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SMART DETECTION AND AUTOMATIC SWITCHING SYSTEM USING AI

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ABSTRACT

In this project, we present a system that integrates face count detection using a web camera with an automatic light on/off mechanism, controlled by an Arduino Nano microcontroller. The system is designed to enhance energy efficiency in smart home and office environments by automatically controlling lighting based on the presence and number of people in a room. The core of the system comprises a face detection algorithm using computer vision techniques, combined with an Arduino-based control unit that interfaces with the lighting system. The face detection module leverages OpenCV libraries to capture video from a webcam and identify faces in real time. The algorithm counts the number of faces present and communicates the count to the Arduino Nano via serial communication. The Arduino is programmed to switch the lights on when one or more faces are detected and turn them off when the room is empty. This eliminates the need for manual light control, thereby reducing energy consumption when rooms are unoccupied. The system is lightweight, cost-effective, and can be easily deployed in various environments such as homes, offices, and classrooms. Testing and results demonstrate that the system is reliable in detecting faces in different lighting conditions and can respond promptly to changes in occupancy. Compared to traditional motion sensor-based systems, this approach provides a more accurate and human-centered method of detecting room occupancy. In conclusion, this face count detection and automated lighting system represents a practical solution for smart energy management, contributing to increased efficiency and convenience in everyday settings.

1.INTRODUCTION

1.1 Introduction:

The project presents a smart lighting system that integrates face count detection using a web camera with an automatic lights on/off mechanism. The system is designed to enhance energy efficiency in smart homes and office environments by automatically controlling lighting based on the presence and number of people in a room. The implementation combines computer vision techniques with an Arduino-based control unit to regulate lighting effectively. With the growing demand for energy-efficient solutions, automation systems have gained widespread attention. Traditional motion sensors have been used for automatic lighting control, but they often fail to differentiate between human presence and other movements, leading to inefficient energy consumption. This project aims to improve upon these limitations by using facial recognition to accurately determine occupancy, ensuring a more precise lighting control mechanism. Crowding is a common phenomenon observed during major events such as concerts, festivals, sports, games, and entertainment. One of the most interesting and active research topic in computer vision is the analysis of crowd behaviour. Crowd is a group of people gathered in a certain location. Crowd differs in different situations like crowd in a temple will be different from the crowd in a shopping area. Crowd is a group of individuals sharing a common physical location. Now a day's increase in human population tends to increase the crowd in public areas. Thus it is required to analyse the surveillance system with several closed circuit Television is used to monitor the crowd.

The human eye cannot observe all the cameras simultaneously. Thus an automated technique must be used for continuously monitoring the crowd for a long period. Challenging problems in detecting the desired events automatically are that, simultaneous occurrence of more than one events, large number of data must be processed, occlusions and real time detection. The proposed method can be applied from small group of object. The Internet of Things is a powerful industrial system of radio-frequency identification and wireless devices that have the ability to transfer data over a network without needing human interaction. Analysis of a crowd behaviour using surveillance videos is an important issue for public security, as it allows detection of dangerous crowds and where they are headed. Computer vision based crowd analysis algorithms can be divided into three groups people counting, people tracking and crowd behaviours analysis. Mainly, IoT consists of three layers, the sensing layer to gather data from real world via existing hardware e.g. sensors, next the network layer to transfer the collected data over wired or wireless network, and the application layer which is responsible for twoway communication between user and systems.

1.2 Objective of the Project

The objective of this project is to develop an intelligent lighting control system that enhances energy efficiency by integrating face count detection with an automatic light on/off mechanism. Utilizing a web camera, OpenCV-based computer vision techniques, and an Arduino Nano microcontroller, the system aims to accurately detect human presence and adjust lighting accordingly. This approach minimizes unnecessary energy consumption, improves automation in smart home and office environments, and offers a more reliable alternative to traditional motion sensor-based systems.

2.LITERATURE SURVEY

2.1 Literature Introduction

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www.ijmece.com
Vol 13, Issue 2, 2025

The Live count is human detection and counting using Python-based ML techniques have garnered considerable attention in recent years due to their plethora of applications in domains such as video surveillance, crowd management, and urban planning. This literature survey furnishes a detailed account of the key research studies and techniques that have contributed to the refinement of efficient systems for accurately detecting and counting humans using Python-based machine learning. Deep Learning Architectures: Deep learning paradigms have taken center stage as powerful tools for Live count human detection and counting. Convolutional Neural Networks (CNNs) have garnered widespread recognition for their ability to automatically learn and extract relevant features from images. Ren et al. (2015) introduced Faster R-CNN, which combines region proposal networks with CNNs for efficient object detection, including humans. Similarly, Redmon et al. (2016) proposed from YOLO algorithm, which applies a single CNN to the comprehensive visual context to predict bounding boxes and class probabilities . Feature Extraction and Representation:

Effective feature extraction and representation hold significant sway over inaccurate human detection. Traditional techniques such as Histograms of Oriented Gradients (HOG) have been leveraged to showcase human specific visual characteristics. With the development of sensor technology, communication technology, and big data science, smart city-oriented intelligent applications have become important services in human life. People's living standard has increased with improved infrastructure and intelligent applications such as smart home furnishing, smart building. With the increasing expansion and prosperity of urban business zones, some people choose to go shopping and seek entertainment in business zones. These large central business zones have become representative of the city image and are the zones with the most economic vitality. Besides, of people. By estimating the number of people, the degree of crowd gathering can be judged for accurate and effective management and planning at a monitored site.

3.PROPOSED SYSTEM

The proposed system is an intelligent lighting control solution that automates the switching of lights based on the real-time detection of human presence using face count detection. The system integrates web camera, computer vision techniques, and an Arduino Nano microcontroller to enhance energy efficiency in smart home and office environments. A webcam continuously captures video feed and processes the frames using OpenCV libraries. A face detection algorithm identifies and counts the number of faces present in the room in real time. The face count data is transmitted to the Arduino Nano via serial communication. The Arduino Nano processes the received face count data. If one or more faces are detected, the Arduino triggers the relay module to turn the lights on. If no faces are detected, the Arduino turns the lights off, reducing unnecessary power consumption. The relay module acts as a switch to control the connected lighting system. The lights

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Vol 13, Issue 2, 2025

respond dynamically based on real-time occupancy detection.

3.1 BLOCK DIAGRAM

- Person Count Detection:

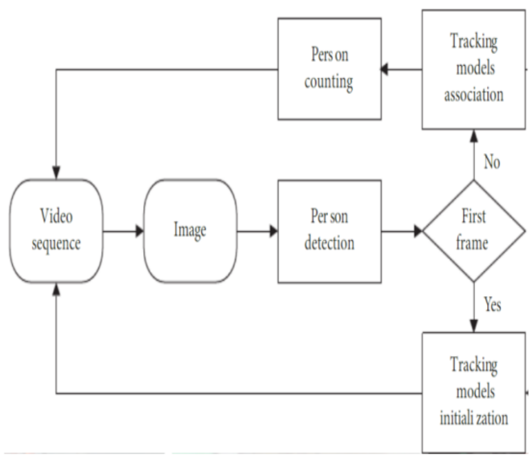

Fig 3.1: Block Diagram of OpenCV

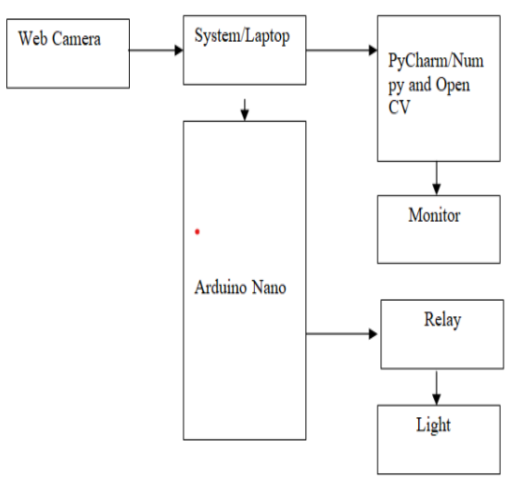

Fig 3.2: Block Diagram of kit

3.3 SCHEMATIC DIAGRAM

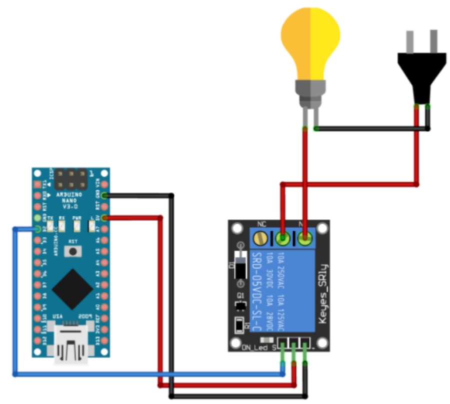

Fig 3.3: Schematic Diagram

3.4 FLOW CHART

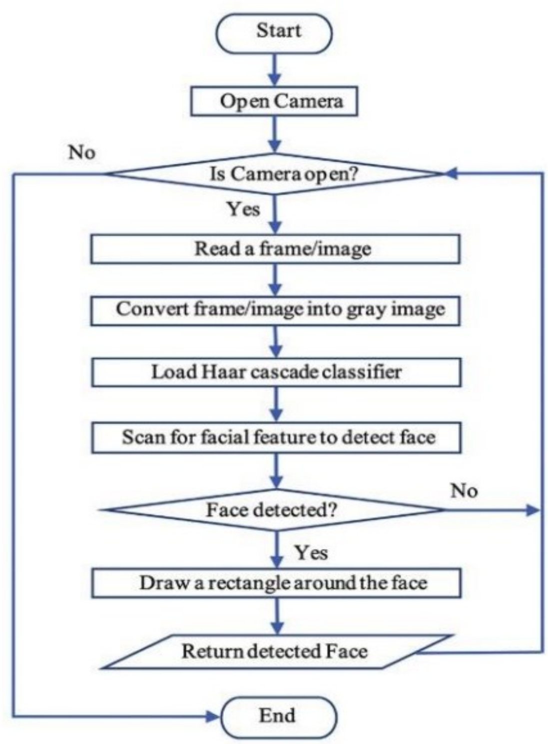

Fig 3.4 : Flow Chart

4. RESULTS

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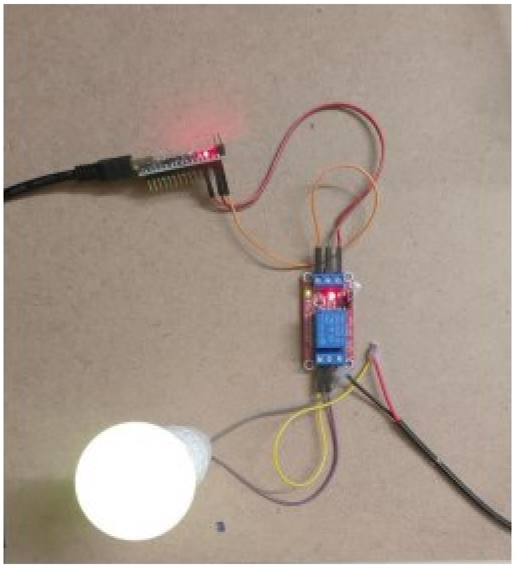

Fig 4.1: Interface of kit

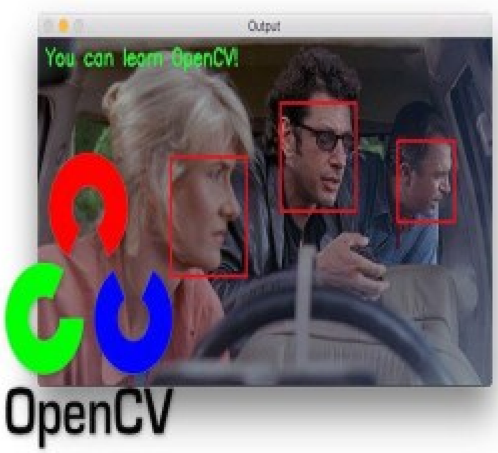

Fig 4.2: Output using OpenCV

The implemented system successfully achieved its objective of automating light control based on real-time face detection. During testing, the face count detection module, built using OpenCV, reliably identified the number of people in the room under various lighting conditions. The serial communication between the computer and Arduino Nano functioned accurately, ensuring seamless operation of the light on/off mechanism.The system demonstrated prompt responsiveness by turning on the lights when at least one face was detected and switching them off when the room became empty. It consistently outperformed basic motion sensor-based systems in terms of precision, as it specifically identified human presence rather than generic motion. This human-centred detection method significantly reduced unnecessary power consumption. Overall, the project proved to be effective, cost-efficient, and adaptable for deployment in smart homes, offices, and classrooms. It provides a practical step toward smarter energy management and showcases the potential of integrating computer vision with embedded systems for real-world applications.

5. CONCLUSION

`The face count detection-based automated lighting system provides an efficient and intelligent solution for energy management in smart homes, offices, and other environments. By integrating a webcam, OpenCV-based face detection, and an Arduino Nano-controlled lighting system, the project eliminates the need for manual light control, ensuring optimal energy usage. The system has proven to be reliable in detecting human presence and dynamically adjusting lighting conditions in real time. Compared to traditional motion sensor-based methods, this approach offers higher accuracy by detecting actual faces rather than movement. Additionally, it is cost-effective, easy to deploy, and requires minimal maintenance. Overall, this project demonstrates a practical implementation of computer vision and embedded systems to enhance automation and energy efficiency. It contributes to a sustainable future by reducing electricity wastage while improving user convenience. Future enhancements could include integrating IoT for remote monitoring and control, making the system even more versatile and adaptable to modern smart environments.

6. FUTURE SCOPE

The system can be expanded by integrating The face count detection-based automated lighting system has vast potential for future enhancements, making it more intelligent, efficient, and adaptable to various environments. As technology advances, the system can be integrated with emerging technologies to improve its performance and usability. One significant improvement is IoT (Internet of Things) integration, enabling remote monitoring and control of the lighting system through cloud platforms. Users can access real-time data on energy consumption and optimize lighting settings accordingly. Additionally, artificial intelligence (AI) and machine learning (ML) algorithms can be incorporated to enhance face detection accuracy, even in varying lighting conditions, and to recognize individuals for personalized lighting preferences. A mobile or web-based control interface can be developed to allow users to manually override or adjust lighting settings remotely. This can be further enhanced with voice control integration using smart assistants like Alexa, Google Assistant, or Siri, making the system more user-friendly and accessible. For wider adoption, the system can be expanded for multiroom and large-scale deployments, making it suitable for office buildings, shopping malls, hospitals, and public infrastructure. Additionally, integrating a hybrid sensing mechanism, such as combining face detection with PIR (Passive Infrared) or ultrasonic sensors, can improve occupancy detection accuracy and reliability. Furthermore, power optimization techniques and renewable energy integration, such as using solar-powered lighting, can enhance the system's sustainability. By implementing these future advancements, the project can evolve into a fully automated, AI-driven smart lighting system that contributes to energy conservation, cost reduction, and improved user convenience in both residential and commercial environments.

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