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Human Detection based Light and Fan Control

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ABSTRACT: This project seeks to create an automated lighting and fan control system using Python and the YOLO object detection algorithm. The system will intelligently manage indoor environments by detecting human presence within a room and analyzing ambient conditions.

When a person is detected in a dimly lit room, the system will automatically illuminate the space. Furthermore, it will activate a fan when the room temperature surpasses a predetermined limit. Conversely, in the absence of human occupants or sufficient ambient light, the system will deactivate both lights and fan to optimize energy consumption. By integrating computer vision and environmental sensing, this project aims to provide a convenient and energy-efficient solution for indoor spaces.

KEYWORDS: Smart Home Automation, YOLO Object Detection, Energy Efficiency

I. INTRODUCTION

As technology advances, there's a growing interest in creating intelligent systems that prioritize convenience and energy savings within our surroundings, particularly indoor spaces. A key area of exploration is automating lighting and climate control. Traditional methods often rely on predetermined schedules or manual adjustments, which can be wasteful and inconvenient. This project proposes a groundbreaking approach that leverages Python and computer vision techniques to address these limitations.

This project focuses on building a smart system that automatically adapts lighting and climate based on real-time data about the environment and whether people are present. The system will combine powerful computer vision techniques with environmental sensors to intelligently react to changes, creating a balance between comfort and energy efficiency. This system will use computer vision to continuously monitor if people are in the space, allowing for dynamic adjustments to lighting levels. This means lights will only be turned on or adjusted when someone is present. It will also utilize ambient light sensors to further optimize energy use. These sensors will ensure lights are only activated when needed, preventing unnecessary use in well-lit areas.

This system doesn't stop at lighting! Temperature sensors are also included to ensure a comfortable environment. If the temperature gets too high, signaling potential discomfort, the system will automatically activate features like fans to regulate the climate and keep things cool.

This system offers a double win: it keeps people comfortable while minimizing energy waste by using resources intelligently. By combining these technologies, we create a powerful tool for managing indoor environments in a smart way. The following sections will detail the project's methods, how we'll build it, and how we'll measure its success. This will showcase how the system effectively improves comfort and promotes sustainability in indoor spaces.

II. OBJECTIVES

- Create a self-learning system for lighting and fan adjustments based on human occupancy and surrounding conditions.
- Leverage YOLO (You Only Look Once) technology to precisely identify when people are in the room.
- The system utilizes environmental sensors, including light sensors to track ambient light levels and temperature sensors to monitor room temperature.
- The system will achieve smooth coordination between computer vision and sensor data to dynamically adjust lighting and fan settings.

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- This system prioritizes energy savings by intelligently activating devices only when needed, using real-time data on the environment and whether people are present.

III. EXISTING SYSTEM

Currently, there are two main ways people control lights and fans indoors. The classic approach relies on manual switches, offering direct control over turning them on and off. However, a growing trend is the use of smart assistants like Alexa. These voice-activated devices allow hands-free control and can even integrate with other smart home features for a more connected experience.

While traditional switches remain popular, other options are emerging. Some users opt for motion sensors, like passive infrared (PIR) sensors. These sensors automatically detect people in a room and adjust lights or fans based on occupancy. This hands-free approach offers convenience and saves energy by ensuring devices are only activated when someone is present. Ultimately, these various control methods cater to different preferences, providing flexibility in managing indoor spaces for both comfort and energy efficiency.

IV. PROPOSED SYSTEM AND METHODOLOGY

A. PROPOSED SYSTEM

This system focuses on real-time human detection using a computer vision technique called YOLO. YOLO works with OpenCV software to analyze a webcam feed and identify people. When someone is detected, the system sends a signal through a serial port to a microcontroller. This microcontroller can then be programmed to take various actions, such as triggering alerts or adjusting the environment based on whether someone is present.
This comprehensive approach focuses on both efficiency (reducing energy waste) and user convenience (maintaining a comfortable environment). This makes the system adaptable to a wide range of applications, from smart homes and offices to educational institutions and retail spaces. The system can automatically adjust lighting and fans based on occupancy and environmental conditions.

B. METHODOLOGY

1. Hardware Setup

- **Microcontroller:** Select a microcontroller with serial communication capabilities (e.g., Arduino, Raspberry Pi Pico, ESP32).
- **Sensors:**
  - Light Dependent Resistor (LDR) for measuring light intensity.
  - Temperature sensor (e.g., DHT11, LM35) for monitoring room temperature.
- **Output Devices:**
  - Relay modules to control the light and fan.
- **Power Supply:** Provide adequate power supply for the microcontroller, sensors, and relays.

2. Microcontroller Programming

- **Serial Communication:** Implement serial communication protocol (e.g., UART) to receive commands from the Python program.
- **Sensor Reading:** Write functions to read data from the LDR and temperature sensor.
- **Control Logic:** Develop algorithms to determine the state of the light and fan based on sensor readings and received commands.
- **Error Handling:** Incorporate error handling mechanisms for unexpected inputs or sensor failures.

3. Python Program Development

- **Serial Communication:** Use a library like pySerial to establish communication with the microcontroller.
- **Object Detection:** Implement YOLO object detection using a pre-trained model to detect humans in the room.
- **Sensor Data Processing:** Read sensor data from the microcontroller and process it to determine light and temperature conditions.
- **Command Generation:** Generate appropriate commands based on sensor data, object detection results, and predefined thresholds.
- **Real-time Processing:** Ensure efficient processing of sensor data and timely communication with the microcontroller.

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4. Integration and Testing

- **Hardware Assembly:** Connect all hardware components according to the designed system architecture.
- **Software Integration:** Upload the firmware to the microcontroller and run the Python program.
- **System Testing:**
  - Test the accuracy of YOLO object detection under different lighting conditions.
  - Verify the system's response to changes in light intensity and temperature.
  - Evaluate the communication between the Python program and the microcontroller.
- **Parameter Tuning:** Adjust threshold values and control algorithms based on test results.

V. SYSTEM DESIGN AND WORKING

The "Human Detection-Based Light and Fan Control using YOLO" project utilizes computer vision to create a smart home system that automatically manages lights and fans. It leverages YOLO, a pre-trained object detection model, to identify people within a live video stream. When someone is detected, a signal is sent to an Arduino board, which then controls the connected lights and fans. The system prioritizes both comfort and energy efficiency by turning on lights and fans upon detecting presence, and turning them off after a short period of inactivity. This intelligent automation, along with features like multi-threading for smooth operation and a user-friendly interface for monitoring, makes this project a compelling solution for smart environment management.

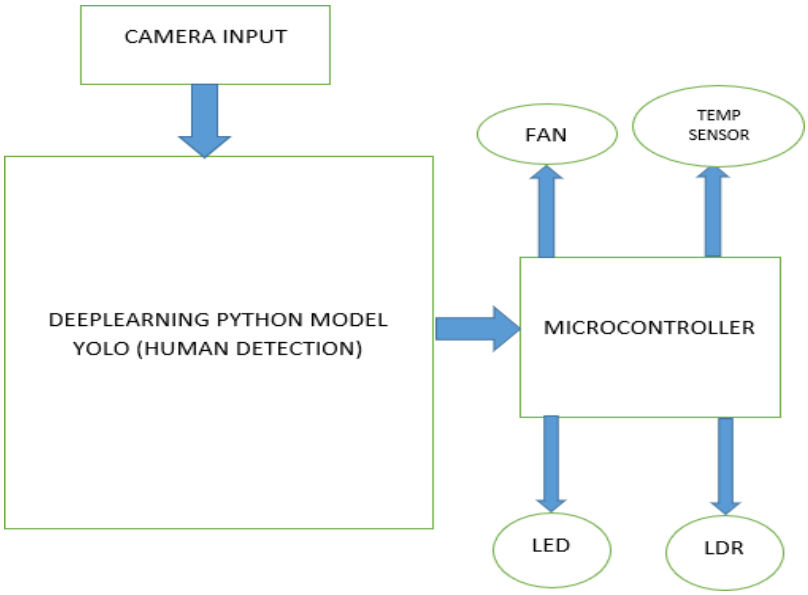

Fig. System Architecture

How it works:

1. **Human Detection:** YOLO, pre-trained to identify people, analyzes each video frame.
2. **Reliable Detection:** The system focuses on the "person" class with a high confidence threshold (0.5) for accurate detection.
3. **Communication:** If a person is detected, a signal ("1") is sent through the serial port to an Arduino board.
4. **Automation:** The Arduino controls lights and fans. It turns them on ("1") when someone is around and turns them off ("2") after 5 seconds of no detection, saving energy.
5. **Continuous Monitoring:** The system constantly checks for changes in presence and sends updated control signals.
6. **Smooth Operation:** Multi-threading ensures the system runs smoothly, handling video processing and communication simultaneously.
7. **User Interface:** A live video feed with bounding boxes around detected people provides visual feedback.
8. **Graceful Termination:** The program properly releases resources and closes windows when stopped with the 'q' key.

This system combines computer vision and automation to create a smart home environment that prioritizes both comfort and energy efficiency.

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VI. CONCLUSION

Creating an intelligent system that autonomously adjusts lighting and fan settings based on occupancy, ambient light, and temperature represents a significant step forward in enhancing both comfort and energy efficiency in indoor environments. By integrating Python programming, object detection capabilities through YOLO, and microcontroller-based hardware, we've developed a dynamic system capable of real-time optimization of indoor conditions.

This proactive approach enhances user comfort while optimizing energy efficiency by reducing unnecessary power consumption.

To summarize, this integrated approach to automated lighting and fan control marks a significant step towards creating more intelligent and sustainable indoor spaces. By seamlessly blending technology with human comfort, we can enhance living conditions while optimizing energy consumption.

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