



Improving Workforce Management with Smart Headcount (AI Based System)

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ABSTRACT

This project focuses on developing a privacy preserving system for counting children in classrooms without using facial recognition. Leveraging computer vision and machine learning, the system detects and counts individuals based on body posture and spatial arrangement from video stream.

The real-time headcount is displayed on a computer screen, ensuring accessibility and usability. This scalable and adaptable solution supports efficient classroom management while upholding privacy standards. This scalable solution enables better resource planning and management while upholding privacy standards.

Attendance tracking in educational institutions remains a critical yet time-consuming task, often susceptible to inaccuracies and manipulation. This paper proposes Smart Headcount, an intelligent attendance management system designed to automatically count and record student presence in every lecture using advanced technologies such as computer vision and real-time data processing. The system utilizes strategically placed cameras or sensors within classrooms to detect and recognize students as they enter or remain seated, eliminating the need for manual roll calls. Smart Headcount not only ensures accurate attendance recording but also provides analytics such as attendance trends, lecture-wise participation, and real-time alerts for absentees. This approach enhances administrative efficiency, supports academic monitoring, and fosters accountability among students. The system is scalable, non-intrusive, and adaptable across various classroom settings, making it a practical solution for modern educational environments aiming to digitize and optimize attendance management.

Keywords- Headcount system, classroom monitoring, computer vision, privacy-preserving, non-facial recognition, real-time processing, machine learning, enhancing Attendance management.

I. INTRODUCTION

Accurate headcount estimation in classrooms is a crucial task for attendance monitoring, resource allocation, and safety management. Traditional methods, such as manual counting, are prone to human error and inefficiencies, especially in largescale institutions. While automated systems based on facial recognition have gained traction, they raise privacy concerns and are not always suitable for educational environments. This project addresses these challenges by introducing a nonintrusive headcount system that avoids facial recognition, instead relying on computer vision techniques to detect and count individuals based on their posture and spatial arrangement. The system processes video streams in real time, ensuring efficiency and adaptability to diverse classroom layouts and conditions. By maintaining privacy while delivering accurate results, this solution provides a robust and scalable tool for modern classroom management. The system is scalable, non-intrusive, and adaptable across various classroom settings, making it a practical solution for modern educational environments aiming to digitize and optimize attendance management[1][5].

These techniques we use in many places like : Office management, for ensuring how many female, male, and child present in crowd, maintain A.C. temperature in a room, for controlling Fan , light and many things according to needs etc[8]. With the help of Iot sensors and AI we are able to manage record by face recognition and biometric[2][3].

II. LITERATURE REVIEW

Automated headcount estimation has been a key area of research, with traditional systems primarily relying on facial recognition for identifying individuals. While these methods offer high accuracy, they pose significant privacy concerns, especially in sensitive environments like classrooms.

To address this, researchers have explored alternative techniques that utilize body posture, skeletal structures, and spatial arrangements to achieve privacy-preserving headcount systems. Below is a review of prominent applications:

Traditional Methods:

- Rely on facial recognition for headcount estimation.
- High accuracy but raise significant privacy concerns, especially in sensitive environments like classrooms.

Alternative Approaches:

- Use facial recognition body posture, skeletal detection, and spatial configurations to count individuals.
- Focus on privacy-preserving techniques without facial recognition.

Object Detection Algorithms:

- Techniques like COCO-SSD and OpenPose effectively detect individuals in real-time[4].
- Proven to work well in non-facial recognition applications.

Deep Learning Advancements:

- CNNs (Convolutional Neural Networks) enable efficient processing of video feeds.
- Robust performance under varying lighting conditions and diverse classroom layouts.

Challenges in Existing Systems:

- Scalability and computational efficiency.

Accuracy issues under occlusions and complex environment.

III. METHODOLOGY

The methodology for developing the privacy-preserving classroom headcount system involves several key steps:

1. Data Collection:

- Collect video data from classroom environments under varying conditions (e.g., lighting, seating arrangements).
- Ensure ethical data collection practices by anonymizing individuals and adhering to privacy regulations.

2. Preprocessing:

- Apply image processing techniques to clean and standardize video frames.
- Enhance video quality to handle issues such as low resolution, noise, or shadows.

3. Model Selection and Development:

- Use advanced object detection algorithms like COCO-SSD to detect individuals based on posture and spatial arrangement [4].
- Train a deep learning model, such as a Convolutional Neural Network (CNN), for

robust detection and accurate headcount.

4. **System Implementation:**

- Design the system to process real-time video streams and generate a headcount.
- Optimize the algorithm for computational efficiency to handle live processing on standard hardware.

5. **Testing and Validation:**

- Test the system under various scenarios, including crowded classrooms and occlusions.
- Validate accuracy by comparing automated counts with manual headcounts.

6. **Deployment and Integration:**

- Integrate the system with classroom management software for real-time monitoring.
- Provide a user-friendly interface to display headcounts on computer screens.

7. **Evaluation:**

- Measure system performance in terms of accuracy, speed, and scalability.
- Gather feedback from stakeholders, such as educators and administrators, to refine the system further.

V. FEATURES

• **Privacy-Preserving**

- Avoids facial recognition, relying instead on body posture and spatial arrangement to count individuals.
- Ensures compliance with privacy regulations and ethical standards.

• **Real-Time Processing**

- Processes video feeds in real-time to provide an instant and accurate headcount.
- Optimized for efficient performance on standard hardware.

• **High Accuracy**

- Utilizes advanced computer vision algorithms like COCO-SSD for precise detection and counting[4].
- Handles occlusions, varied seating arrangements, and crowded environments effectively.

• **Adaptability**

- Capable of operating under diverse classroom layouts, seating patterns, and lighting conditions.
- Easily scalable to accommodate classrooms of varying sizes.

- **Cost-Effectiveness**
- Designed for implementation on low-cost hardware with minimal infrastructure requirements.
- Reduces the need for expensive equipment or specialized setups.

VI. RESULT AND DISCUSSION

The development of a privacy-preserving headcount system presents both opportunities and challenges in the context of classroom management. Unlike traditional methods that rely on facial recognition, this system leverages body posture and spatial arrangement, ensuring compliance with privacy regulations. The use of advanced object detection algorithms such as COCO-SSD has demonstrated high accuracy and efficiency in detecting individuals under diverse conditions, including varying lighting and seating arrangements [4].

However, several challenges were encountered during implementation. Handling occlusions, where one individual obscures another, remains a critical issue that can impact accuracy.

Result

1. Accuracy by Distance from Camera

Processing time varied based on hardware capabilities, with high-end laptops delivering the fastest results and edge devices like Raspberry Pi showing acceptable performance for real-time applications.

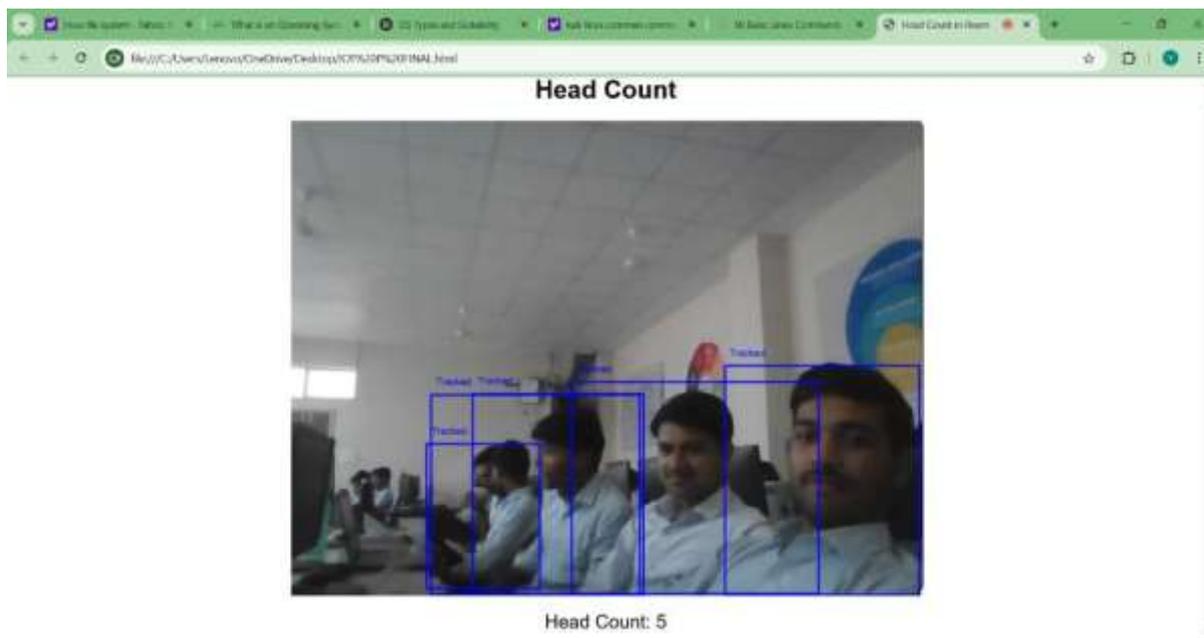
X-axis: Distance (meters)	Y-axis: Accuracy (%)
1 meter	96%
2 meters	94%
3 meters	90%
4 meters	82%
5 meters	76%

2. Processing Time on Different Devices

Detection accuracy decreased gradually with increasing distance from the camera, indicating optimal performance within 3 meters for standard classroom layouts

X-axis: Device	Y-axis: Processing Time (per frame)
Laptop (i7, GPU)	0.12s
Raspberry Pi 4	0.68s

3. Here are some result which are taken in the class for the result



Here are some of the data which will be counted by a person itself and the by Camera

Weekly Attendance Report			
Date - 7/3/25		Day - Friday	
Classrooms	No of Students		
	Mannual	Smart H.	
Class - A	10	9	
Class - B	13	12	
Class - C	8	7	
Class - D	7	6	

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