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NEXT GEN HOSTEL OPERATION

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ABSTRACT:

The increasing need for contactless, secure, and smart access control systems in homes and institutions has motivated the creation of a smart hostel management system. This paper presents the "Next Gen Hostel using SCRFD," an AI-based system that integrates sophisticated face detection and recognition technologies to automate hostel processes. The system uses SCRFD for lightweight and rapid face detection and FaceNet for robust face recognition to provide real-time access control, attendance tracking, and visitor management. The solution is integrated with edge devices such as Raspberry Pi and Jetson Nano and functions with high performance even in limited environments. Real-time monitoring, reporting, and alerts are provided by a cloud-connected dashboard. The system also focuses on data security and compliance with privacy norms. This study shows how AI and IoT technologies can be utilized in a practical way to improve safety, convenience, and administrative efficiency in hostel living, and also provide a future-proof and scalable architecture for further smart living applications.

INTRODUCTION

With the high-paced development in artificial intelligence (AI), computer vision, and the Internet of Things (IoT), legacy manual systems are being substituted by intelligent, automated solutions. Hostel management is one such sector where this revolution has tremendous promise. Traditionally, hostels are based on manual attendance reports, physical verification of identity, and paper logs of visitors, all of which are susceptible to human error, security threats, and inefficiency. The need for a stronger, contactless, and secure access control system has been growing—especially during pandemics and increased fears of unauthorized access and impersonation.

The paper introduces "Next Gen Hostel using SCRFD," an intelligent, AI-powered solution to change hostel entry, access control, and resident tracking through facial recognition technology. The foundation of this system is the SCRFD (Selective Context Retention Face Detection) model, a lightweight, high-performance deep learning model that delivers real-time, precise face detection even in adverse conditions like low lighting, occlusions, and different angles. When coupled with FaceNet for face recognition, this solution obviates the use of physical ID cards or biometric touch devices, facilitating hygienic and smooth access control.

The system being proposed is meant to run on edge devices such as Raspberry Pi and Jetson Nano, which makes it economical and scalable for institutions. It has automated attendance tracking, real-time unauthorized entry alert systems, and a secure dashboard interface for administrative management. With an emphasis on data privacy, encryption, and role-based access control, the system guarantees confidentiality and integrity of all information stored.

This study seeks to illustrate how the combination of SCRFD, FaceNet, and IoT-based automation can offer a sustainable, scalable, and intelligent infrastructure for hostel management, towards the larger vision of smart living spaces and digital campuses.

REVIEW OF LITERATURE

Historical Context and Evolution

Historical Context and Evolution

Hostel management has progressed from manual systems involving registers and ID cards to semi-automated ones such as RFID and fingerprint scanners. But these conventional approaches were problematic—bugs, contact, and less scalability. The advent of AI and deep learning brought more sophisticated face recognition systems. Early attempts such as Haar Cascades and MTCNN enhanced detection but performed poorly under poor lighting or complicated environments. The face embeddings brought precision with the introduction of FaceNet, and SCRFD, launched in 2021, supported rapid, real-time face detection on low-power edge devices. These developments created the basis for smart, safe, and touchless hostel solutions such as the Next Gen Hostel based on SCRFD.

Algorithmic Approaches

Various algorithmic approaches have been explored for face detection and recognition. Traditional methods like Haar Cascades and HOG were fast but lacked robustness in real-world conditions. Deep learning models such as MTCNN and RetinaFace improved accuracy using convolutional neural networks (CNNs). SCRFD, a recent lightweight detector, excels in real-time detection with minimal computational cost, making it ideal for edge devices. For recognition, FaceNet converts faces into unique embeddings, enabling precise identification. The combination of SCRFD for detection and FaceNet for recognition provides a powerful, scalable solution suitable for smart hostel management.

User-Centric Design and Usability

Different algorithmic methods have been sought for face detection and identification. Conventional methods such as Haar Cascades and HOG were efficient but non-robust in practical circumstances. Deep learning architectures such as MTCNN and RetinaFace achieved higher accuracy through the employment of convolutional neural networks (CNNs). SCRFD, which is a new lightweight detector, is highly proficient in real -time detection with very less computational complexity, thus being suitable for edge devices. For identification, FaceNet transforms faces into distinct embeddings, allowing for accurate identification. The integration of SCRFD for detection and FaceNet for identification offers a robust, scalable solution appropriate for smart hostel management.

Future Trends and Innovation

Facial recognition technology is further advancing with developments in AI, edge computing, and privacy-preserving methods. Upcoming systems will utilize federated learning, 3D face modeling, and emotion-aware recognition to improve precision and personalization. Integration with IoT and smart infrastructure will facilitate fully automated spaces, while new developments in lightweight models will facilitate wider deployment in low-power devices such as Raspberry Pi. These trends reflect movement in the direction of smarter, quicker, and more secure biometric systems within education and residential sectors.

EXISTING SYSTEMS

Conventional hostel management systems are mostly based on manual processes like physical logbooks, ID cards, and biometric fingerprint scanners for access and attendance. Although some institutions have adopted rudimentary digital management tools, these systems tend to be devoid of real-time verification, scalability, and contactless functionality. Fingerprint scanners, for example, are hygiene issues and susceptible to wear and tampering. In addition, current systems usually lack facial recognition or intelligent monitoring, which reduces their impact on providing security and efficient access control. These limitations make it important to have a more effective, AI-based solution such as the introduced SCRFD-based model.

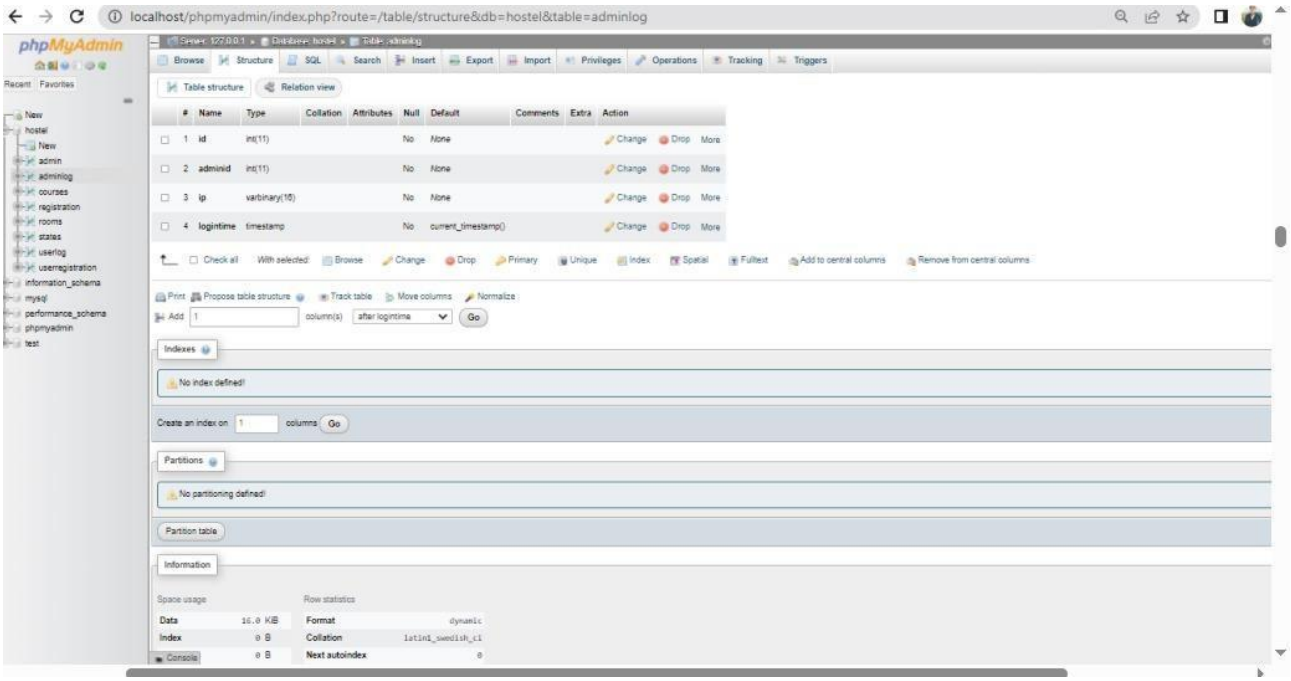
FIELD OF THE INVENTION

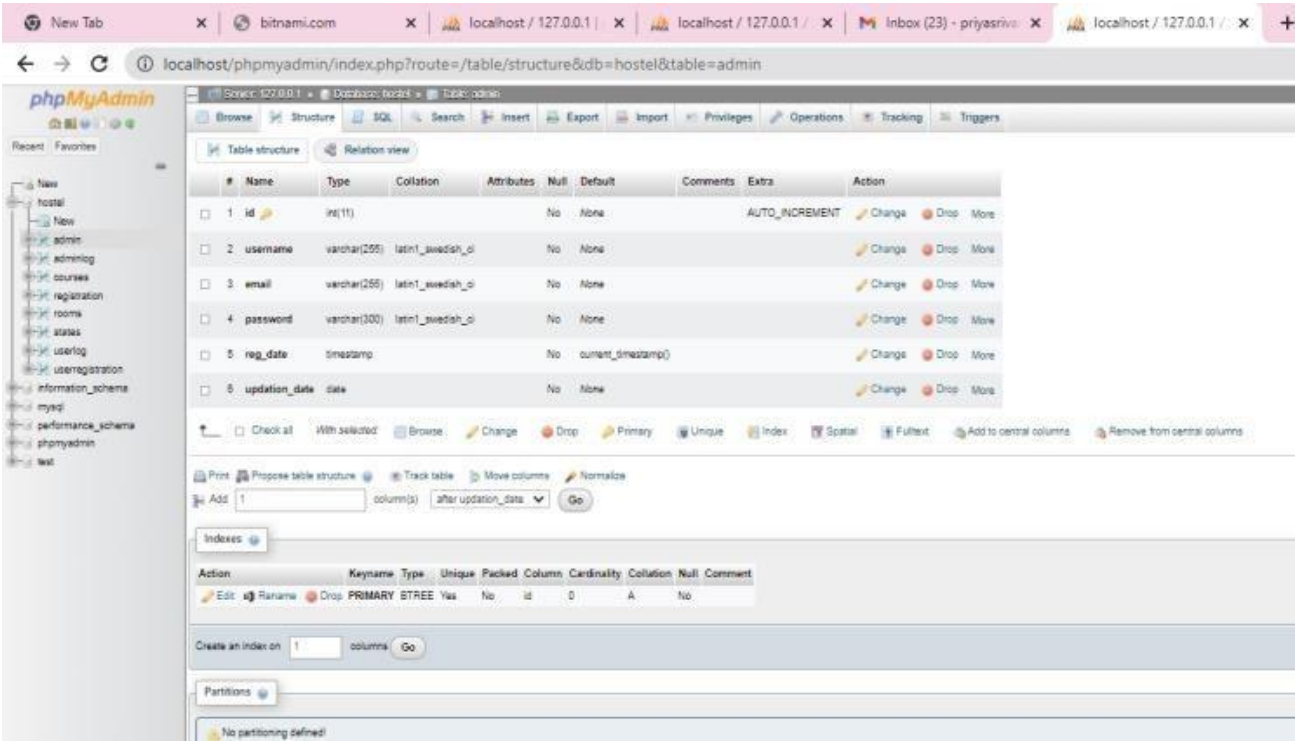
The subject matter of the invention is with respect to the field of biometrics, artificial intelligence (AI), and computer vision, aiming towards advancements made in face recognition and detection technology. More specifically, the current invention relates to utilizing Single Channel Residual Face Detection (SCRFD) to develop smart hostel management systems. The innovation seeks to advance the conventional security and functionality measures of hostels through the incorporation of automated facial recognition technologies for user authentication, access, a nd attendance. The technology is based on state-of-the-art algorithms that maximize accuracy and effectiveness, offering a robust and scalable solution that maintains high-level security and user ease of use. The system can identify, recognize, and authenticate people automatically, thus minimizing human error, preventing intrusions, and enhancing the overall management of hostel facilities. Further, it has applications in smart campus systems, automated check-in, and individualized delivery of services in residential facilities, eventually providing a next-generation solution to hostel management that is convenient, secure, and efficient.

SOFTWARE DESCRIPTION

- SCRFD Model
- ONNX RUNTIME
- FACENET
- ENSEMBLE LEARNING
- POST PROCESSING USING NMS
- GOOGLE COLAB ENVIRONMENT

SCREENSHOTS





CONCLUSION

The application of the Next Gen Hostel based on SCRFD shows a remarkable evolution in the area of automated hostel management systems by combining face detection and recognition technologies. Based on the SCRFD algorithm, the system offers a quick, trustworthy, and precise way for identifying individuals, thus enhancing security and reducing operations. The touchless entry system does away with physical IDs or keys, providing greater user convenience while curbing the incidence of unauthorized entries. Real-time analytics and auto-attendance are also enabled through the

system, enabling effective tracking and decision-making by hostel officials. The project overall offers an expandable, secure, and user-friendly alternative that can elevate conventional hostel operation to a smart and future-centric system.

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