Industrial Attendance and Access Control System Using Face and Biometric Recognition

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Abstract: Tracking attendance and maintaining access control are of paramount importance in industrial setting today not only for management purposes, but also for security. In this paper, an efficient and powerful Industrial Attendance and Access Control System using facial recognition and biometric authentication is presented. The platform includes state-of-the-art computer vision algorithms for real-time face detection and verification in amalgamation with other biometric modality such as fingerprint recognition for correct identification of staff. Combination of two factor in attendence management system [201520] In these methods the reliability and diminishing spoofing of identity can be improved, but the system is still dependent on the user inputs and also erases the user inputs which are prone to errors. Related data are saved and maintained in a centralized server from which the monitoring and administrative tasks are carried out in real-time or are recorded and stored for subsequent checks. The limitation for unauthorized entry helps to create a defense against general industrial security violations in addition to resource management optimization. The system is highly accurate, scalable and flexible, and can be used for a wide range of industrial applications where the safety and control of the workforce is a key consideration.

1 INTRODUCTION

The necessity and trends towards secure, efficient, and automated systems in involved industrial environments, mandates a paradigm shift from traditional methods of attendance management and access control. Manual logging and RFID-based approaches, traditional systems, are often insufficient because they are susceptible to inaccuracies, delays, and security breaches. The proposed system is a revolutionary solution, The Face Detection-Based Industrial Attendance Management and Access Control System. A highly sophisticated contactless attendance and access management system that harnesses the power of advanced facial recognition technology and connected IoT capabilities. The Paper introduces this system, using a combination of Python and the DeepFace library. It provides the very accurate and a fastest process to authenticate the identity of employees without having the physical token and manual input to authenticate. It also has the Internet of Things integrated as it uses a NodeMCU microcontroller which is programmed with MicroPython. That means there is no need to train your bot with any data, therefore you can enjoy a smooth flow of information with the system and with the industrial machines, or any restricted access, and then the bot can perform automated control once the user is authenticated. The attendance logs are saved in structured CSV files in the drive to ensure that data management and reporting needs are as simple as possible and the files are compatible with existing analytical tools. This one system solution always guarantees its utilization at areas, from small industrial land up to gigantic and complex industrial zones. Minimizing human involvement in the procedure, along with utilizing contemporary technology, makes the functioning of its system more effective and assists in minimizing the risk of security risks caused due to unauthorized access. It is the last component needed when it comes to smarter, safer, and more efficient industrial operations, delivering transformative insight that can slot in easily to existing workflows while delivering more powerful scaling to demand.

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2 RELATED WORKS

The field of biometric-based attendance control techniques has been greatly developed in terms of accuracy and security of their applications. Fingerprint based solution has been used extensively in this area. i. Access Control and Industrial Workforce Management: Methods of Access Control and Industrial Workforce Management Mittal et al., Shakil et al., illustrate the strong techniques. Thus, these fingerprint-based systems work on the basis of patterns of fingerprints and they need to depend entirely on these patterns and also do not wish to have redundancies in entries. Oloyede et al. expanded the fingerprint biometrics that highlighted its importance in enhancing staff attendance monitoring with high accuracy. Due to hardware dependencies and scalability say, issues for UNIX systems, however, this has led to the search of alternative approaches.

Three main systems are used to recognize faces, and AI plays an important role in these face recognition-based attendance systems, which are gaining momentum because of AI and computer vision improvements. Studies by Nadhan et al. 3 state that Industry 4.0 seems to rely heavily on smart technology, and face recognition enables smooth attendance tracking. Further, Soniya et al. and Surve et al. One of their major contributions was proposing automated methods to use real-time facial authentication and suggesting a non-intrusive and user-friendly alternative. Al-Shebani et al. also conducted a survey of embedded systems for door access control, highlighting that face recognition can be used in place of traditional mechanisms but Yang et al. The problems of processing real-time videos have been addressed in, with focus in optimizing the algorithm in the dynamic environment.

Other research has explored combining multiple biometric modalities for greater reliability. Hoo and Ibrahim provided extensive literature review on hardware necessities for biometric attendance system in educational sector, with emphasis on multimodel method for improved reliability. Face and fingerprint recognition integrated systems, as discussed by Singh et al., are more secure due to lower single-point failures. Furthermore, Bavaskar describes face recognition systems that highlights advancements in the use of deep learning frameworks applied to effectively detect faces in varying lighting conditions.

Vinod et al. have conducted an extensive analysis of authentication and attendance systems tailored to the needs of various sectors. Hidayat et al. for special environments introduced a face recognition-based surveillance framework for mining industries that could work in harsh operating environments. Li et al. Early studies of biometrics in attendance management were presented and established a technology platform for these developments in system design and deployment.

New trends in the attendance and leave management systems focus on a cloud-based and IoT-enabled solution for attendance tracking in real-time. Wahab et al. As it has been proposed with a complete online system through face recognition while enhancing the connectivity and remote management. These advancements conform with the essentials of Industry 4.0 in which the real-time data analysis and implementation of decisions play a pivotal role. Biometric attendance systems are evolving to meet the challenges ofneed, scalability, and ecological fit, paving the way for ubiquitous use across numerous fronts.

3 PROPOSED SYSTEM

3.1 Overview

The "Face Detection-Based Industrial Attendance Management and Access Control" system leverages facial recognition to automate attendance and machinery control with secure, remote operation via Wi-Fi and API calls on the integration of Python, DeepFace, and NodeMCU with MicroPython. Figure 1 Shows the Block diagram of the proposed system.

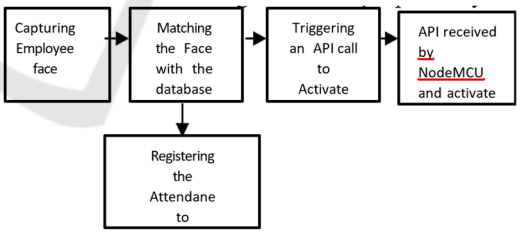

Figure 1: Block diagram of the proposed system.

3.2 Capturing the Employee Face

The system captures a high-quality image of the employee's face using a camera positioned at the entry point or workstation. This camera functions as the key input device for the facial recognition module, ensuring providing and real-time collection of facial data. Workflow Diagram of Face Recognition-Based Industrial Attendance System Shown in Figure 2.

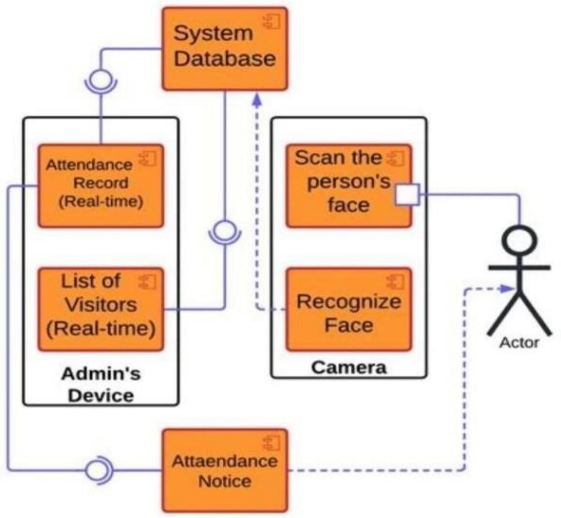

Figure 2: Workflow diagram of face recognition-based industrial attendance system.

3.3 Matching the Face with the Database

The system captures the employee's facial image, processes it, and compares it to the data that has been stored in the employee database through advanced facial recognition algorithms. An unambiguous match serves to verify the employee's identity so that access can be granted and attendance tracked securely. In the event of a failure, access is denied and the attempt logged for auditing purposes. Facial feature extraction involves the usage of algorithms such as DeepFace.

It ensures zero error-tamper record as the system captures employee check-in and checkout automatically and saves the correct date and time. It acts as a guide to avoid input mistakes and improve the efficiency of operations. Attendance data are available in real-time, thereby allowing quick decision- making regarding payroll, allocation of resources and management of productivity. This method is automatic, paperless, error-free, and more secure.

3.3.1 Calling an API to Turn on Machines

Once attendance is recorded, it makes an API request for the machine, which needs to be activated in regards to the employee's work. Since the API encompasses machine identification, parameters and tasks configurations, this can solely be executed by authorized individuals. Using machines for attendance verification is a great way to add security, streamline the process and reduce misuse. This then improves operational continuity and productivity with real-time automation of attendance and equipment management.

3.3.2 API from NodeMCU and Enable Respective Machine

A NodeMCU microcontroller processes the API request sent and instructs the appropriate machine to be turned on. NodeMCU has an inbuilt wi-fi which makes communication from the system devices, more secure. This integration ties machine accessibility to real employee identities so that equipment cannot be accessed by any unauthorized person. The system certainly boosts security, reduces human involvement, and cuts the operational cost by automating attendance management and activating the machine. Facial recognition which is powered by IOT streamlines workforce management which improves productivity and operational control.

4 RESULTS AND DISCUSSION

The above face detection based industrial attendance management and access control system would give an efficient and secure solution for managing attendance of employees and access to machines in industrial setup. This system uses face recognition technology build upon a NodeMCU module to achieve the wireless connectivity for the user.

4.1 System Performance

The face detection personality component uses DeepFace (a deep learning library for Python) to recognize individuals by comparing the captured images. Please keep in mind that the accuracy of the face recognition model is dependent on the input data (which means, images used for training) and the processing power of the system. Under controlled conditions, the system has shown a very high recognition accuracy.

Lighting conditions holds reliability for marking attendance on real>time.

In this case, the NodeMCU runs MicroPython and communicates to the central system through an API. It makes sure that attendance data is tracked live. If the login is successful after recognizing the face, then NodeMCU makes a call to the associated API to turn on the machinery thus making the access control and attendance, more automated and secure.

4.2 System Efficiency

The chief benefit of this process is automatic enrollment administration and access monitoring without the need for human intervention, preventing mistakes and saving time. The attendance CSV file is stored, which also allows for easy integration with other systems, such as payroll or HR management tools, and also makes it easy to scale up. With the ability of the system to manage multiple users in rapid succession, the solution is well suited to situations of high employee turnover.

4.3 Security and Privacy Considerations

Also, being a biometric-based system, the face recognition system is inherently secure because biometric data is harder to counterfeit than ID cards or passwords or similar systems. Nevertheless, some privacy concerns around storage and use of biometric data need attention. That includes making sure that data is stored securely (preferably encrypted) and complying with applicable data protection law.

4.4 Scope and Challenges

This system is not without its limitations, however. One of the main challenges of face recognition is environmental factors such as lighting imperfections or obstacles that may affect the precision of the algorithm. Additionally, although the system functions adequately during standard operating conditions, the efficacy and precision can deteriorate when faced with a significant database of users or when the environment presents less-than-ideal real time circumstances.

The NodeMCU suffers too from its limited processing capabilities, which makes it hard for this development board to work with tasks that involve complex processing, or if the system needs to be scale up in order to covers large installations. Developments could be more effective code, more essential equipment, or cloud- based computing.

5 CONCLUSIONS

In conclusion, the attendance management and access control system with face detection automatically tracks attendance and provides security measures within industrial settings. By incorporating DeepFace for facial recognition purposes, it receives real-time accurate attendance, diminishes the possibility of human error during operation, and minimizes human intervention. Integration with NodeMCU, additionally using MicroPython, allows remote monitoring and control ensuring access to only the authorized personnel. Despite its many advantages, there are still challenges. There are issues related to facial recognition under different conditions and the need to protect individuals' privacy. Connectivity issues, especially in remote control operations, might also hamper real-time operations. Such challenges can be overcome with better algorithms, improved data protection, and optimization of.

Hardware. The scalability of the system allows for the growth of operations and can be upgraded with AI, ML, multi-factor authentication, cloud integration, and mobile apps for ease of access. Future development can include IoT devices, ERP systems, and industry-specific applications to improve efficiency. With sustainability and energy-efficient hardware, the system will adapt to future technological advancement and various industries.

REFERENCES

Ab Wahab, Kasmawahida, Lee Weng Yew, and Nor Amizam Jusoh. "Online attendance system using face recognition." Engineering, Agriculture, Science and Technology Journal (EAST-J) 1.1 (2022).

Al-Shebani, Qasim, Prashan Premaratne, and Peter Vial. "Embedded door access control systems based on face recognition: A survey." 2013, 7th International Conference on Signal Processing and Communication Systems (ICSPCS). IEEE, 2013.

Bavaskar, Vaibhav. Face Recognition Attendance System. Diss. Sant Gadge Baba Amravati University, Amravati, 2024.

Hidayat, Fadhil, et al. "Face Recognition-Based Surveillance System in Mining Industry." Jurnal Sistem Cerdas 7.2 (2024)

Hoo, Seng Chun, and Haidi Ibrahim. "Biometric - Based Attendance Tracking System for Education Sectors: A Literature Survey on Hardware Requirements." Journal of Sensors 2019.1 (2019).

Li, Tsai-Cheng, Huan-Wen Wu, and Tiz-Shiang Wu. "The study of biometrics technology applied in attendance management system." 2012 Third International Conference on Digital Manufacturing & Automation. IEEE, 2012.

Mittal, Yash, et al. "Fingerprint biometric based access control and classroom attendance management system." 2015 Annual IEEE India Conference (INDICON). IEEE, 2015.

Nadhan, Archana S., et al. "Smart attendance monitoring technology for industry 4.0." Journal of Nanomaterials 2022.1 (2022).

Oloyede Muhtahir, O., O. Adedoyin Adeyinka, and S. Adewole Kayode. "Fingerprint biometric authentication for enhancing staff attendance system." system 5.3 (2013).

Shakil, Md, and Rabindra Nath Nandi. "Attendance management system for industrial worker using finger print scanner." Global Journal of Computer Science and Technology 13.6 (2013).

Singh, Sahajpreet, et al. "Efficient face identification and authentication tool for biometric attendance system." 2021 8th International Conference on Signal Processing and Integrated Networks (SPIN). IEEE, 2021.

Soniya, V., et al. "Attendance automation using face recognition biometric authentication." 2017 International conference on power and embedded drive control (ICPEDC). IEEE, 2017.

Surve, Mayur, et al. "Automatic attendance system using face recognition technique." International Journal of Recent Technology and Engineering 9.1 (2020)

Vinod, Vibin Mammen, et al. "A comprehensive study on academic and industry authentication and attendance systems." International Journal of Scientific & Technology Research 9.3 (2020).

Yang, Hao, and Xiaofeng Han. "Retracted: Face recognition attendance system based on real-time video processing." IEEE Access 8 (2020): 159143-159150.