VISHWAKARMA UNIVERSITY Maximising Human Potential	**PROJECT SYNOPSIS**

DEPARTMENT: COMPUTER ENGINEERING **ACADEMIC YEAR:**

- **Project Group ID: B4**
- **Title of the Project: IoT-Based Energy Optimization**
- **Domain of Project: IOT , AI**
- **Team Members:**

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- **Technical Key Words (Ref. ACM Keywords)**
  Internet of Things (IoT)
  Smart Classroom
  Human Detection
  Machine Learning (ML)
  ESP32 Microcontroller
  ESP32-CAM
  Energy Optimization
  Automation Systems
  Laser Sensor
  Occupancy-Based Control
  Embedded Systems
  Sustainable Computing
  Edge Computing
  Computer Vision

Real-Time Systems

- **Technical Keywords (Other than ACM Keywords)**

Human Presence Detection
Energy-Efficient Automation
Intelligent Lighting Control
Smart Fan Regulation
IoT-Based Smart Infrastructure
Sensor-Based Occupancy Detection
Object Recognition in Embedded Systems
AI-Powered Human Detection
Real-Time Sensor Fusion
Microcontroller-Based Automation
Low-Power Wireless Communication
Edge AI for IoT
Thermal and Visual Sensing
Classroom Energy Management
Embedded Vision System

- **Problem Statement**

. Smart IoT-Based Human Detection and Energy Optimization System for Classrooms

- **Abstract:-**

Our project aims to develop an IoT-based system that intelligently manages classroom electrical devices, such as lights, fans, and projectors, by detecting human presence. The system ensures energy efficiency by turning off all devices when no human is present and selectively controlling them based on real-time occupancy.

The system comprises an ESP32 microcontroller for overall control and an ESP32-CAM module integrated with a machine learning algorithm to accurately detect humans while filtering out other living beings. Additionally, a laser sensor determines the precise location of individuals within the classroom, enabling a targeted approach—keeping only the lights and fans directly above the detected occupants switched on while turning off unused devices.

This intelligent automation solution enhances energy conservation, reduces manual intervention, and contributes to sustainable energy usage in educational institutions. Future extensions may include integrating attendance monitoring, voice commands, or mobile app

control for enhanced usability.

- **Objectives and goals:-**

Energy Efficiency: Reduce electricity wastage by automatically turning off lights, fans, and projectors when no human presence is detected.

Accurate Human Detection: Implement an ML-based ESP32-CAM system to ensure only humans are identified, eliminating false triggers from animals or objects.

Location-Based Control: Utilize a laser sensor to pinpoint the exact location of individuals and activate only the necessary devices in their vicinity.

Automation and Convenience: Minimize manual intervention by creating an intelligent system that operates autonomously based on real-time classroom occupancy.

Scalability and Future Enhancements: Design a system that can be expanded to integrate attendance tracking, mobile app control, or voice-based automation for improved usability.

This project aims to enhance sustainability in educational institutions by promoting responsible energy consumption while ensuring a seamless classroom experience for students and faculty.

- **System Description:-**

  - **Input:**

    1. ESP32-CAM (Camera Module) → Captures real-time video frames to detect human presence using the AI model.
    2. Laser Sensor → Measures distance and determines the exact location of individuals in the classroom.
    3. ESP32 Microcontroller → Collects and processes data from the camera and laser sensor.
    4. Machine Learning Model → Analyzes video feed to differentiate humans from other objects or living beings.
    5. User Input (Optional) → Manual override through a mobile app or voice command for device control.

  - **Output:**

1. Lights and Fans Control → Switches ON only in areas where people are detected and OFF in unoccupied zones.

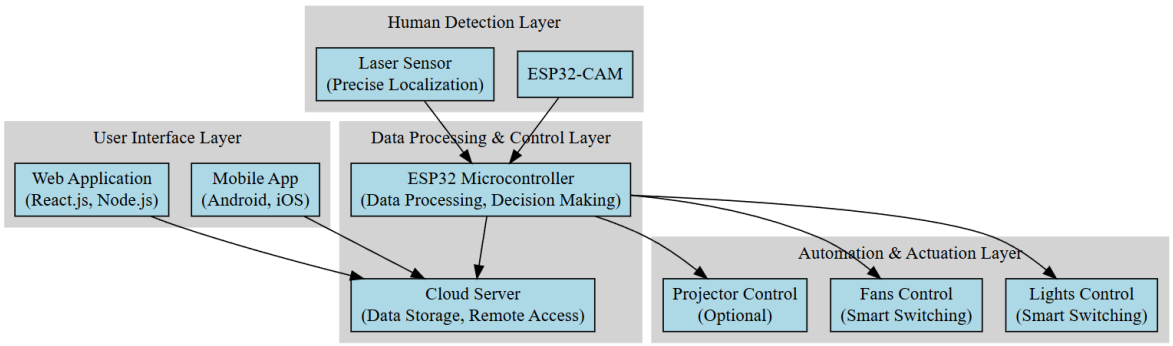
2. Energy Optimization → Turns OFF all devices when no one is in the classroom to prevent energy wastage.

3. Data Transmission → Sends status updates to a cloud server or mobile app for remote monitoring.

4. Alerts/Notifications → (Future scope) Generates reports on energy usage, occupancy, or attendance tracking.

System architecture

Fig: System Architecture.



Explanation –

- **Functions :**

1. Human Presence Detection → Detects the presence of people in the classroom using an ESP32-CAM and a AI model.
2. Zone-Based Device Control → Activates only the lights and fans in the areas where people are present, ensuring targeted energy usage.
3. Automatic Power Saving → Turns off all electrical devices (lights, fans, projectors, etc.) when the classroom is unoccupied.
4. Real-Time Monitoring & Control → Provides real-time updates on classroom occupancy and device status via a cloud-based dashboard or mobile app.
5. Manual Override → Allows users (teachers, administrators) to manually control devices through an app, web interface, or voice command.
6. Energy Usage Optimization → Reduces electricity consumption by automating device control based on occupancy, contributing to cost savings and sustainability.
7. Scalability & Multi-Room Support → Can be extended to multiple classrooms with centralized control.
8. Security & Safety Alerts → (Future scope) Can integrate fire or unauthorized access detection to enhance security.
9. Attendance Tracking → (Future scope) Can log student presence data for automated attendance monitoring.

- **Success Conditions:**

1. Accurate Human Detection → The AI model correctly identifies humans in the classroom and avoids false detections (e.g., pets, shadows, or objects).
2. Precise Localization → The laser sensor accurately determines the position of individuals to activate only the necessary lights and fans.

3. Energy Efficiency → Lights and fans turn ON only in occupied zones and OFF when no one is detected.
4. Seamless Automation → The system operates without manual intervention while allowing overrides via a mobile app (if implemented).

5. Real-Time Processing → Detection and response occur with minimal delay, ensuring a smooth user experience.

6.Scalability & Reliability → The system functions effectively across multiple classrooms with consistent performance.