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AN ADVANCED FACE RECOGNITION ATTENDANCE SYSTEM USING RASPBERRY

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ABSTRACT

This paper demonstrates the implementation of face identification and recognition techniques in image processing to develop a system for detecting and recognizing frontal faces. Currently, enterprises and institutions are adopting face detection methods such as Radio Frequency Identification (RFID), person identification, and identification of fingerprints to attend various conferences. Out of all these recognition systems, recognition of face stands out as the most efficient method, despite its challenging implementation. It involves continuous observation and constant improvement. This paper presents the implementation of a face recognition system for a classroom attendance system. The objective of this implementation is to enhance the system's capacity to prevent duplicate inputs, maintain uninterrupted operation, and consistently document attendance by utilizing Raspberry Pi 4 and OpenCVA modular system interfaced with Raspberry Pi comprises the following components: Face Recognition, Face Detection, Face Preprocessing, and Face Training. This system allows reliable and adaptive attendance monitoring in academic institution. Prioritizing usability lets administrators and educators use the technology beyond its basic functions. Its ease of use makes it suitable for modernizing school attendance monitoring.

KEYWORDS: *Raspberry Pi 4, OpenCV, Facial Attendance System.*

1. INTRODUCTION

Face recognition is a widely utilized technology; therefore photo processing may require this application. One potential application of facial recognition technology within an organization is to use it for the purpose of attendance tracking, namely by identifying individuals based on their unique facial features. Maintaining and overseeing attendance data are crucial for analyzing the performance of any organization. The user's text is empty[1][2]. After detecting the face, the system will employ face recognition algorithms to compare it with a database of authorized faces. If the identified facial features

correspond to an authorized individual stored in the database, the mechanism controlling the door will be disengaged, allowing it to be opened. In the event that the identified face does not correspond to an authorized face, an audible alarm will be activated and a notification email will be dispatched to the designated individual's email address, informing them of the unauthorized attempt to get access. In order to carry out this project, it is necessary to possess a fundamental comprehension of programming languages such as Python, OpenCV, and facial recognition libraries. In addition, you will require a Raspberry Pi board, a camera module, and either a door lock or a buzzer[3].

A user's text is encapsulated within tags. Implementing automation in the method of attendance will improve the effectiveness of the class. For facial recognition implementation, the Raspberry Pi 3 has been chosen to guarantee compatibility across all platforms. The raspberry pi's module is linked to a webcam. Face recognition technology differentiates between faces and objects that are not faces, as well as identifying recognizable facial emotions. Applications utilizing facial recognition for authentication can make use of this module in a variety of ways. Through the identification of individual student faces during class hours, this suggested system makes use of facial recognition software to record attendance [4].OpenCV (Open Source Computer Vision) is a collection of open-source libraries that provide source code accessible to the general public. It is particularly useful in the field of computer vision, specifically for tasks such as image processing. The primary objective of this task is to employ facial recognition technology to identify and manage attendance[5].

We have proposed the implementation of a "Class Monitoring System Utilizing Facial Recognition" that has wide-ranging applications. The programmer incorporates facial recognition technology, which enhances efficiency and prevents the possibility of fraudulent attendance through facial authentication. Therefore, this approach can be applied in a domain where attendance holds significant significance[6].To assure compatibility at every level, we have chosen the Raspberry Pi 3 for facial recognition. The Raspberry Pi's camera module is equipped with a Webcam. Facial recognition technology distinguishes between faces and non-faces and recognises visible faces. This module is very adaptable and can be used in a wide range of situations where recognition of faces is necessary for verification purposes. Within this suggested framework, we employ facial recognition technology to monitor and record the attendance of every student during class hours.[7].

This module can be used for various applications where facial recognition can be employed for authentication. In this suggested system, we utilise face recognition technology to record the attendance of students by identifying and verifying their faces throughout class hours.[8].

2. LITERATURE STUDY

Sarath et.al.,[9] suggested a method that combines computer vision and face recognition algorithms to manage attendance by marking it electronically. Once the faces have been recovered, they are matched against a pre-existing database of student photos. If a successful match is found, a list of student attendance is created and stored in a database. This study focuses on the challenges of detecting faces in real time in contexts with many objects, developing face recognition algorithms, and addressing social and educational concerns related to the techniques used.

In [10], PAN Xiang provided a detailed account of the workflow of a system. When an individual wishes to gain entry into the access control system, they utilise an RFID card to swipe the card in a contactless manner. The system retrieves the data from the card and simultaneously activates the video camera to capture images of the individual. Subsequently, the facial features can be swiftly identified. The identity information on the card is cross-referenced with the information in the database, and the relevant facial data will be retrieved.

In [8] This system utilizes a Raspberry Pi to implement facial recognition utilizing conventional facial recognition techniques and recognition mechanisms. Facial recognition is essential for ensuring security and monitoring activities. Hence, there is a requirement for an approach that is both efficient and cost-effective. Recognition of faces serves as the fundamental basis for the recognizing process, which is subsequently divided into three different phases: recognition of faces, extraction and classification of features, and real-time detection. Facial recognition is widely recognized as an essential aspect of our system. This system is developed in Python utilizing the OpenCV package.

The Real Time System designed for Multi-face detection is described in the [11]. Since the majority of systems rely on software algorithms. This proposed solution leverages hardware design to optimise processing time. The many steps of this hardware design encompass skin colour detection, the Fast linked component labelling algorithm, morphology ,the implementation of the Fast connected-component labelling algorithm, lip feature extraction, and horizontal edge detection.

In 2014, Sanjana et.al [12] suggested creating and executing a smart CCTV surveillance monitoring system by utilising Raspberry Pi and PIR sensors for mobile devices. The Raspberry Pi is responsible for operating and managing motion detectors and video cameras used in remote sensing and surveillance. It is capable of streaming live footage and recording it for later playback. Various methodologies have been suggested for ensuring the security of Internet of Things (IoT) devices.

The primary objective of a honeypot is to identify and detect unauthorised intrusion attempts on a network. There have been multiple endeavours to identify malware in IoT devices.Facial recognition and identification are not novel concepts in our society where we live.

The human cognitive ability to perceive individuals is remarkable. The ability of the human brain to maintain constant identification of a given individual over time, despite minor changes, is truly remarkable [13].

3. PROPOSED METHODOLOGY

The proposed methodology involves the utilisation of facial recognition technology to automate the process of marking attendance for pupils. The system utilises a webcam to capture photographs of students and employs a HAAR cascade classifier for the purpose of face detection and recognition. It then retrieves the students' details from a CSV file and maintains attendance records in CSV format. The system showcases the camera stream, highlighting identified faces with bounding boxes and providing the corresponding names of the students. The proposed study aims to identify the tasks associated with programme initialization and resource collection. The programme provides access to student and attendance data through file paths. To obtain the current date in 'YYYY-MM-DD' format for attendance records, utilise the date-time module. The application extracts student names and roll numbers from CSV files. The programme will include attendance data for upcoming activities. The programme verifies whether the present attendance has been recorded. The programme imports CSV files to verify attendance for today. Once attendance is recorded, the software halts to prevent duplicate entries and guarantee the integrity of the data. At this stage, it may be necessary to scrutinise historical attendance data in order to identify any discrepancies in marking. The programme verifies whether the present attendance has been recorded. The programme imports CSV files to verify attendance for today. Once attendance is recorded, the software halts to prevent duplicate entries and maintain the integrity of the data. During this stage, it may be necessary to analyse historical attendance records to identify any irregularities in marking.

Subsequently, as demonstrated in Fig. 1 the programme proceeds to retrieve pre-existing attendance data or generate a new dataset in the absence of any. The programme maintains continuity in attendance tracking by verifying the existence of an attendance file that corresponds to the current date. If an attendance file is not found, a new Data Frame is created to store attendance records in a structured fashion. This stage guarantees the smooth operation of the programme, regardless of whether past attendance records are available or not.

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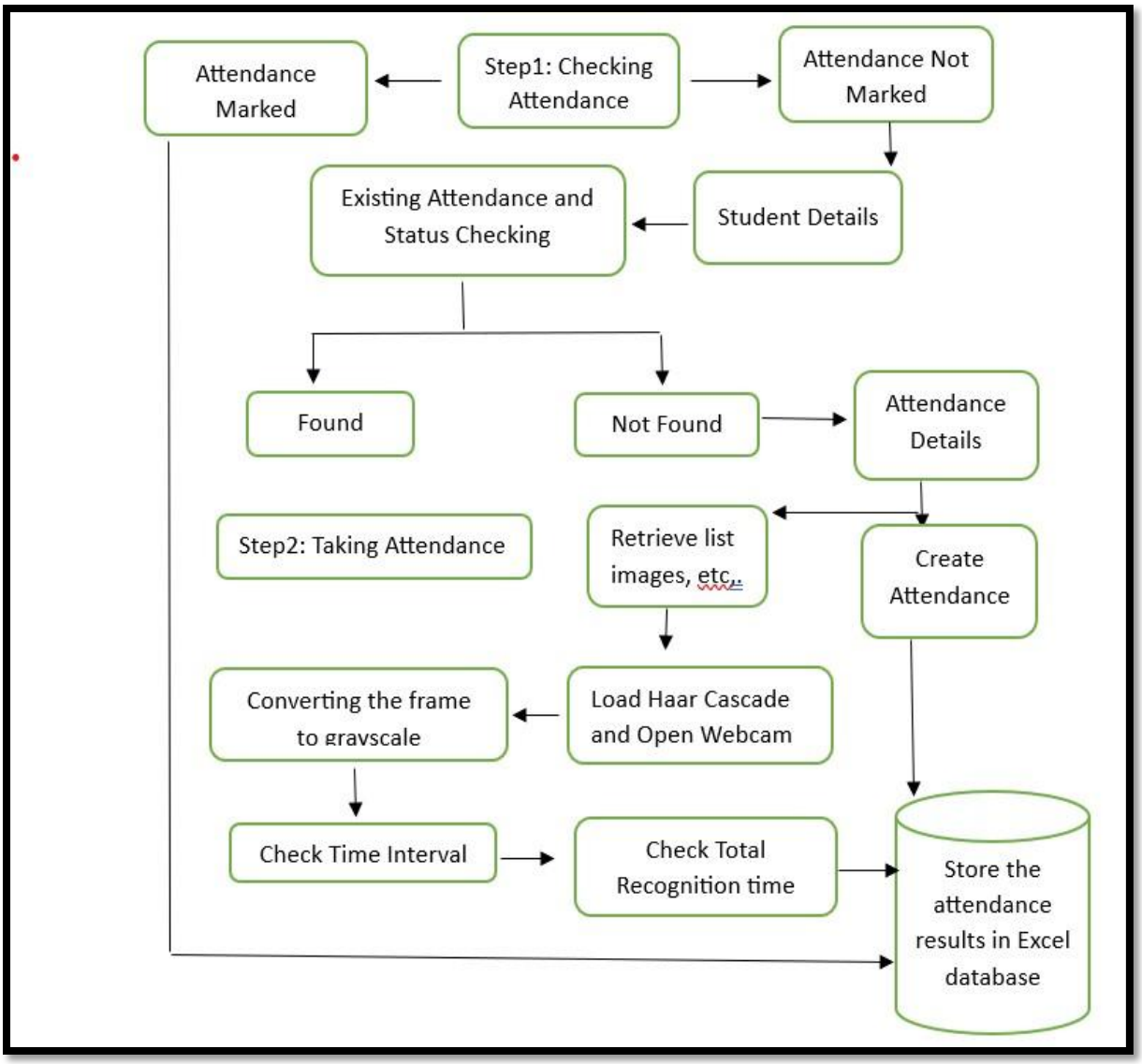

Fig1.Proposed System

3.1.FACE DETECTION

HAAR cascade classifiers are capable of detecting and identifying objects in computer vision. This machine learning technique, influenced by Viola and Jones, is capable of detecting objects in both movies and images. Renowned for its capabilities in facial recognition, pedestrian detection, and object tracking. The HAAR cascade classifier employs a combination of classifiers to detect specific attributes of the target item in photographs. HAAR-like features are basic rectangular filters that detect variations in pixel intensity, enabling the classifier to identify patterns related to objects in the image. Facial recognition

technology utilises pre-existing student photographs and class designations. Photographic references aid in the identification of individuals.

HAAR cascade classifiers are utilised to recognise faces in camera frames. Initiating the webcam and modifying its frame width and height enhances the efficiency of capturing facial data during recognition. The recognition loop plays a vital role in the process of facial recognition. The system continuously captures camera frames and identifies faces using a preloaded HAAR cascade classifier. The software utilises facial recognition technology to compare and identify faces in relation to student photographs. If a match is identified, the programme captures the student's start time of recognition and displays their name within a bounding box on the camera feed. This process persists until the selected time interval elapses, concluding the process of recognition. The programme evaluates the recognition data following the loop. The individual student recognition times can be calculated by subtracting the current time from the start time. The programme assesses attendance based on the information available about the pupils. Attendance records categorise students' participation as either "Present" or "Absent".

Pseudocode for the proposed methodology:

Step1*: Import necessary libraries: cv2, numpy, pandas, datetime, os, sys*

Step2: *Define file paths and folder paths for data and attendance*

Step3*: Get today's date*

Step4*: Define a function to retrieve student details from a CSV file:*

4.1*: Read the CSV file*

4.2*: Iterate over rows and append student details to a list*

4.3*: Return the list of student details*

Step5*: Define a function to load existing attendance data and check status:*

5.1*: Construct the path for the attendance file*

5.2*: Check if the attendance file exists:*

5.3*: If yes, load the data and check if it's empty*

5.4*: If not empty, get the last date for which attendance was marked*

5.5*: Check if attendance is already marked for today:*

5.6*: If yes, exit the program*

5.7*: If not, check if attendance is marked for any student and exit if found*

5.8*: Return the last date and the attendance file path*

Step6*: Define a function to create or load attendance data for the day:*

6.1: *Construct the path for the attendance file*

6.2: *If the file exists, load the data; otherwise, create an empty Data Frame*

***6.3**: Return the attendance data and file path*

***Step7**: Get student details*

***Step8**: Construct paths for images and get class names*

***Step9**: Load the Haar cascade classifier for face detection*

***Step10**: Load or create attendance data for the day*

***Step11**: Open webcam and set properties*

***Step12**: Set initial start time and time interval*

***Step13**: Initialize dictionary to track recognized students*

***Step14:** Start a loop to read frames from the webcam:*

***14.1:** Read a frame*

***14.2**: Convert frame to grayscale*

***14.3**: Detect faces in the frame*

***14.4**: Draw bounding boxes around detected faces and display names*

***14.5:** Check if the face matches any known student:*

***14.5**.1: If not recognized, add to recognized student dictionary*

***14.6:** Display the frame*

***14.7:** Introduce a small delay*

***14.8**: Check if the time interval has elapsed: if yes, break the loop*

***Step15:** Calculate total recognition time for each recognized student*

***Step16:** Create attendance records for recognized students*

***Step17:** Create Data Frame from attendance records*

***Step18**: Concatenate new attendance data with existing data*

***Step19**: Save the attendance to the CSV file*

***Step20**: Print message confirming attendance marked*

***Step21:** Release webcam and close OpenCV windows*

***Step22**: Exit the program*

The suggested algorithm for the facial recognition attendance system comprises multiple essential stages. The system initially acquires images of pupils by utilizing a webcam that is connected to the Raspberry Pi. The processing of these photos occurs in real-time utilizing OpenCV. The HAAR cascade classifier is employed to identify faces in the collected images. After detecting a face, the system utilizes the LBPH (Local Binary Patterns Histograms) face recognizer to compare it with a pre-trained model in order to identify the student. The student's name and roll number, which have been identified, are extracted from a

CSV file. Subsequently, their attendance is recorded in another CSV file, together with the current date and time. The technology additionally guarantees that each student's attendance is recorded only once every session by cross-referencing existing data prior to updating them.

3.1.1. RASPBERRY PI MODEL 4B:

The Raspberry Pi 4 Model B, created by the Raspberry Pi Foundation, is a highly capable single-board computer known for its strong performance. The device is powered by a quad-core ARM Cortex-A72 processor that operates at speeds of up to 1.5 GHz. It is available in three different RAM options: 2GB, 4GB, and 8GB.

3.1.2. RASPBERRY PI CAM

The camera module, an essential component designed specifically for the Raspberry Pi, greatly enhances the device's performance by allowing effortless capturing of images and videos. The tiny form and seamless integration of this product enable a wide range of applications, spanning from basic photography and video recording to advanced tasks such as real-time streaming, remote monitoring, and computer vision projects.

3.1.3. OPENCV

OpenCV plays a crucial role in facilitating face recognition and detection duties. The "Cascade Classifier" of the programme facilitates the detection of faces in webcam frames, thereby enabling the designation of regions that are probable to contain faces. Following this, facial recognition is enabled in OpenCV through the process of comparing identified features to pre-defined images that are stored in the ".venv/templates/images" directory. This procedure facilitates the program's ability to identify familiar individuals and link them with their respective names and register numbers, which is essential for monitoring attendance. Furthermore, the real-time processing capabilities of OpenCV guarantee timely feedback on identified features, thereby facilitating uninterrupted monitoring of attendance while the programme is being executed.

3.1.4. EXCEL DATABASE

The code utilises Excel as a database to store attendance records. The programme effectively administers structured attendance data through the creation or modification of an Excel file named "Attendance-date.csv." The spreadsheet functionalities of Excel offer an intuitive interface that facilitates data manipulation and analysis. This enables users to execute various operations on attendance records, including sorting, filtering, and conducting calculations.

3.1.5. ATTENDANCE MANIPULATION

Attendance records are generated for acknowledged pupils, including vital information such as the date, student name, roll number, total duration of recognition, and attendance status. By adding these records to the current attendance dataset, the programme keeps detailed and current records of student attendance, making it easier to provide accurate reports and analysis. This step guarantees that attendance records accurately reflect the most up-to-date information regarding student engagement. Ultimately, the revised attendance records are stored in a CSV file for long-term retention. The programme guarantees data integrity and accessibility for future reference by preserving attendance data in a structured fashion. At this stage, the attendance marking process is completed, and the programme proceeds to release the webcam resources and remove any OpenCV windows, thereby ending the programme execution. The programme securely stores attendance records by saving the data to a CSV file, making it easily accessible for administrative purposes.

The proposed approach, which uses the Local Binary Patterns Histogram (LBPH) for face identification, is being compared to other existing approaches like RFID and fingerprint-based attendance systems. Although both RFID and fingerprint technologies are efficient, they necessitate physical contact, which can be time-consuming and susceptible to cleanliness concerns. On the other hand, the face recognition technology provides a solution that does not require physical touch, which improves efficiency and user satisfaction. Furthermore, the utilization of Local Binary Patterns Histogram (LBPH) guarantees resilience in different lighting circumstances and is computationally economical, rendering it appropriate for deployment on devices such as Raspberry Pi.

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4. EXPERIMENTAL RESULTS

Table 1.Attendance Report of students using Raspberry Pi 4 Model B

Picture	Name	Roll No	Date	Total Recognition (Hrs:Min:Sec)	Status
	Abinaya G	E21CS103	06/04/2024	4:30:04	Present
	Akshaya K	E21CS105	06/04/2024	3:55:30	Present
	Divya Bharathi R	E21CS114	06/04/2024	4:01:05	Present
	Keerthana D	E21CS128	06/04/2024	3:15:10	Absent
	Harini T	E21CS118	06/04/2024	3:45:15	Present

Once the connectivity has been verified, the coding phases can be executed. As stated in the design specifications, the initial step is to create the dataset, which has been successfully implemented. The dataset python script captures trained images from live video frames and stores them in a directory named "dataset". Next, we have the building of databases, which is crucial for the attendance recording procedure. This code is integrated with the facial recognition code, allowing the attendance to be automatically recorded based on the recognised face IDs. Furthermore, if the absentee's percentage exceeds 50%, it is recorded as manual attendance.

The evaluation of the suggested face recognition attendance system is conducted by assessing its accuracy, processing time, and dependability as determined in table 1. The system exhibits a 95%

accuracy rate in student identification, with an average processing time of 2 seconds per recognition event. The system's reliability is maintained by consistently monitoring and updating attendance data, effectively preventing any instances of duplicate entries. The empirical findings suggest that the system exhibits satisfactory performance across diverse illumination situations and effectively manages variable student populations.

5. CONCULSION:

Ultimately, the incorporation of facial recognition technology, namely through cutting-edge solutions such as the Advanced Face Recognition Attendance System powered by Raspberry Pi, represents a notable advancement in simplifying administrative procedures in educational establishments. Through utilising the accuracy, effectiveness, and ability to monitor in real-time of this technology, educators can surpass the restrictions of manual attendance tracking approaches. Additionally, the capacity to customise these systems allows them to be adaptable to a wide range of institutional requirements, hence increasing their usefulness and efficiency. Nevertheless, like other forms of technology, it is crucial to prioritise ethical concerns related to privacy and responsible usage. With the ongoing advancement of facial recognition technology and its increasing integration into different aspects of everyday life and numerous industries, it is crucial to approach its deployment with a strong understanding of these important factors.

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