Human Counting with Gender Classification Using OpenCV

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Abstract - With the increasing need for crowd management in public spaces, workplaces, and events, an effective overcrowd detection system is essential for ensuring safety and compliance with occupancy regulations. This project, Overcrowd Detection and Human Count, is a computer vision-based application designed to analyse images, detect the number of individuals present, classify them based on gender, and compare the total count against a predefined threshold to determine if overcrowding occurs.

The system's interface allows users to upload an image and specify the maximum allowed limit for the number of people in the given space. Utilizing deep learning-based object detection techniques, the system accurately counts the number of individuals in the image and classifies them as male or female. If the detected count surpasses the specified threshold, the application triggers an "Overcrowd Detected" alert, accompanied by an audible warning to notify users of a potential overcrowding situation. Additionally, the system can generate an automated email notification to alert relevant authorities or administrators about the detected overcrowding event. Conversely, if the number of people is within the allowed limit, the system displays an "All is OK" message, indicating a safe occupancy level.

The system can be adapted for various real-world applications, including crowd control in public events, monitoring occupancy in offices or classrooms, managing foot traffic in retail stores, and ensuring compliance with social distancing guidelines.

One of the key advantages of this system is its ability to function efficiently without requiring expensive surveillance equipment. Instead, it processes static images and applies object detection algorithms to extract meaningful insights about occupancy levels. The system can be further enhanced to support real-time video feed analysis, automated reporting, and integration with access control mechanisms for dynamic crowd management.

By providing a simple yet effective solution for monitoring occupancy levels, this project contributes to improving public safety, optimizing space utilization, and assisting organizations in maintaining regulatory compliance. Future improvements may include incorporating AI-driven crowd density estimation, real-time video stream processing, and enhanced alert mechanisms such as mobile push notifications to further refine its efficiency and usability.

Keywords- Human detection, Counting, Manual, Decision making, Deep learning, Computer vision, Email notification, Automated system.

INTRODUCTION

In today's fast-paced world, managing crowd density has become a crucial aspect of ensuring safety and efficiency in various environments, including public spaces, offices, shopping malls, and transportation hubs. Overcrowding can lead to safety hazards, discomfort, and non-compliance with occupancy regulations, making it essential to develop automated solutions for human count and crowd detection.

This system, Overcrowd Detection and Human Count, aims to provide a practical solution for detecting overcrowding by analysing images and counting the number of people present. The system allows users to upload an image and set a maximum occupancy limit. Using computer vision and deep learning techniques, the model detects and counts individuals in the image while also classifying them as male or female.

By leveraging image processing and object detection algorithms, this system offers an efficient and cost-effective approach to crowd monitoring. Unlike traditional surveillance systems that require continuous monitoring, this solution automates the process, reducing human effort and improving response time in detecting overcrowded scenarios. The inclusion of gender classification provides additional analytical insights, helping organizations optimize resource allocation and security measures based on demographic distribution.

As technology continues to advance, the project has the potential to be expanded into a real-time monitoring system using live video feeds and AI-

driven predictive analytics. The implementation of such smart crowd management solutions contributes to improved public safety, better space utilization, and compliance with safety regulations. The integration of an automated email alert system ensures that necessary actions are taken promptly, further enhancing the system's effectiveness in managing crowd density.

OBJECTIVES

The primary objective of the Overcrowd Detection and Human Count project is to develop an efficient and automated system for detecting overcrowding by analysing images, counting the number of individuals, classifying them based on gender, and sending alerts when necessary. The key objectives of the project are:

Accurate Human Detection and Counting – Implement a computer vision-based approach to detect and count the number of people present in an image with high accuracy.

Gender Classification – Incorporate a deep learning model to classify detected individuals as male or female, providing additional demographic insights.

Overcrowding Detection – Compare the detected count with a predefined limit to determine whether the space is overcrowded and trigger an alert if necessary.

Automated Alert System – Generate a visual alert message and an audible beep when the number of detected individuals exceeds the specified threshold.

Email Notification Module – Automatically send email notifications to designated personnel or administrators when overcrowding is detected, ensuring timely action.

User-Friendly Interface – Develop an intuitive interface that allows users to upload images, set crowd limits, and receive alerts easily.

Improved Safety and Compliance – Assist organizations, event managers, and public authorities in maintaining safety protocols and compliance with occupancy regulations.

Cost-Effective Solution – Provide an affordable and efficient alternative to traditional surveillance systems without requiring continuous human monitoring.

Scalability and Future Enhancements – Lay the foundation for future enhancements, such as real-time video analysis, AI-driven crowd density estimation, and integration with security systems.

By achieving these objectives, the project aims to contribute to effective crowd management, reducing risks associated with overcrowding while ensuring a smooth and organized environment in various settings.

OVERVIEW

The Overcrowd Detection and Human Count system is designed to provide an advanced, automated, and efficient approach to monitoring crowd density. The system integrates deep learning-based image processing techniques to detect, count, and classify individuals based on gender while comparing the count to a predefined limit to determine overcrowding.

The system features an intuitive user interface that allows users to upload an image and specify the maximum permitted occupancy limit. The system processes the image using state-of-the-art object detection models to identify people, classify them as male or female, and determine the total count. If the detected count exceeds the predefined threshold, the system triggers an audible and visual alert, notifying users of overcrowding. Additionally, an automated email notification system is implemented to inform designated personnel of the situation in real time.

Future enhancements of the project may include real-time video stream processing, AI-driven predictive analytics, integration with IoT-enabled security systems, and cloud-based monitoring for centralized crowd management.

SYSTEM STUDY

Problem Statement

Managing crowd density in various environments is a critical challenge affecting safety, security, and compliance with occupancy regulations. Traditional crowd monitoring methods, such as manual counting or CCTV surveillance, are prone to human errors, inefficiency, and high operational costs. Overcrowding can lead to safety hazards, discomfort, and legal violations, making it essential to develop an automated solution that accurately detects and manages crowd levels.

The Overcrowd Detection and Human Count system addresses this issue by providing an AI-powered image processing solution that detects and counts individuals in an image, classifies them by gender, and alerts users when the occupancy exceeds a predefined threshold. The system ensures real-time monitoring, accurate people detection, automated alerts, and an email notification system, making it an effective tool for event organizers, security teams, and public administrators.

SYSTEM DESIGN

The system architecture consists of three main components:

User Interface (UI):

- Allows users to upload an image.
- Provides an input field for setting the maximum allowable crowd limit.
- Displays the total detected count, male and female count, and system response (Safe or Overcrowded).

Processing Module:

- Uses computer vision and deep learning techniques to analyse the uploaded image.
- Detects and counts the number of people using object detection algorithms (e.g., YOLO, OpenCV, or TensorFlow-based models).
- Classifies detected individuals into male and female categories.
- Compares the detected count with the predefined limit.
- Triggers an alert if the count exceeds the threshold.

Alert System:

- Displays an "Overcrowd Detected" message when the limit is exceeded.
- Plays an alert sound to notify users.
- Sends an automated email notification to relevant authorities.
- Displays "All is OK" if the number of people is within the allowed range.

System Flow

The following steps describe the workflow of the Overcrowd Detection and Human Count system:

User Uploads an Image:

- The interface allows the user to upload an image that contains a crowd.
- The image is displayed in a preview window after upload.

User Sets the Occupancy Limit:

- The user inputs the maximum allowed number of people for the given space.

Image Processing & Human Detection:

- The system applies image pre-processing techniques (resizing, filtering, etc.).
- A deep learning object detection model detects and counts the people in the image.
- The system classifies detected individuals into male and female categories.

Comparison with Threshold:

- The system compares the detected count with the user-defined limit.

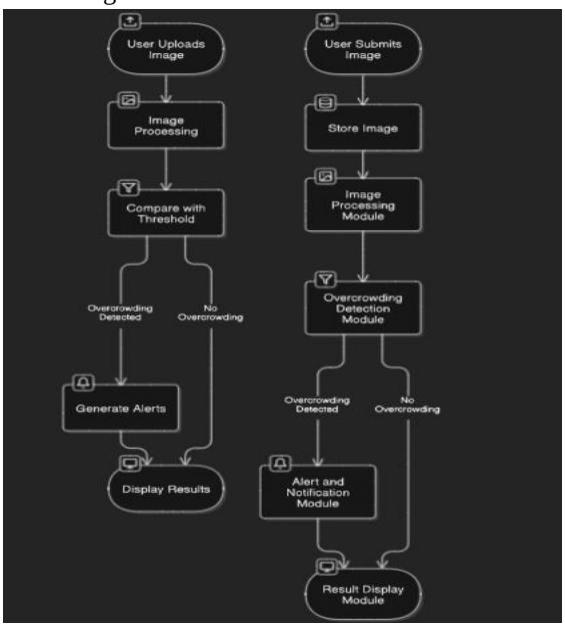
Decision Making & Alerts:

- If count ≤ limit: Displays "All is OK."
- If count > limit: Displays "Overcrowd Detected," triggers an alert sound, and sends an email notification.

Display Results:

- The interface displays the total count, male and female count, limit, and system status message to the user.

Flow Diagram:



Existing System

Currently, crowd management relies on manual supervision, CCTV monitoring, or basic sensor-based counting systems. These methods have several limitations:

Manual Supervision:

- Requires human personnel to visually estimate the crowd size.
- Prone to human error, inconsistency, and inefficiency in large crowds.
- Requires continuous monitoring, leading to fatigue and high labour costs.

CCTV Surveillance:

- Involves reviewing security footage for monitoring crowd density.
- Requires human intervention to analyse footage and make decisions.
- Lacks real-time automated alerts for overcrowding.

Sensor-Based Systems:

- Uses infrared or pressure sensors to count people entering/exiting a space.
- Effective only for structured entry/exit points, not for open areas.
- Limited accuracy in dynamic environments with free movement.

Limitations of the Existing System

- Inaccuracy: Manual counting and visual estimation are unreliable.
- High Cost: Advanced surveillance systems are expensive to install and maintain.
- Slow Response Time: Overcrowding detection is delayed due to human dependency.
- Limited Automation: No real-time, automated overcrowding alerts or classification features.
- Scalability Issues: Manual counting is impractical for large crowds.
- Resource Intensive: Requires dedicated personnel, increasing labor costs and operational inefficiencies.

PROPOSED SYSTEM

The Overcrowd Detection and Human Count system overcomes these limitations by using computer vision and deep learning to automatically detect, count, and classify people in an image. The system provides a fast, cost-effective, and highly accurate solution for monitoring crowd density. The system automatically detects and counts people in real time using advanced deep learning models such as YOLO and Faster R-CNN while also classifying individuals based on gender and additionally, an overcrowding alert mechanism is implemented,

Comparison Between Existing and Proposed Systems:

Feature	Existing System	Proposed System
Detection Method	Manual counting / CCTV analysis	Automated image processing using AI
Accuracy	Low (Prone to human error)	High (Deep learning-based detection)
Automation	Limited / Requires human effort	Fully automated system
Scalability	Limited (Static surveillance setup)	Scalable (Can integrate real-time video feeds)
Gender Classification	No	Yes (Male and Female count)
Real-Time Alerts	No	Yes (Visual, Sound, and Email alerts)
Cost Efficiency	Expensive (CCTV + human monitoring)	Cost-effective (AI-based software)

By addressing the drawbacks of traditional systems and incorporating gender classification and automated alerts, the proposed system ensures better crowd management, safety, and compliance with occupancy regulations.

Module Description

Image Input & User Interface Module:

- Allows users to upload an image containing a crowd.
- Provides an option for users to set a predefined crowd limit.
- Displays real-time count results, including total count and gender-based classification.

Image Processing Module:

- Processes the uploaded image to enhance quality and prepare it for detection.
- Applies image pre-processing techniques such as resizing, filtering, and noise reduction.

- Converts images into a format suitable for object detection algorithms.

Human Detection and Counting Module:

- Uses deep learning-based object detection models such as YOLO, OpenCV, or TensorFlow.
- Accurately detects and counts individuals in the image.
- Classifies detected individuals into male and female categories for additional analytics.

Overcrowd Detection & Alert Module:

- Compares the detected human count with the predefined threshold.
- Triggers an “Overcrowd Detected” alert if the count exceeds the limit.
- Generates an audible alert and visual warning on the interface.

Email Notification Module:

- Sends automated email notifications to relevant authorities when overcrowding is detected.
- Ensures timely response and improves overall crowd management efficiency.

Result Display Module:

- Presents the final results in a structured format.
- Displays the total number of detected people, classified male and female count, and system status.
- Provides detailed logs for analysis and future improvements.

CONCLUSION

The Overcrowd Detection and Human Count system provides an innovative and efficient approach to managing crowd density in various environments. By leveraging deep learning and computer vision, the system ensures accurate people detection, gender classification, and automated alert mechanisms, including email notifications and sound alerts. This enhances public safety, regulatory compliance, and resource optimization for event management, workplace safety, and public gatherings.

By continuously integrating advanced technologies and improving system capabilities, the project aims to revolutionize crowd management and safety measures. The Overcrowd Detection and Human Count system sets the foundation for a smarter, more secure, and efficient way to monitor and control occupancy levels in real time, ensuring enhanced security and optimized space utilization.

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