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Utilizing Classroom Application of Facial Recognition Techniques through Internet of Things (IOT) Devices

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Abstract

In the contemporary era, technology has become an indispensable component of our daily lives, augmenting our existence in manifold ways. Notably, face recognition and Internet of Things (IoT) have undergone significant advancements in performance over the last few years. This phenomenon can be attributed to two factors namely, optimization of cost and time in the classroom, while simultaneously ensuring accuracy in attendance, and the ability to connect with electrical equipment automatically. The current study proposes an automatic smart classroom application that utilizes the concepts of IoT and face recognition. Specifically, the application relies entirely on face detection and recognition to automatically detect the presence of students in the classroom and mark their attendance. Moreover, the application also provides advanced technology that enables automatic switching on of electrical power, including but not limited to lamps, fans, LCDs, and air conditioning systems. This feature not only reduces energy consumption but also allows for monitoring of units consumed. The proposed solution represents a significant step towards establishing a smart classroom. Results and analysis of the IoT solution demonstrate that it accelerates the availability process in the classroom without requiring human intervention.

Keywords: *Classroom Application, IoT, Face Recognition*

INTRODUCTION

To this day, a copious amount of research has been conducted on a plethora of techniques that can be utilized to execute efficacious attendance monitoring systems. These techniques vary in terms of the approach employed for inputting data, the mode of data processing, and the controllers implemented to execute the system. In this particular section, we shall introduce the sundry solutions that are available and expound on the respective merits and demerits of each system.

Traditional forms of personal identification necessitate the usage of external elements such as keys, security passwords, RFID cards, and ID cards in order to gain access to private assets or enter public spaces (Januzaj, Luma, Januzaj, & Ramaj, 2015). It is a widely known fact that several procedures, including withdrawing money from a bank, necessitate the usage of passwords. Similarly, the utilization of a parking ticket is obligatory for private parking spots. In certain settings, such as households, the house key is of utmost importance. However, the traditional approach has certain drawbacks which include the occurrence of lost keys or forgotten passwords (Senthilkumar, Gopalakrishnan, & Kumar, 2014). The consequences of these events can be quite severe. As a result, the use of biometric technologies is slowly gaining momentum since it provides a potential solution to these problems. This approach necessitates the use of specialized equipment such as fingerprint scanners, palm scanners, and DNA analysers to collect data for a large number of individuals. In the majority of biometric applications and targets, the device must be physically touched in order to obtain data (Liew, Hani, Radzi, & Bakhteri, 2016; Anggara et al., 2023; Ateş and Khameneh, 2023). Like biometrics, this approach allows for the differentiation of an individual's physical characteristics and is extensively utilized in security settings. Moreover, it is regarded as one of the safest methods of authentication (Januzaj et al., 2015). Essentially, biometric technology can be classified into two categories: physical recognition and behaviour recognition.

In recent times, the technology of facial recognition has garnered significant attention from researchers and is gradually emerging as a replacement for other biometric security systems, as noted by Sajjad et al. (2020). Facial

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recognition, also known as image matching, is a field that is rapidly evolving and progressing towards replacing conventional methods. The utilization of human faces in facial recognition makes it more dependable and reliable than other biometric recognition methods, as it exhibits high accuracy and the lowest false recognition rate, without affecting individuals' daily lives, as highlighted by Senthilkumar et al. (2014). Therefore, facial recognition is a highly advantageous method that can be applied for various purposes, including unlocking house doors through facial recognition, without incurring additional maintenance costs. The concept that we propose prevents any unauthorized physical access to the automated system. Facial recognition has been employed in numerous applications, such as vehicle security (Motlagh, Bagaa, & Taleb, 2017), smart classrooms (Bhattacharya, Nainala, Das, & Routray, 2018; Chang, 2011; Liu and Phongsatha, 2022; Susiani et al., 2022), home security systems (See & Lee, 2007), smart houses (Mano et al., 2016), and intelligent surveillance, among others.

Problem Statement

The classroom is a significant setting where students and lecturers converge for the purpose of learning in various educational institutions such as universities, colleges, and schools. Attendance, being an obligatory requirement, is a crucial aspect of every class session. Nevertheless, the task of maintaining a daily attendance register is a demanding and time-consuming responsibility. The issues concerning attendance in the classroom can be categorized into two.

Firstly, there are numerous predicaments related to the traditional attendance system. These include, but are not limited to, the manual taking and tracking of students' attendance, misplacing attendance sheets, academic dishonesty, wasted time, and high error rates. These issues pose challenges to lecturers who rely on the existing attendance system and those who lack the time to utilize manual student attendance (Narendar Singh, Kusuma Sri, & Mounika, 2019).

Secondly, another issue that needs to be addressed is the inability to monitor electricity consumption in the classroom. For instance, electrical appliances may still be switched on even when there are no individuals in the room, leading to energy wastage (Bhattacharya, Nainala, Das, & Routray, 2018; Chang, 2011).

Research Questions

The study attempts to address the research gap by reviewing the literature and identify possible application on attendant classroom. Accordingly, following research questions have been derived.

- What is an application can minimize issues for traditional attendance?
- How can the application also reduce the electricality waste?

Purpose of the Study

The aim of this study is to design an Internet of Things (IoT) and facial recognition-based application to track classroom attendance. Additionally, this project involves the development of an application that can regulate electrical power consumption in real time within the classroom. The application, which has been developed in the context of this research, facilitates attendance monitoring by enabling educators to register students and track their performance from any location.

RESEARCH METHODS

Based on the literature survey, as we have studied various topics thoroughly that are directly linked with our project, we are going to design a possible solution to our problem. In this part we will propose a method that will give an overview of the approach to our project and the ways it should be done. As the previous work was not enough which led us to the development in this project in the most feasible and efficient way possible. The following figure shows the project design.

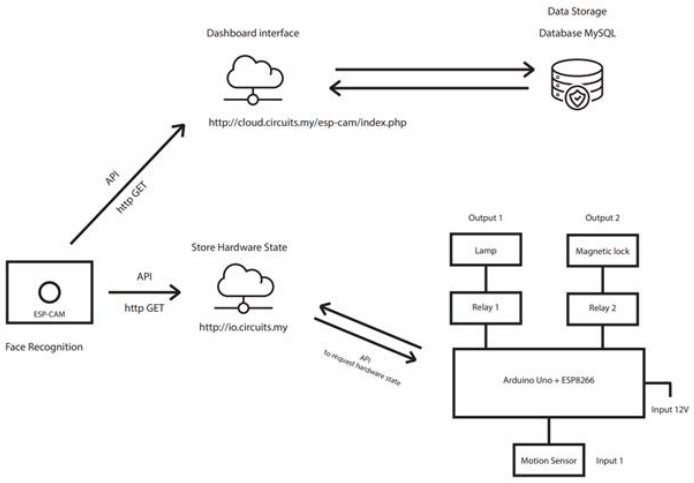

Figure 1: The block diagram of a proposed IoT Smart Classroom

From figure 1 the USB Camera is connected to the IoT controller camera slot. Live video stream of students is captured in the class with USB1 camera, IoT controller takes those images as input images and uploaded to the cloud server platform and we make use of face recognition service to compare the input images with the existing image. Matched images are detected and attendance is marked with date and time for students present in class in the local database using MYSQL. This process is carried out for every period and students are given attendance accordingly. This happens due to importing at the initial stage of the development of the project. In addition, when face is recognized, this IoT device will also turn on the lamp and at the same time, the door in classroom will open. The application in this project is designed for the purpose for listing students present and absent in the class. Below is a flow chart of IoT Smart Classroom in this project.

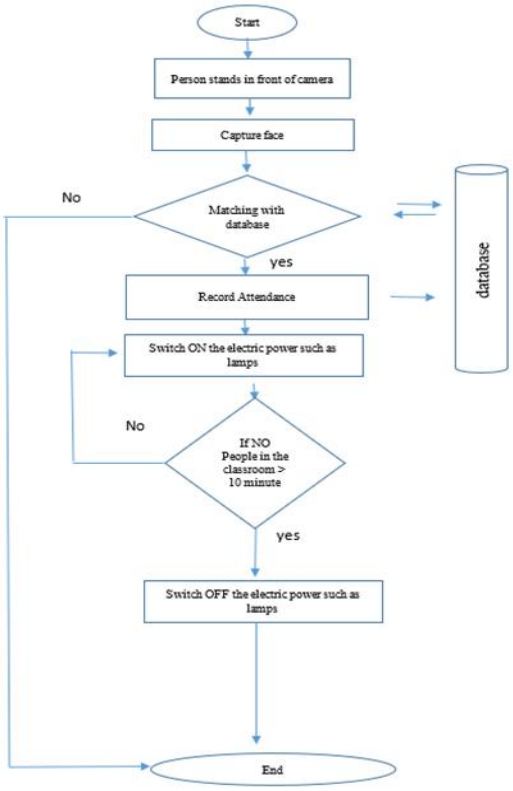

Figure 2: Flow chart of a proposed IoT Smart Classroom

From the Figure 2 Camera captures the face image, while the face detection resizes the captured image up to certain point. The image is compared with the present data sets and faces are recognized. The application records the attendance if the particular student face image matching with image in the database. The attendance of the students is displayed in this application. When the face of the students is recognized by application, at same time, the door open and the lamp in the classroom switch ON. The lamp will be OFF automatically when there are no people are detected by sensor more than 10 minute.

FINDINGS

After executing the IoT which is using face detection algorithm in the application we get following results. Face recognition is tested on two types which are by testing image and real-time to determine the accuracy. For testing image, there are ten images that are not in the database are tested for each label which are authorized person. The tested image will have labelled the image with names for authorized person while unknown for unauthorized person. Figure 4 (a) and (b) shows the tested image with positive and negative results for authorized. Real-time face recognition is performed using web camera shown in Figure 3. An authorized person can be recognized through the application and vice versa. The name of the user will be shown below their face as shown in Figure 4 (a), while unauthorized person is shown in Figure 4 (b).

Figure 3: Camera stored in a box

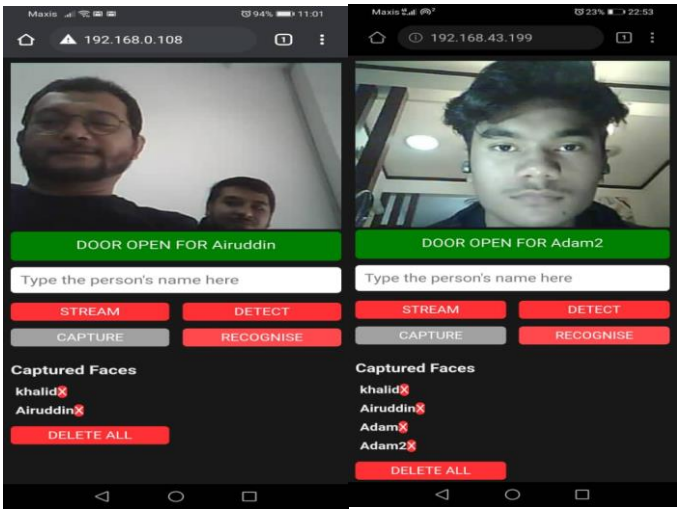

Figure 4 (a): Positive result authorized person labeled with name

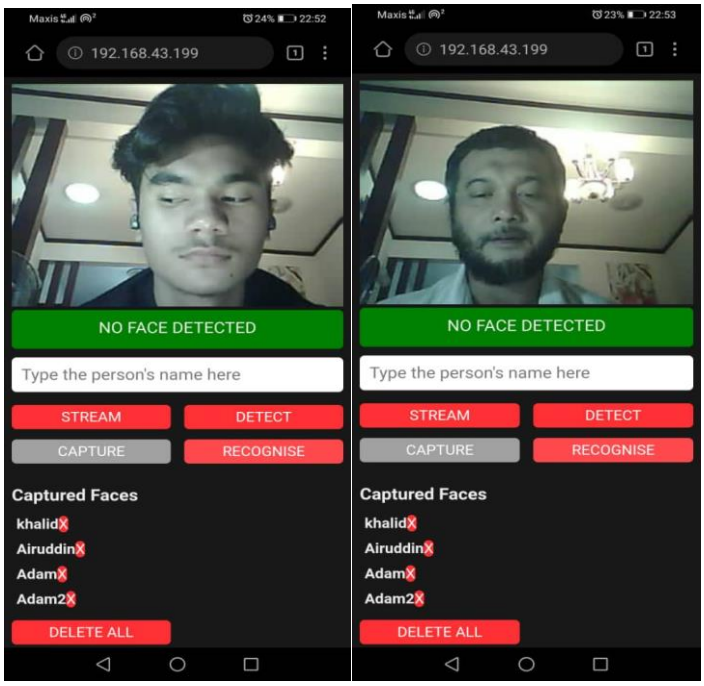

Figure 4(b): Negative result for authorized

Face recognition and IoT are integrate and build in prototype application. When face is recognized by the application, the door will open automatically as shown in Figure 5 and also the lamp in the classroom will switch ON illustrated in Figure 6. Door access and power of electricity can also be controlled through in this IoT application.

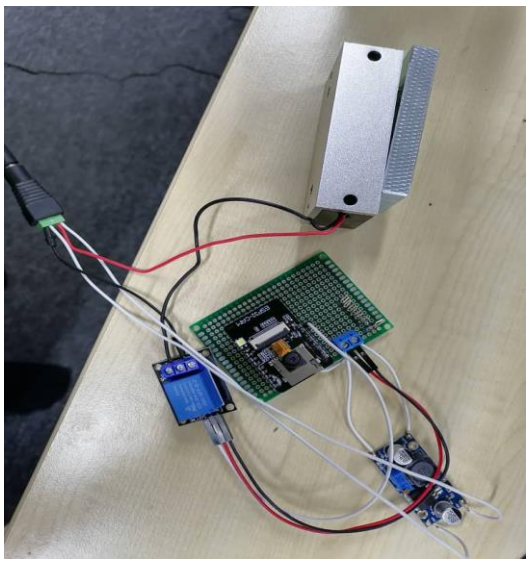

Figure 5: The door open when the face recognizes by the application

Figure 6: The lamp automatically switches ON when face was recognized by application

Figure 7: Student Attendance database in cloud server

Face recognition of enrolled student the followings are the implementation test and its results produced during the attendance taking process as shown one student been recognized and enrolled as Present.

CONCLUSION

As a concluding remark, the application that utilizes a combination of face recognition and IoT has been successfully executed. The face recognition technology is capable of identifying individuals and sending notifications to the user upon detection of known or unknown individuals through IoT. Furthermore, the project has introduced advanced technology that allows for the automatic activation of electrical power in the classroom, thereby reducing energy consumption and monitoring energy usage. However, it is worth noting that this project still requires significant improvements, particularly concerning the efficiency of the image processing component. The time interval of the writing process was prolonged, thus prolonging the time required to process the images and take necessary actions. By utilizing a more sophisticated module, this project can be substantially enhanced.

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