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DEEP LEARNING BASED REAL-TIME CROWD COUNTING AND INTELLIGENCE SYSTEM IN GIRIVALAM PATH

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Abstract—*The large number of pilgrims on the Girivalam path makes crowd management and public safety difficult. To address this, the project introduces a deep learning–based real-time system that can monitor and analyse crowds effectively. It uses live video from surveillance cameras to understand how people are moving and gathering in different areas. The system applies computer vision techniques such as convolutional neural networks, density estimation, and facial recognition. These methods help in counting the number of people, detecting crowded areas, and tracking movement patterns. When the crowd becomes too dense or unusual activity is noticed, the system quickly identifies it. In addition, the system compares captured faces with a watchlist database to identify most wanted individuals. If a match is found, it immediately sends alerts to the authorities for quick action. This helps improve security and prevent potential threats. Overall, the proposed system increases safety, makes monitoring easier, and provides a smart solution for managing large gatherings like the Girivalam pilgrimage.*

Keywords: *Deep Learning, Crowd Counting, Computer Vision, Facial Recognition, Real-Time Surveillance.*

I. INTRODUCTION

Every year, thousands of people visit the Girivalam Path in Tiruvannamalai with strong faith and devotion. It is a very special and spiritual experience for them. But at the same time, managing such a large crowd becomes very difficult. Sometimes, it can even lead to safety issues if not handled properly.

In this project, we are trying to make this situation safer and easier to manage. We use a smart system based on deep learning that can watch the crowd through cameras in real time. This system can count the number of people, understand how they are moving, and find areas where the crowd is too heavy.

It can also recognize faces and help identify any suspicious or wanted persons. If there is any problem, the system quickly sends an alert to the authorities so they can take action immediately.

The main aim of this project is not just technology, but people's safety. We want every pilgrim to feel safe and peaceful during their visit. By using this system, we can reduce risks, improve monitoring, and create a better experience for everyone.

II. LITERATURE REVIEW

Introduced an easy and smart way to count objects in images. Instead of finding each object one by one, their method creates something called a density map. This map shows how crowded an area is, and by adding the values, we can get the total count. This approach works really well in crowded places where objects overlap, like people in a crowd. Because of its simplicity and accuracy, this method became very important in crowd counting and is widely used in modern computer vision systems.[1]

Introduced a deep learning-based approach for crowd counting using a Scale-Adaptive Convolutional Neural Network (CNN). The key idea of this method is to handle the variation in sizes of people within an image. People closer to the camera appear larger, while those farther away look smaller. The proposed model automatically adapts to these scale differences, allowing it to accurately estimate the number of people in crowded scenes. This approach significantly improved accuracy in dense crowd situations and became an important step forward in modern crowd counting techniques.[2]

Instead of using just one neural network, the researchers use multiple small networks (columns) working together. Each one looks at the image differently—some focus on small details (like people far away), and others focus on bigger shapes (like people closer to the camera). This helps because in crowd images, people appear in different sizes depending on distance.

Rather than directly counting people one by one, the system creates something called a density map. Think of it like a heatmap—areas with more people will glow more. Then it simply adds up all those values to get the total count. The cool part is, the system can automatically adjust to different crowd scenes without needing extra information about the camera angle or perspective.[3]

Imagine trying to count people in a very crowded place—like a festival or pilgrimage—where people are packed so tightly that you can't even clearly see individual faces. That's the kind of problem this paper tries to solve. The researchers came up with a smarter idea using something called dilated (or expanded) convolution. In simple terms, this technique lets the AI look at a wider area of the image without losing fine details. It's like zooming out to see more of the crowd, but still keeping everything sharp.[4]

Instead of using heavy, complex neural networks (which are slow and need powerful hardware), the researchers designed a lightweight model. This means the system is smaller, faster, and uses less memory, but still gives good accuracy.[5]

III. PROPOSED SYSTEM

CCTV cameras are placed along the path to monitor how people move and gather. These cameras work all the time, day and night, and continuously record live video. Since they are installed in different locations, they cover a wide area and give a full view of the crowd. This live video becomes the main input for the system and helps it understand what is happening in real time. Once the video is captured, it goes to the preprocessing stage. This step is important because raw video may not always be clear. Sometimes it may be too dark, too bright, blurry, or have unwanted noise. In this stage, the system improves the video quality. It adjusts brightness and contrast so people can be seen clearly. It also resizes the video frames into a fixed size so the system can process them quickly. Any noise or unnecessary details are removed. In simple words, preprocessing makes the video clean and ready for analysis. After that, the video is sent to the main part of the system, which is the crowd counting model. This model is built using deep learning and is trained with many crowd images. It works like the brain of the system. It looks at each frame and tries to estimate how many people are present. Counting each person one by one is very difficult, especially in crowded areas where people stand close together. Some people may also be hidden behind others. To solve this, the system uses a method called a density map. Instead of counting individuals, it shows where people are present using small values spread across the image. The density map looks like a heatmap. Areas with more people appear brighter, and areas with fewer people appear darker. This makes it easy to understand how the crowd is spread. By adding all the values in the map, the system can estimate the total number of people. This method is more accurate, even when the crowd is large or the camera angle changes. Next comes the analysis stage. Here, the system studies the density map to find crowded and less crowded areas. If any place has too many people, it is marked as a congestion zone. The system can also track how the crowd changes over time. For example, it can notice if more people are quickly gathering in one area. This helps in predicting problems before they happen. In the final stage, the system helps in decision-making. If a crowded area is detected, alerts are sent to authorities or security staff. They can take quick action, like guiding people to other paths, opening extra entry or exit points, or controlling the flow of people. This system is very useful in places like temples, festivals, and public events where large crowds gather. It helps prevent accidents like overcrowding or stampedes and improves safety. Overall, the system works like a smart helper. It watches the crowd, cleans the video, counts people using intelligent methods, identifies risky areas, and helps authorities take the right action at the right time.

IV. IMPLEMENTATION

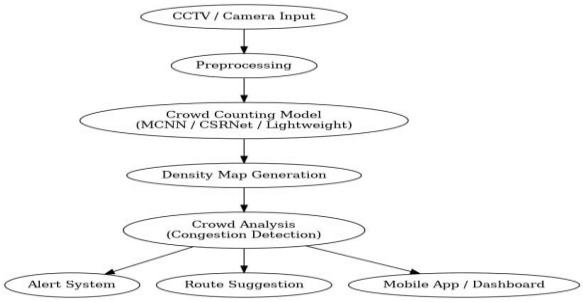

Fig. 1 Implementation of the system

- **CCTV Setup** – Cameras are placed along the path. They continuously capture live crowd video.
- **Video Input** – Live video is collected in real time. It acts as the main input for the system.
- **Preprocessing** – Video quality is improved. Brightness, clarity, and size are adjusted.
- **Model Processing** – Deep learning model analyses frames. It understands crowd patterns.
- **Density Map** – Crowd is shown as a heatmap. Bright areas mean more people.
- **People Counting** – Total crowd is estimated. Values from the density map are added.
- **Crowd Analysis** – System studies crowd distribution. It finds crowded and empty areas.
- **Congestion Detection** – Overcrowded zones are identified. Risk areas are highlighted.
- **Prediction** – Future crowd growth is predicted. Helps avoid overcrowding.
- **Alert System** – Alerts are sent to authorities. Action is taken to manage the crowd.

V. RESULTS AND DISCUSSION

The system uses a camera to capture live crowd video. The video is processed using deep learning to perform crowd counting, movement analysis, and face recognition. It estimates crowd density, tracks people movement, and matches faces with a watchlist database. If high density, suspicious activity, or a wanted person is detected, the system generates real-time alerts.

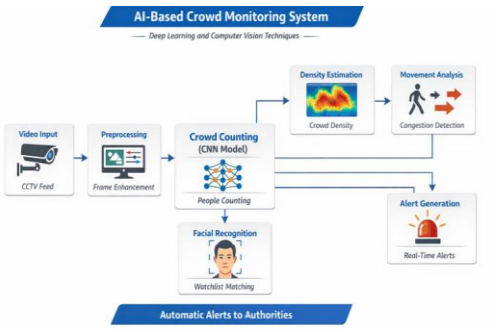

Fig.2 Sample Detection Results

VI. CONCLUSION

The system uses CCTV cameras to capture live crowd video and improves it for better clarity. AI then counts people, checks crowd density, and tracks movement. It also matches faces with a database. If overcrowding, unusual activity, or a wanted person is detected, it sends alerts to authorities for quick action.

The proposed deep learning-based real-time crowd counting and intelligence system provides an effective solution for managing large public gatherings. By integrating crowd counting, movement analysis, and identification of most wanted individuals, the system enhances public safety and improves surveillance efficiency. It reduces manual Effort, increases accuracy, and enables real-time decision-making through automated alerts. Overall, the system is reliable, scalable, and suitable for deployment in high-density areas.

VII. FUTURE SCOPE

Integration with IOT and smart city systems then advanced behaviour and anomaly detection with deployment on edge devices for faster processing of development of mobile alert applications expansion to multi-camera may be large area monitoring improved face recognition with larger dataset.

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