Automated Vacancy Detection from Image Using IoT Technology

Real-Time Seat Monitoring with Image Processing, YOLOv5, HTTP, Flask and ESP32 M5Stack

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Project Motivation

Manual Monitoring Limits

Inefficient and time-consuming process

Real-Time Demand

Smart campuses require instant seat availability updates

Resource Optimization

Improves scheduling and classroom management

Post-COVID Safety

Supports compliance with occupancy and distancing policies

Problem Statement

Challenges

- **Automate vacant versus occupied seat detection**
- **Integrate computer vision with IoT hardware**
- **Lightweight, low-cost real-time processing**

Objectives

- **Use ESP32 M5Stack for image capture & communication**
- **Provide instant seat status updates**
- **Minimize human intervention and error**

System Architecture Overview

1

User Interface

Sends seat availability request

2

Flask Server

Handles request and forwards to ESP32

3

ESP32 M5Stack

Captures image, sends to server

4

YOLOv5 Model

Performs seat detection inference

5

Display & Interface

Outputs vacancy status

Methodology: Step-by-Step Process

User Request

Initiates vacancy check via interface

HTTP Request

Flask sends to ESP32 IoT device

Image Capture

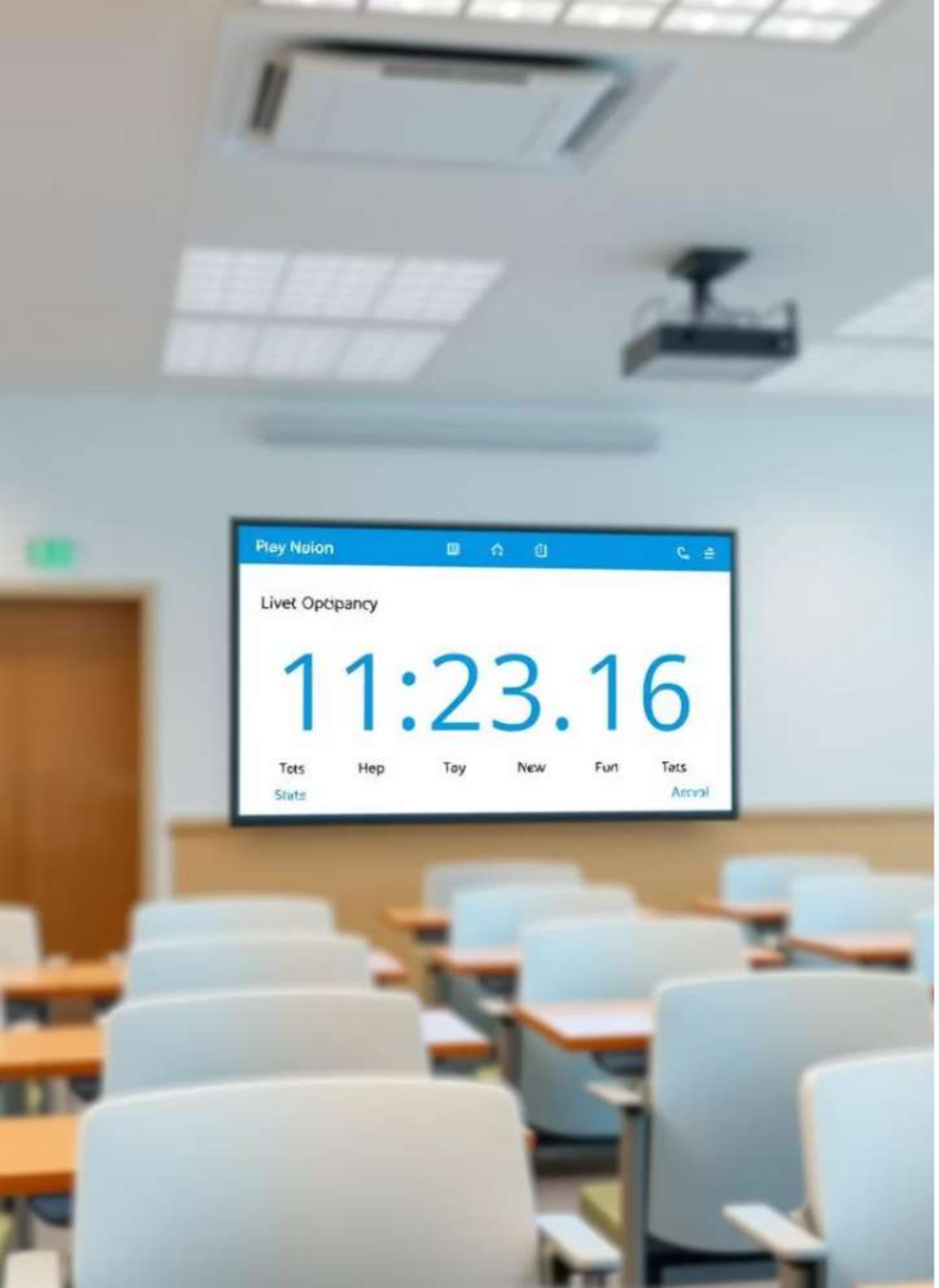
ESP32 captures and uploads image

Inference

YOLOv5 processes image on server

Result Display

Vacancy shown on web and ESP32 screen



Real-Time Dashboard on ESP32 M5Stack

Live Seat Stats

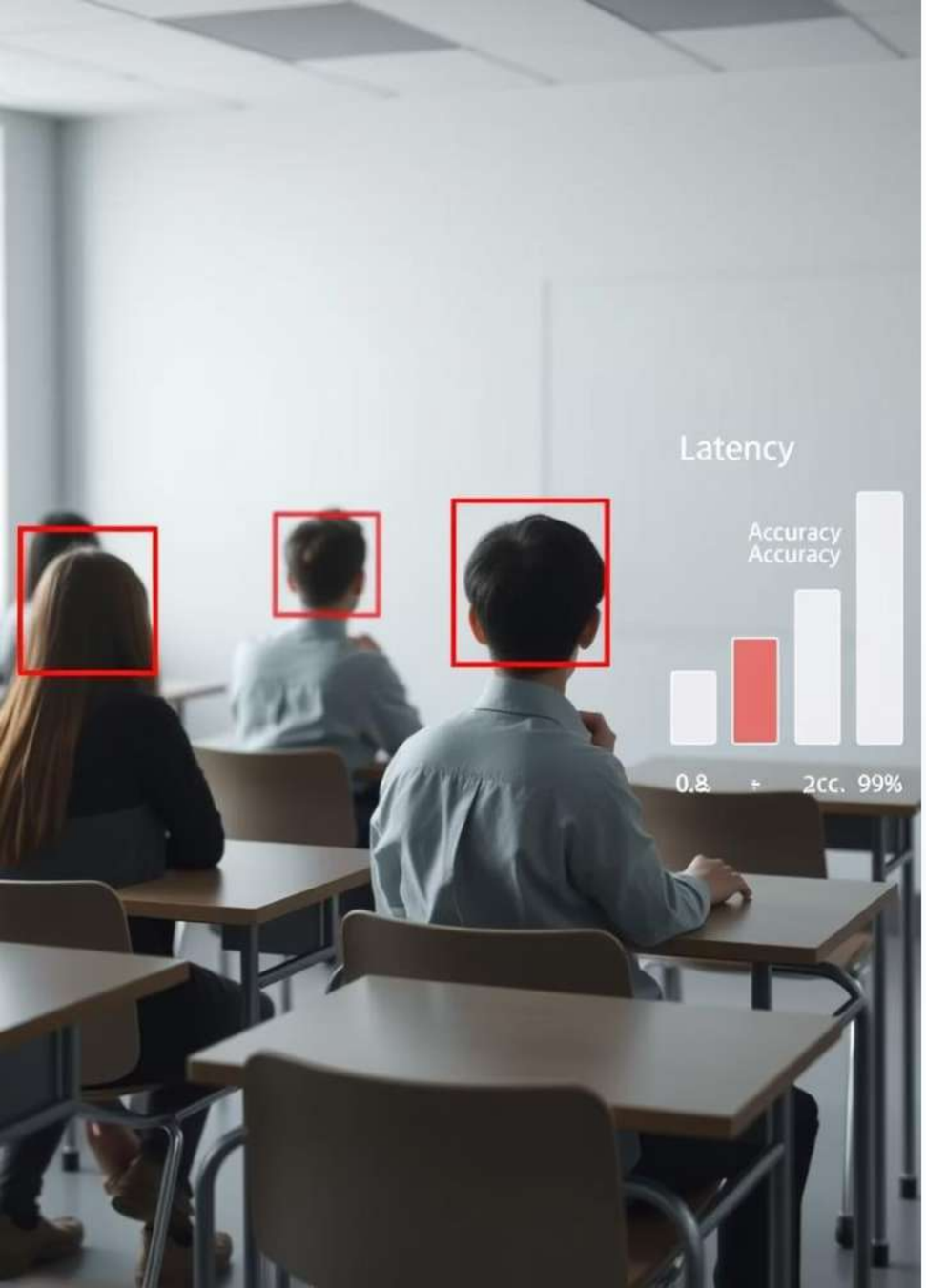
Total seats: 24

Occupied Seats

16 seats detected as occupied

Vacant Seats

8 seats currently free



Results and Key Observations

1. **Accuracy**
   ~90% in good lighting
2. **Inference Time**
   250ms on server GPU
3. **Latency**
   700ms-1s overall ESP32 display delay
4. **Environment**
   Best with top-down, well-lit views

Conclusion

Automated Detection

Real-time, image-based seat vacancy system

IoT Integration

Combines YOLOv5, Flask & ESP32 seamlessly

Smart Campus Impact

Enables efficient, scalable infrastructure management

Cost-Effective

Low-cost hardware, lightweight processing solution