

DESIGN AND IMPLEMENTATION OF TOUCHLESS ATTENDANCE SYSTEM

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Abstract--This study is developed to create an Automated Attendance System that uses a Raspberry Pi 4B microcomputer to handle Face Recognition to verify a student's identity, and a Temperature sensor to check the student's body temperature. After a successful verification, the system will communicate with an API to record the attendance automatically. Additionally, it lets administrators to see the attendance record, body temperature, and vaccination card. The development is divided into four phases: REST API development using NodeJS, ExpressJS, and MySQL database; creation of a frontend desktop application with ReactJS and Redux that lets administrator see the student's attendance; the hardware development with a , Temperature sensor, Raspberry Pi microcomputer; and the Face Recognition functionality that uses several Python libraries. A System Development Life Cycle (SDLC) is applied in the first three phases to help plan the development, analyze the requirements needed to be accomplished, and ensure its maintainability after the implementation. The system successfully utilized and integrated the face recognition capabilities to identify students with an acceptable accuracy, resulting in a successful attendance recording, with the student's body temperature and vaccination card, and providing logs that can be seen in a desktop application.

Index Terms--Computer Vision, Internet of Things, Face Recognition, Microcomputer

I. INTRODUCTION

University departments are required to monitor students' attendance during their studies. It is a crucial part of the teaching process, both for the students and for the instructors as well. Traditionally, this has been done by filling the attendance sheet at the beginning of the lecture. Nevertheless, this is time consuming for the instructor to monitor every student during the entire semester, and also students can just write someone else's name without the student actually being there. To avoid such things and to make it easier for the students and the instructors, engineers have been trying to implement some technological approaches.

For instance, in most of the college departments in the Philippines, they have started to use RFID cards for this purpose. Regardless that this was much more practical than the attendance sheets, it did not come without disadvantages. Students can give the card to their colleagues without the professor noticing it.

Face has been known as the only thing that cannot be duplicated. So, to solve the problem this thesis will propose usage of Computer Vision techniques for face detection and face recognition. The study is specifically developed to solve the problem in Surigao del Norte National High School – Senior High and teachers.

Lastly, the implementation of the "No Identification No Entry" policy should be stricter than ever to remove the risk of unauthorized entry into the school.

The researchers carefully developed an Automated Attendance System using, Face Recognition, with a temperature sensor and a vaccination card data using a Raspberry Pi 4b microcomputer by carefully considering the above drawbacks. The system has several benefits for Surigao el Norte National High school as it provides efficiency and high-level verification attendance in the institution and assures parents and guardians of the children as it uses face recognition with a temperature sensor whenever the children enter the school premises.

The researchers conducted this study and developed a functional end-project to cater the problems the academic

institution, Surigao del Norte National High School is currently experiencing as they transition back to face-to-face classes again.

II. Review of Related Literature

Salim et al. (2018), proposed a method of developing a comprehensive embedded class attendance system using facial recognition with controlling the door access. The facial recognition is done by implementing Local Binary Patterns (LBP) and Haar Feature-based Cascade algorithm, images are then detected and cropped for its region of interest.[3].

To Nimithka K et al. (2017), attendance begins by the facial recognition process; divided into two main parts: processing productivity and output of both the teachers and students, as well as better consumption of time [8]. An Automatic Attendance System Using Image Processing, maintaining attendance is very important and compulsory in all the institutes for checking the performance of students. Every institute has its method in this regard. Some are taking attendance manually using the old paper or file-based approach and some have adopted methods of automatic attendance using some biometric techniques. There are many automatic methods available for this purpose i.e. biometric attendance. All these methods also waste time because students have to make a queue to touch their thumb on the scanning device [9]. Face detection and recognition section detect face from the image capture by the camera, and the image of the face is crop and store. The element recognizes the images of student's faces, which have been registered manually with their names and ID code in the record. Face recognition data and face identification data are verification into the record. Automatic face recognition (AFR) technology has seen a remarkable improvement in presentation over the past years, and such systems are now widely used for safety and marketable applications. An automatic system for human face recognition in a real-time environment for a University to mark the attendance of its employees [10].

III. Conceptual Framework

The researchers used a waterfall model that describes the entire flow of the study depicted in Figure 1.

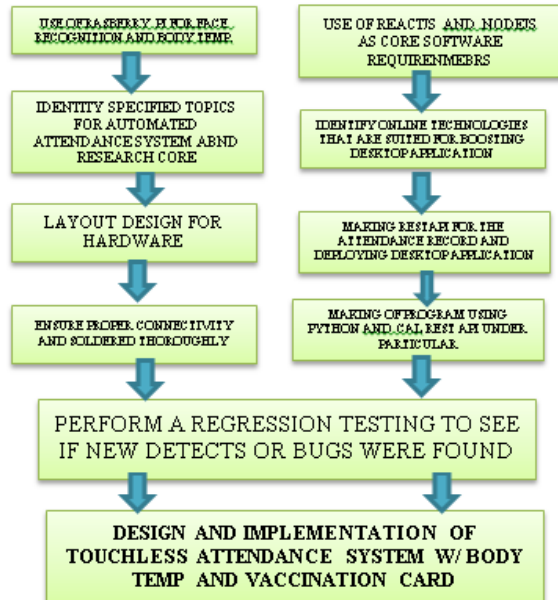


Fig. 1. Conceptual Framework of the Study

Objectives

The ultimate objective of the study is to create a touch-less attendance system by face recognition in order to make it hassle-free for teachers to manually check the attendance for the students.

Specifically this study focused on the following:

1. Create a touch less attendance system by face recognition using python programming language.
2. Testing its usefulness and adaptability and flexibility.
3. To implement the project in SURIGAO DEL NORTE NATIONAL HIGH SCHOOL.

IV. METHODOLOGY

Research Design

The researcher used the deductive approach in solving a complex query wherein Plan-Do-Check-Act (PDCA) criteria were used as a model in finding a solution. After gathering all knowledge from different stages of planning, the researcher scrutinized the data and converted it to facts then postulated to come up with a tangible end-product.

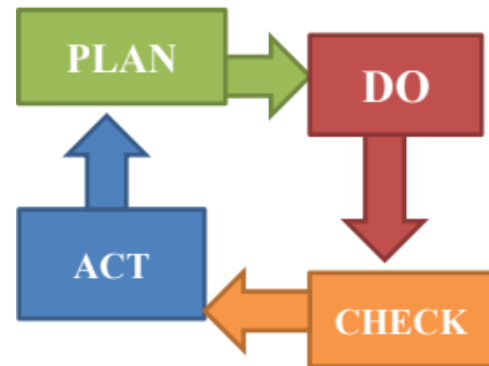


Fig 2. Schema of the Study

A. Plan

The researchers used a Raspberry Pi 4 Model B, a full-fledged tiny and affordable computer with a high-performing 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 4GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability. This will handle all operations of sending and retrieving data from the REST API and the face recognition functionality. An RC522 RFID Module.

For the face recognition functionality, the researchers used Python v3.10.4 to be the main language for the creation of the face recognition script and a 1280x720p USB Camera. A package installer called pip is also used to install packages that are needed for the development.

Furthermore, the researchers created a Web Application that will let students see their attendance record and give administrators a way of managing students in the database. Users will have to login using the credentials given by the administrators after registering them in the database.

Moreover, the researchers created a Representational State Transfer (REST) API that will be consumed by both the created Desktop Application and the Raspberry Pi to access and modify information in the database during attendance recording and student registration.

B. Do

During the development, the researchers used the following technologies to develop all functionalities and features present in the Automated Attendance System using Face Recognition, and temperature sensor both hardware and software:

1. **Python with Thonny IDE**, used for coding all parts connected in the Raspberry Pi and Face Recognition.
2. **ReactJS, Redux, MantineUI**, primarily used for the Frontend of the Desktop Application.
3. **NodeJS, ExpressJS, Postman**, used for

building the REST API.

4. **Sequelize ORM, MySQL database**, for creating SQL queries and the database.
5. **Heroku, Netlify**, for hosting the Web Application and REST API in the web.

The researchers used Python language in the Raspberry Pi as the main development language for every part present in the hardware such as Raspberry Pi and temperature sensor. Additionally, pip package installer is used to install libraries needed for the face recognition such as dlib that includes machine learning techniques and tools for writing complicated software, cmake for testing, OpenCV, and face-recognition package for manipulating faces and the recognition of them. A Histogram Oriented Gradient (HOG) algorithm is used which is the basis of the recognition functionality that works by locating faces in an image that are then converted into grayscale images [32]. In order to recognize faces, the image is compared to the HOG patterns that are extracted from the trained faces to the most common pattern with the known pattern and marked.

In the frontend of the desktop application, ReactJS is used for building its UI as it is easier to maintain and use. MantineUI is also utilized to make use of its ready-made UI components for faster development and design.

The REST API is built around NodeJS and ExpressJS frameworks together with Sequelize ORM to easily write SQL queries for accessing the MySQL database. Additionally, the frontend web application is hosted in the internet via Netlify and Heroku for the REST API. This makes the application accessible by anyone around the web.

Finally, the face recognition functionality and Body temperature scanning are integrated to each other as it is the main security needed to be met to create the attendance of an individual in the database.

C. Check

After identifying what pins are needed to be utilized for every hardware component based on the created schematic diagram, they are then prototyped on a breadboard to see if every component is working properly before they are carefully connected to the Raspberry Pi and attached to the created enclosure. The deployed frontend web application and REST API were also checked to see if they are all working the way they are intended and is accessible in the web by anyone. The face recognition and Body temperature scanning are also checked if they are both running simultaneously when the codebase is executed.

D. Act System Testing

The researchers first tested the created REST API as it is the backbone of attendance recording and the frontend Desktop application using Postman. All methods created are all tested to see if they are all

working the way they are intended, as well as its security for possible data leaks. Upon reaching a desirable result during the test, it is then connected first to the Desktop Application to check every functionality, and debugged the code when an error and vulnerability is recognized. The researchers then tested the functionality of the face recognition to check its accuracy and speed when recognizing an individual. The algorithm and codes of the functionality are progressively tweaked to reach a satisfying ending.

IV. RESULTS AND DISCUSSIONS

This chapter discusses all results presented in the research methodology. It showcases all results related to the objectives of the study and the process of making the output.

1.1 To design and fabricate an Attendance System Face Recognition, and BODY TEMPERATURE attendance data to the DESKTOP APPLICATION using a REST API

The researchers fully designed and fabricated a functional end-product that does all its features based on the first objective. Figure 2 shows the entire setup of the project, where the entire hardware parts are located on the left side of the figure inside its acrylic enclosure. Figure 3 shows how the REST API is connected to both the web application and Raspberry Pi for manipulating the database. Figure 4 shows the circuit diagram of the whole project.

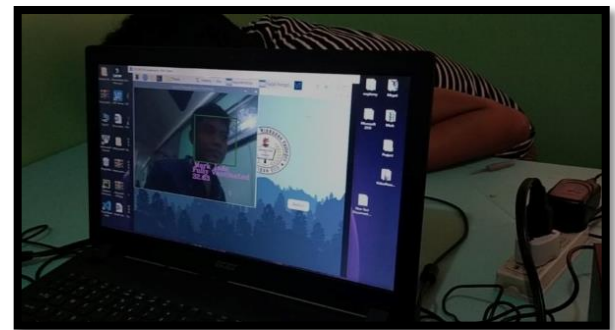


Fig 2. Face recognition with body temperature scanner attendance system.

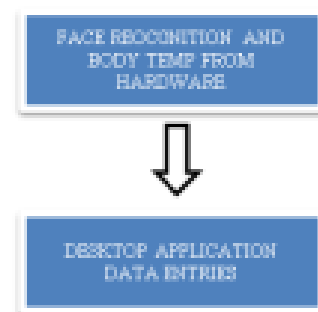


Fig 3 REST API connections for both the desktop application and raspberry pi.

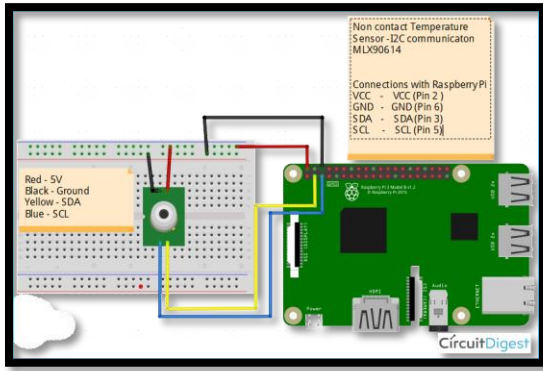


Fig 4. Automated system diagram

V. CONCLUSIONS AND RECOMMENDATIONS

After a series of multiple and thorough testing processes conducted by the researchers, the fabrication and development of the Automated Attendance System using Face Recognition, and temperature sensors were found and proved to work effectively and efficiently with good maintainability as hardware parts are available locally.

Conclusions

The researchers were able to design and fabricate an Attendance Face recognition for student verification, sending attendance records to the database via REST API. During registration, the inputted names for both face recognition must be similar as they will be matched before the attendance is recorded. The tag must also be registered using the Desktop Application as it will be the basis of creating the attendance record in the database. No tag in the database means no creation of the attendance. The development of REST API for communicating with the database also proved to be beneficial as it lets other application in different platform access the database as long as they have the correct credentials for using it.

Moreover, a MERN (MySQL, ExpressJS, ReactJS, NodeJS) stack-based Web Application were deployed to the web using Netlify for the frontend and Heroku for the backend API as the hosting providers to let students see their attendance record and history. The desktop application is also mobile responsive, meaning every functionality that it has are compatible and can be used in devices with smaller screens.

Furthermore, the use of a Raspberry Pi 4B as the main microcomputer of the project played a huge role in the accuracy and entire processing speed of the entire system especially on Face Recognition. The positioning of an individual during facerecognition must also be the same to the dataset or images captured from them during the registration to easily and accurately recognize the individual.

The functionalities of the Automated Attendance System using Face Recognition with body temp sensor, were all met and is functioning correctly, due to

this, it is planned to be installed and implemented in Surigao del Norte National High School particularly in the Senior High sector.

Recommendations

Since the developed project has limitations, the researchers recommend to the future researchers to redesign the system to be more flexible in terms of the following aspects:

1. The ability for the system to reset the GSM Module when no signal is detected and RC522 if it reaches the inactivity state.
2. Integrate a login-logout functionality to it and create a GUI using Tkinter for the registration part of the project instead of the CLI in the Thonny IDE.
3. Use a Raspberry Pi Touch Display instead of a computer monitor, a 3d outer design for better output quality, and a better computer or microcomputer as image processing requires a lot of memory resources.
4. Use a better or upgrade the hosting provider for both the Frontend Web Application and the REST API instead of using a free tier plan.

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