge volumes of data.

Literature Survey

Sr. No	Title of Paper	Author's Name	Publication Year & Details	Advantages / Salient Remarks	Drawback / Future scope
4.	Stampede Events and Strategies for Crowd Management	Chun-Hao, Shao	2019	Factors contribute to stampedes, particularly at entrances, exits and staircases.	Future Scope: investigate the impact of parameters, such as crowd density and total number of people.
5	Utilization of Deep Learning- Based Crowd Analysis for Safety Surveillance	Osama, S., Faragallah	2022	Development of an efficient detection model for crowd counting and social distancing.	Future scope: study of crowd analysis algorithms, techniques to improve the accuracy, efficiency of crowd counting.
6	Video based human crowd analysis using machine learning	Deevesh, Chaudhary	2021	Discusses various techniques and algorithms used for crowd analysis	need to address the challenges of scale variation, and complex crowd dynamics

Literature Survey

Sr. No	Title of Paper	Author's Name	Publication Year & Details	Advantages / Salient Remarks	Drawback / Future scope
7.	Intelligent video surveillance: a review through deep learning techniques for crowd analysis.	Durai	2019	Factors contribute to stampedes, particularly at entrances, exits and staircases.	Future Scope: investigate the impact of parameters, such as crowd density and total number of people.
8.	Large scale crowd analysis through the use of passive radio sensing network.	Stijn denis	2020	benefits of dividing an experimental environment into subregion for crowd analysis and estimation	Research can be done to address the limitations of the passive RF sensor network use for crowd estimation such as its accuracy and reliability.

Outcome of literature Survey

- From the literature survey it is seen that the surveys provide insights into different aspects of crowd management and surveillance, with a focus on crowd counting models, surveillance drones in smart cities, and the cognitive and psychological perspectives of crowd behavior.
- Also there are some limitations such as some system cannot handle huge volume of data, some not studied the parameters such as crowd density and total number of people etc. so to overcome these limitations there is a need to introduce additional system apart from the above systems.
- So there is a need to propose a better system for effective operation.

Proposed System

- The proposed system will capture an image of Kumbh Mela and will analyze the image with the help of computer vision software to see what kind of crowd that is it a march, is it a procession, are there some fights or stampede are happening.
- we can send that analyzed data to the police department and can prevent the crowding, beatings and thefts and avoid the stampede in that place.
- It will improve management, and pilgrim experience by the development and implementation of innovative technologies, including a drone-based real-time crowd monitoring system.
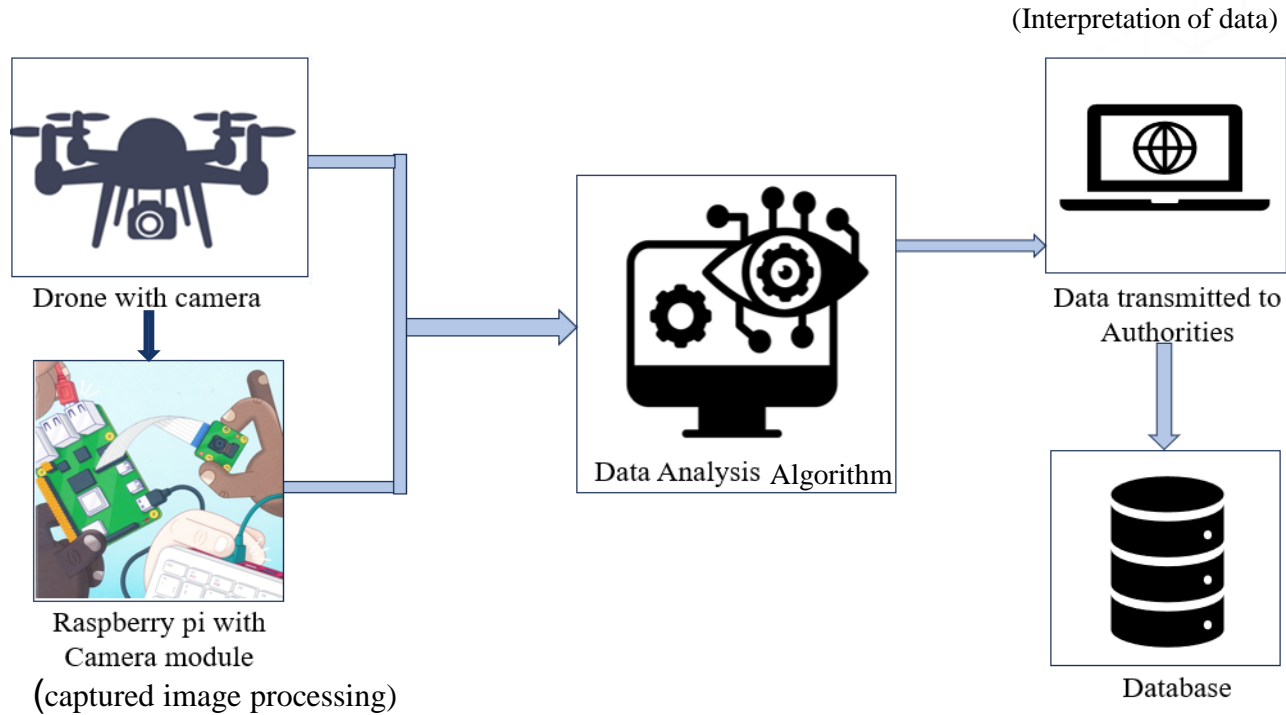
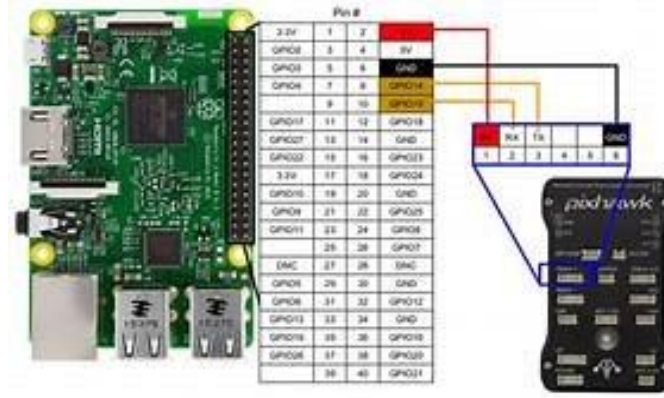Fig. Block Diagram of proposed System
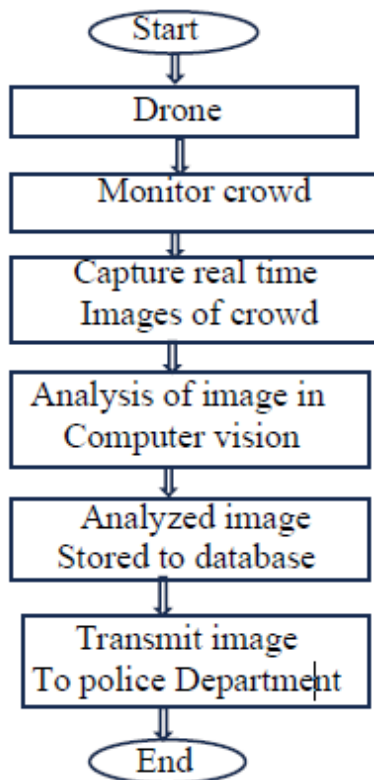
Methodology of proposed system

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Drone With Camera

Raspberry Pi with Pixhawk

- A drone equipped with a camera is a versatile aerial platform designed for capturing high-quality photos from the air.
- This particular drone features a 8MP high resolution camera with a 3-axis gimbal for stabilized footage, ensuring sharp and smooth shots.
- It is capable of capturing series of images to a remote control or ground station in real-time, allowing for precise monitoring and control.
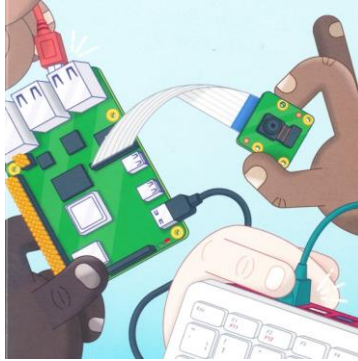
Raspberry Pi with camera module

- The Raspberry Pi camera module is a versatile accessory that allows you to capture photos and videos with your Raspberry Pi single-board computer.
- There are several versions of the camera module available, but the most common ones are the Raspberry Pi Camera Module V1 and V2.
- The Camera Module V1 is a 5-megapixel camera with a fixed-focus lens.
- The Camera Module V2 is an 8-megapixel camera with a larger sensor.
- These camera modules can be used with various Raspberry Pi models, such as the Raspberry Pi 3, 4, and Zero.

- To use the camera module, you need to connect it to the Raspberry Pi's camera connector, which is a small ribbon cable.
- Make sure to enable the camera in the Raspberry Pi's configuration settings and install the required software libraries.
- There are commands to perform various tasks **raspistill** command is use to capture images and **raspivid** command is use to record videos.
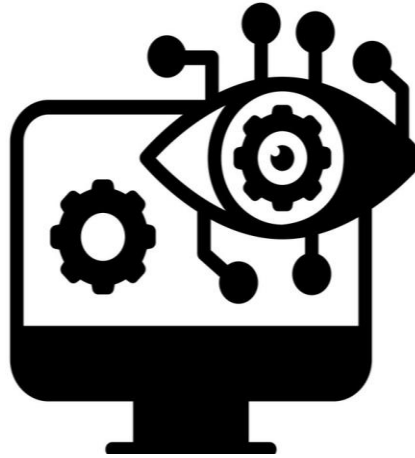
Data Analysis software(Open CV)

- OpenCV is widely used computer vision library that provides tools for image processing, detection and analysis.
- The integration in between OpenCV and raspberry pi is used to perform real time analysis on the stored images.
- TensorFlow or PyTorch is useful to deal with more complex image analysis tasks such as deep learning-based objects detection or image classification, frameworks.
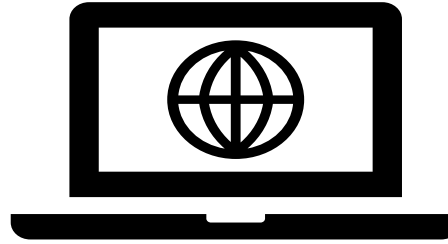
Data transmitted to authorities

- Stream Processing in which the frameworks like Apache Kafka or Apache Flink.
- The frameworks is useful to analyse real time images to handle continuous stream of images.
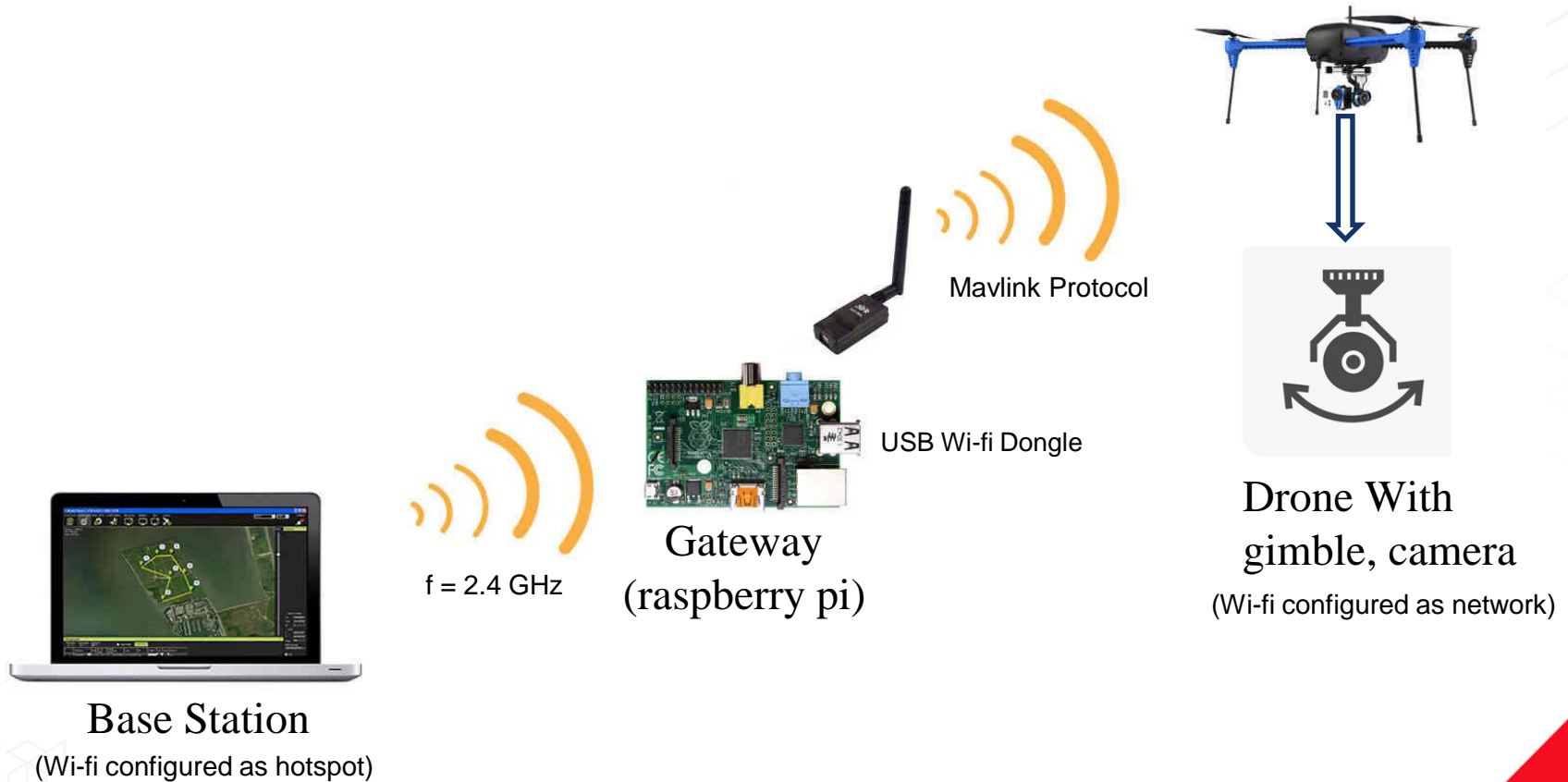
18
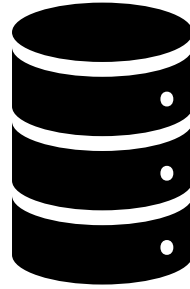
Database

- Store images in the chosen database along with relevant metadata.
- Use image analysis frameworks to process image based on your specific requirements such as object recognition, anomaly detection or feature extraction.
- If dealing with a continuous stream of images, consider implementing a pipeline that processes images in real time.

Camera Integration with drone

Mavlink Protocol

USB Wi-fi Dongle

Gateway
(raspberry pi)

f = 2.4 GHz

Drone With
gimble, camera
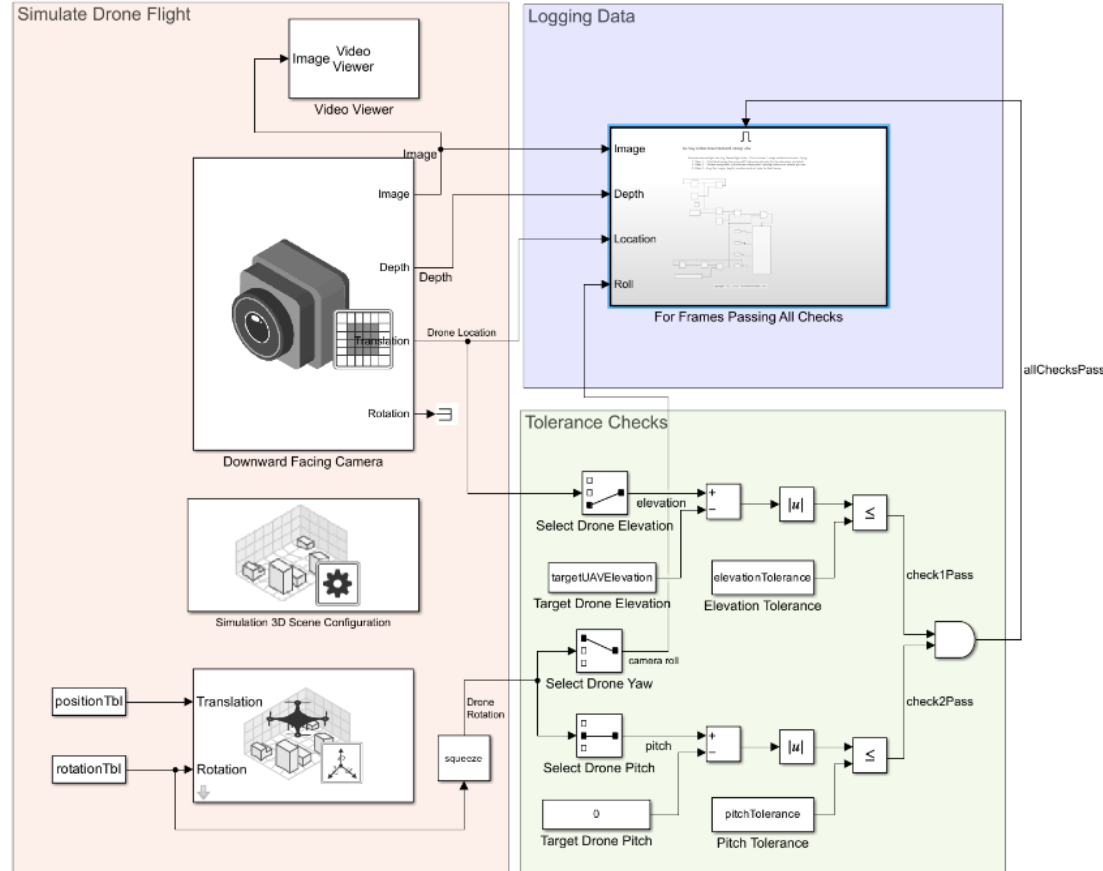(Wi-fi configured as network)

Base Station
(Wi-fi configured as hotspot)

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Fig. modeling of system in MATLAB Simulink

The Simulink model of proposed system consist of three blocks which are Simulate drone flight, logging data, and tolerance check.

Simulate drone flight:- Consist of downward facing, camera, simulation 3D scene configuration, 3D UAV vehicle, squeeze and video viewer block.

Downward facing camera provides an interface of a camera with a lens in the 3D visualization environment.

3D scene configuration configures the 3D simulation environment in which we can create the environment to fly the drone. UAV vehicle is used in the environment to capture the images. Video viewer block is use to see the simulation results of overall simulation.

Logging data:- consist of the frames passing all check block this is use to log filtered data this involves 3 steps while the drone flying. Step 1 find the frames that passes all 2 tolerance check for the elevation and pitch. step2 select every Nth such frame where roll velocity tolerance check passes step 3 log the image , depth, location and roll data for that frame.

Tolerance checks block:- consists, constant block, selector block and logical AND operator. Constant blocks is used to specify the constant value parameter in this simulation we have used 2 constant blocks one indicates Target drone elevation and another indicates elevation tolerance

Selector block is use to select the parameter in this 3 selector blocks are used to select the Drone elevation, Drone yaw, Drone pitch.
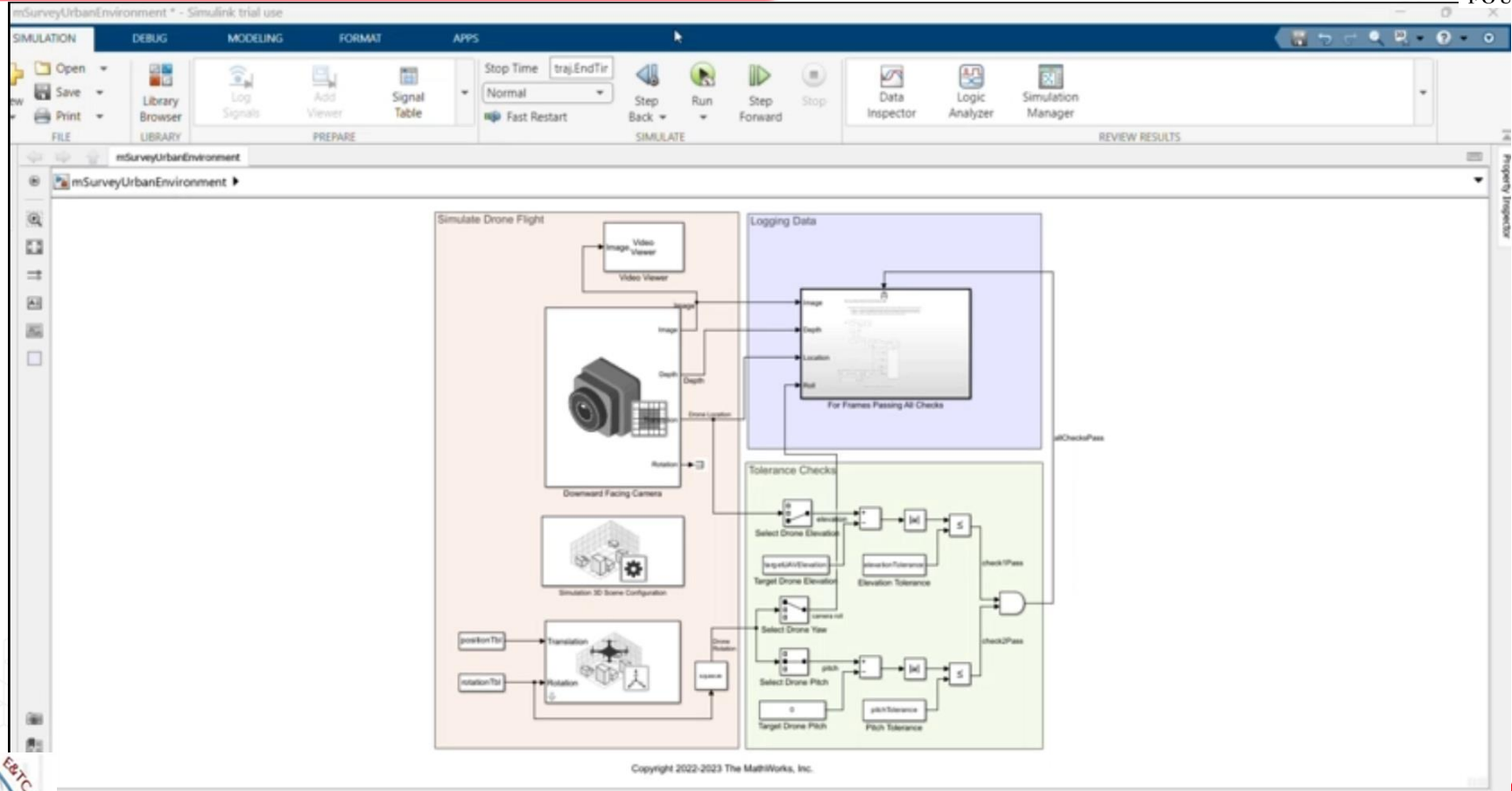
- **Enhanced Crowd Safety:** Drone-based monitoring offers real-time insights on crowd density, movement, and congestion. Authorities can then proactively prevent stampedes and enhance pilgrim safety.
- **Timely Intervention:** Real-time drone data helps authorities spot crowd issues early and allocate resources promptly, leading to faster and better crowd control strategies.
- **Efficient Resource Allocation:** Drone-collected data optimizes security and medical resource distribution, ensuring effective deployment where needed most, thereby enhancing overall management efficiency.
- **Reduced Loss of Individuals:** Implementing riverbank safety measures reduces incidents of lost individuals, boosting overall pilgrim safety, particularly for vulnerable groups like children and the elderly.
- **Improved Pilgrim Experience:** A well-managed and safe Kumbh Mela enhances the overall experience of the pilgrims. Attendees can focus on their spiritual activities and interactions without constant concerns about safety and overcrowding.

- **Technological Challenges:** Developing a drone-based system demands advanced tech and infrastructure. Issues internet connectivity, battery life, and crowded environments pose hurdles.
- **Privacy Concerns:** Drone monitoring raises privacy worries. Balancing crowd control and individual rights is crucial.
- **Regulatory Hurdles:** Operating drones in crowds involves complex rules and permissions from aviation and local authorities.
- **Cost Implications:** Establishing a drone system is expensive – drones, training, communication setup, and ongoing management.
- **Dependency on Tech:** Relying solely on tech might lead to negligence in human decision-making. Backup plans are vital in case of tech failures.
- **Cultural Sensitivity:** Implementing tech should respect Kumbh Mela's cultural and religious importance to pilgrims.

Fig. Applications of Crowd Monitoring[9]
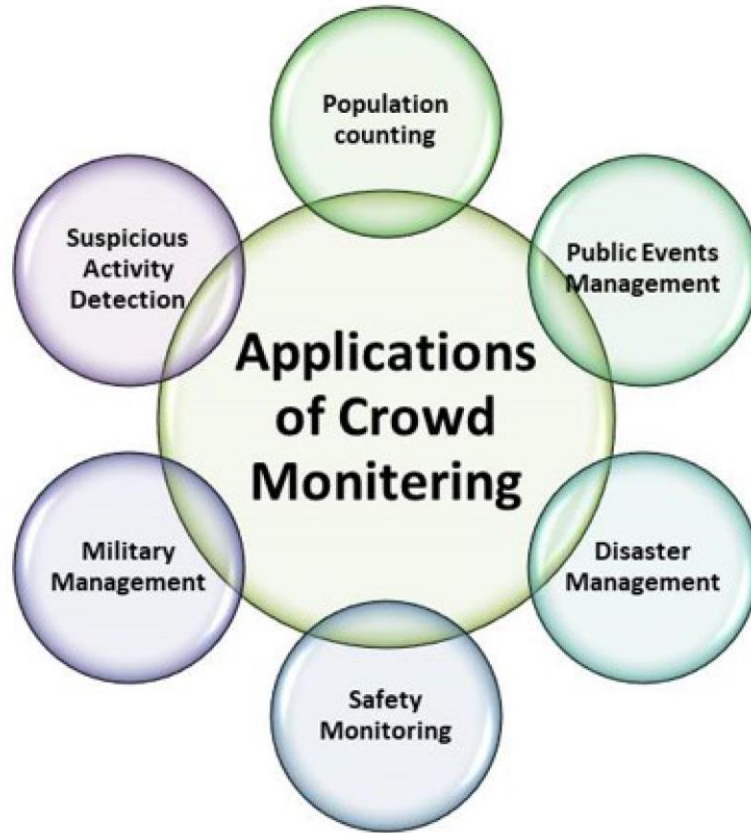
✓ **Real-Time Crowd Monitoring and Management System**

✓ **Lost Individual Tracking and Assistance**

✓ **Information Dissemination and Communication**

- To Increase the flight time by improvement on battery power in terms of weight and capacity.

- A look into incorporating charging modules like solar panels so that the vehicles can have long duration and range while on air.

- To develop a Early warning system for stampede avoidance.

The drone-based crowd management plan for Kumbh Mela concludes with promise. It aims to enhance safety via real-time monitoring, address lost individuals with tracking tech, and preserve tradition while embracing innovation. Challenges include tech complexity and privacy concerns. Balancing these, it could redefine event safety and experience.

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Thank You !!

Questions if any…