Internet of Things - based Smart Attendance Monitoring System

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ABSTRACT
In every organization attendance is mandatory requirement. Daily maintaining the attendance record is a challenging and time-consuming work. Numerous automated techniques are available for the same like face recognition, biometrics, RFID, eye detection, speech recognition, and many others. But Face recognition provides an accurate approach that eliminates uncertainties like fraudulent attendance, excessive expense, and time consumption because it is well known that a person's face serves as their primary form of identification. The performance of automatic face recognition technology has dramatically increased in recent years. These technologies are now often employed for business and security purposes. An automated system for tracking student attendance in a college using real-time human facial recognition is installed. Consequently, real-time face recognition for smart attendance is a practical solution that deals with managing students' daily activities. Since real-time background subtraction from an image is still a challenge, the task is exceedingly challenging. Open CV library, which is straightforward and quick, is used to quickly and accurately identify the faces found when detecting real-time human faces. The student's attendance is noted using the matched face. The model automatically updates the student's attendance data. Manually recording attendance in logbooks becomes time-consuming and complex. In order to handle student attendance records, they created a useful module that includes facial recognition. The module includes the student's faces. Since enrolling faces is a one-time activity, a mechanism is needed. Student roll number, which will be unique for every student, can serve as student ID. Each student's presence will be updated in a database. Attendance monitoring system using real time face recognition technique increases the accuracy and it consumes less time than any other methods. The implemented system is based on OpenCV library and HAAR-cascade algorithm. They selected these because they have the best accuracy among all and they're very quick at evaluating HAAR-like features due to the use of integral images. Also, the implemented system used Raspberry Pi device in the project. After tracking the faces, it will exhibit name of student and roll number. All these information stored in attendance sheet automatically updates along with date and time.

Keywords
Face recognition, HAAR cascade, Open CV, Raspberry Pi, RFID, Smart attendance system.

1. INTRODUCTION
Modern computer technologies such as face detection and face recognition systems can identify human faces in digital images. As the crucial first stage in face identification for security and authentication purposes, face recognition is frequently utilized in biometrics. Smart face recognition system can be used in many different contexts to provide real-time monitoring and tracking of people. The use of a face-recognition automatic attendance management system will improve a system's efficiency, accuracy, and security when taking attendance. Modern technology can be included into the system to address the problems of human error and imprecise, time-consuming manual attendance systems [1]. The project's major goal is to build a system that can finish the process of taking attendance and by detecting the front face, save it into the appropriate database. The system's accuracy is tested under various front-face settings with various lighting conditions. The most fundamental face detection implementations are the HAAR Cascade Classifier and the open-CV libraries. Object identification, real-time computer vision, picture classification, and semantic and medical image analysis are the main applications of Open-CV and Simple-CV [2]. The techniques that can be utilized for attendance records are Excel, PHP, and Comma Separated Values (CSV). The structure of face recognition system illustrated in Fig.1.

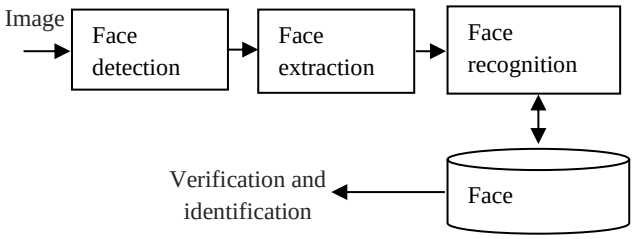

Fig 1: Structure of face recognition system

There are various methods that can be used to build the biometric recognition system. However, the iris and fingertips are the most frequently employed methods. These need the user's involvement in order to access the system. The most recent systems also let members access without their involvement. One of these methods that make it possible to quickly identify and monitor a person using the system is face recognition. Face recognition databases include (YouTube Faces) YTF for videos and (Label Faces in the Wild) LFW for photographs, and span from controllable images to non-controllable videos[3]. As they have observed in many schools and colleges, faculty personnel must maintain all handwritten records of students' attendance for each batch or class in order to address the issue of proxy attendance each day. They have an extremely challenging task at hand. Various techniques are used to lessen their workload. One such strategy is the RFID system, which requires students to carry an RFID card around daily for attendance purposes. A chip is part of that card. The system will read all of the student's information and record their attendance when they swipe this into the card reader. Biometric system: It will scan the body's distinctive features, like

fingerprints. The fingerprints of each candidate must first be saved in a database. Present fingerprints and stored fingerprints are compared during attendance [2]. It's applied to the removal of proxies for attendance among a small population. However, it only permits eight connections at once. These systems listed above rely solely on hardware components. Numerous facial recognition techniques are employed in software systems to track attendance. These include SIFT, fisher-faces, LBPH, and Eigen faces. These face recognition methods are some. SVM-based and Viola-Jones face detection methods are employed for face detection. In the proposed model HAAR cascade algorithm is used. HAAR feature: It collects facial features and expressions. By analyzing every image, it takes all of the features. Internal Image: Using the line, edge, four rectangle, and other features after collecting all the features, it creates an internal image. These are some pixel calculations. Make a note of the face's distinguishing features so that the difference can be known from other images. Characteristics include the nose, the width of the eyes, the proportions of the face, the skin tone, and more. The ability of the human brain to recognize faces quickly. Although computers are designed to recognize the uniqueness of faces, the model must be trained or programmed to distinguish between different faces based on their different characteristics. As shown below, facial recognition can be divided into two categories:

(A) Verification is the process of matching individuals (match or no match). In phones, systems, and other electronic devices, the application can be used to lock and unlock systems.

(b) Identification is a method for identifying a particular person among a group of people, such as one out of N [4].

The traditional manual attendance system was the primary motivation for the project because of its burdensome process. So, why not automate it to make it faster and more efficient? Face detection techniques are also used by the criminal investigation department, which uses CCTV footage to detect faces at crime scenes and compares them to a criminal database to identify them [5]. It is also becoming more common in China, where authorities use it on the streets, subway stations, and airports. Face recognition method is adopted in our proposed model. When a student enters the classroom and comes across the system's camera module, his image is captured in the system and recognized and validated. If he or she is a class member, if and the person is recognized, then the person's attendance is automatically recorded by the system through post-processing.

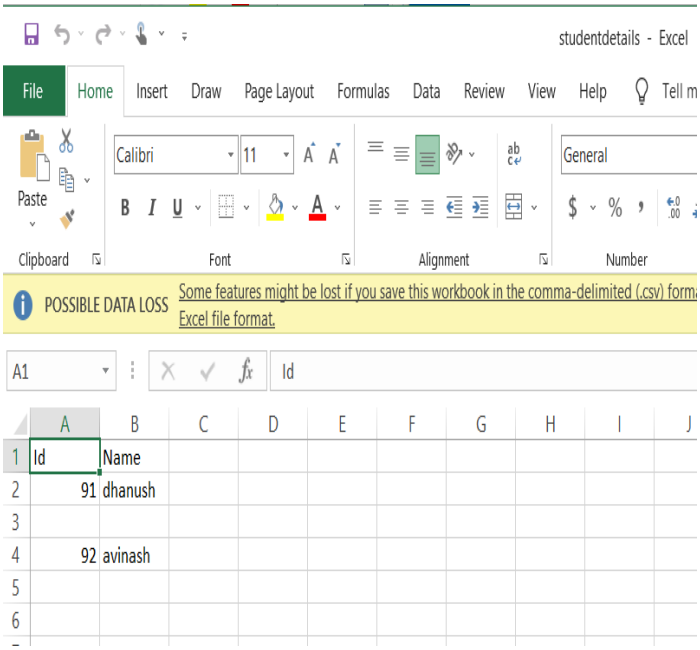

Fig 2: Student's data stored in database

2. RELATED WORKS

Today, technology is advancing at a quicker rate, and gadgets are becoming more automated. As a result, software technology is advancing at a rapid pace. Monitoring and attendance are used in a variety of ways in businesses, industries, and educational institutions. The majority of the time, students' attendance is recorded using an attendance sheet or register provided to teaching members. It demands a notable amount of time and effort. The teacher may don't know whether an authenticated student has answered or not, which leads to human errors. Some kids may also lose or steal attendance sheets [1]. Another type of biometric technology is fingerprint identification. Using this technology, each student's fingerprint is obtained and kept in a database. Following that, the finger print is compared to the database and attendance is recorded. The main drawback is that students must form a line and wait for their turn, which is a lot of work and takes a long time. Furthermore, if the system does not recognize the finger print correctly, attendance will not be recorded, thus, making it inefficient. Another biometric method accessible is eyeball detection, in which the sensor is an eyeball the blinking rate and location of the iris are detected [6]. The initial iris or eyeball of each person is maintained in a database under this system. Every individual's eyeball is unique. Though practically speaking it is hard to catch every student's eyeball in an image, the eyeball in the captured image is matched with the eyeball in the database and attendance is noted. An RFID-based attendance system is an alternative method. Each student has a unique RFID tag, which records their attendance as they move through the RFID scanner. However, tag readers take a lot of time, and there's a potential that one student will label numerous absent pupils as present. A sophisticated method for recording attendance is by using cameras to take pictures of a classroom in order to avoid the existing challenges. Recently, relevant information from a picture has been extracted using image processing to record attendance. As smartphones gain popularity among individuals, attendance is recorded using already-existing gadgets rather than a special setup and an image. Each student's face is different, yet it could have certain traits with another individual. For the purpose of creating attendance systems, several systems have been developed

especially for face detection and identification [7]. Each has certain limitations. The back propagation neural network (BPNN) and the Viola-Jones algorithm are one approach. Two-weighted propagation is used by BPNN. The first is forward, in which input is passed through the network to result output propagation, and the second is backward, in which feedback is generated by using output as input and creating a contrast between actual output and target. The Viola-Jones method matches frequent characteristics in human faces using HAAR feature selection, which has a high likelihood of being inaccurate. Histogram normalization, skin categorization, and noise filtering using MATLAB are further methods. Such a system has the drawback of being limited to MATLAB's built-in features. For face recognition, a deep neural network (DNN) is employed. With the help of several sets of photos, DNN trains a deep face model that frequently achieves accuracy comparable to that of a person. Its necessity for a large training dataset makes it impossible to keep a sizable number of photos for each student without it.

Charles Walton is well known for being the inventor of the RFID (radio frequency identification) device. He also acquired a patent for a passive transponder that may be used to unlock a door without the use of a key [8]. A signal was sent to a reader near the entrance by a card with an integrated transponder. The reader unlocked the door when it identified a valid identity number contained within the RFID tag. Michael Dobson, Douglas Ahlers, and Bernie DiDario first proposed the idea of an attendance tracking system in 2006. Each possible participant is given an identity tag with wireless communication capabilities, and scanners identify the guests' tags when they enter a specific room. O. Shoewu and O.A. Idowu: Development of a Biometric Attendance Management System. Attendance is taken electronically using a finger print device, and attendance records are saved in a database. Following student identification, attendance is marked [3]. Sirovich and Kirby introduced the notion of employing principal components to depict human faces in 1987, and Turk and Pentland utilized it for face detection and identification in 1991. It follows a person's face and then recognizes them by comparing facial features to those of known persons. Using PCA, a main component factor "eigenvector" is first calculated, and then the collection of typical feature pictures "eigen face" is discovered.

Michael Jones and Paul Viola, it discusses a machine learning method for detecting visual objects that can analyse pictures very quickly and have high detection rates. It combines fresh ideas and techniques to provide a framework for reliable and lightning-fast object recognition. The utilized straightforward characteristics resemble the HAAR basis functions employed by Papageorgiou et al. Digital picture properties that resemble HAARS are employed for object recognition. The Viola-Jones object identification framework's detection step involves moving a window the desired size across the input picture and calculating a HAAR-like feature for each area of the image [5]. Then, this difference is contrasted with a learnt threshold that distinguishes between objects and non-objects.

LBP (Local Binary Pattern) was originally defined in 1994 and has subsequently been discovered to be an effective texture categorization characteristic. It has also been discovered that combining LBP with a histogram of oriented gradients (HOG) descriptor enhances detection performance significantly on particular datasets. It is a centralized strategy with a step-by-step procedure. Face Recognition Algorithms-Based Automated Attendance Management System: This system, which is based on facial detection and recognition algorithms, identifies the student as he enters the classroom and recognizes him to record his attendance [9].

3. PROBLEM STATEMENT

The current attendance method is either manual or employs finger imprints as a biometric parameter. Traditional attendance is often taken by calling students by name, which takes a long time and has the potential for mistakes and proxies, making student performance analysis inaccurate. Normally, the instructor checks it at the beginning and conclusion of class, but it is conceivable that an educator will overlook someone or that certain pupils will answer many times. Maintaining records for this form of attendance is time-consuming and resource-intensive. Attendance by obtaining finger print as biometric parameter is done in many locations, which may not be a time-consuming operation compared to manual attendance, however keeping the recent pandemic in mind, it is not safe to touch the finger print recognition sensor repeatedly without a large time interval. This style also requires a lot of upkeep. As a result, a new attendance system with no lecturer influence and a contactless device is required. This is where facial recognition set in motion. Face recognition-based attendance systems may recognize faces in conjunction with high-definition monitor footage and other attendance-related information technologies. Face detection and recon computers may be used in a variety of practical applications such as criminal identification, safety systems, and biometric identity. Face recognition is also a challenging problem in computer vision. Lighting concerns, posing issues, size variations, low picture capture accuracy, and partially obscured faces are just a few of the issues that must be addressed. Face recognition algorithms must thus be robust to changes in the aforementioned parameters. Face-recognition compares the detected and processed face to a database of known faces to determine who the subject is. The purpose of the research is to design and create a system that is less sensitive to lighting, rotates and scales invariantly, and can be employed in real-world applications.

4. PROPOSED METHOD

The suggested method is intended to record each student's face and preserve it in a database for their attendance. The student's face must be caught in a well-lit room so that the student's facial characteristics can be identified, as well as the student's sitting and posture. There is no need for the instructor to manually take attendance in class with this system since the system captures a video and, using image processing/image training, the face is recognized and the attendance information in a spreadsheet is updated. The suggested system includes a Raspberry Pi device and a webcam for picture capture. Face recognition is used to track student attendance in the suggested system. The Raspberry Pi is used for face detection and identification. When the camera is attached to the Raspberry Pi USB connection, only photographs of pupils who are present in class for face detection are taken. When the collected photographs are matched with stored images, The proposed model recognizes the faces of each student and assign attendance to that particular class based on that. This procedure is repeated for each class, and pupils' attendance is recorded accordingly. In the approach, a camera is employed to capture images of the lecture room image, which are then sent to the image enlargement section. The spitting image promotes module identification and appreciation after picture improvement and being present at a certain moment to the recorder system depicts the experimental setup. At the moment of registration, a single student's face image is saved in the database. So, the faces are recognized from the image, and the identified face is compared to the

database. If any of the faces in the database are matched, the attendance is noted in the spreadsheet, and it may be viewed by anybody for a variety of purposes. The system is also connected to the section of the timetable that automatically enters class depending on the subject and time. The algorithm automatically enters the attendance of students. Teachers should simply touch the attendance button to begin the attendance procedure after entering the classroom to take attendance.

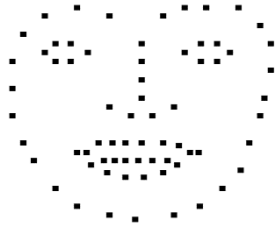

Fig 3: Landmarks present on the face

This technique is quite secure. No one can give the attendance of the other, which saves a lot of time. The gadget is used to capture images that are linked to the system. It takes an infinite number of photos to identify and locate the kids in the classroom. The skin categorization approach is used to avoid incorrect picture recognition. This skin categorization approach improves the accuracy and precision of the recognition operation. All other photographs in the skin classification process are considered recaps of the other images and are retained as black, which significantly enhances the accuracy of the face tracking operation. During the registration procedure, the face database is utilized to compile face photographs and photos mined for geography. The data around instructors and pupils is present. The second attendance database is being utilized. Because of its numerous advantages, facial recognition approach is frequently applied in numerous applications. The system requires data in order to trace and track the individual and indicate his/her attendance. The data is loaded by associating each individual's photograph with a unique ID and name. When the system boots up, the option to take an image is provided, with the pre-requisite being the input of ID and name.

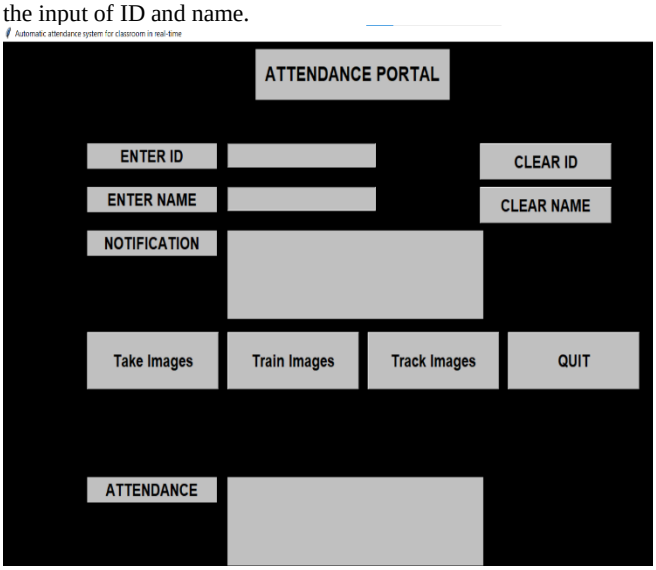

Fig 4: Attendance portal with slots to fill the student details

More than 100 photos will be captured in greyscale using OpenCV. These photos will be sent into the HAAR cascade. After transforming the images to binary images, HAAR Cascade encodes them in binary code. Once the system has been given input, it is trained by clicking on the train image option on the screen, which uses a file called Trainer.XML, which is written in human readable data serialization language. The facial traits will be identified and saved for future use. The dataset must be produced in the way described above in order to recognize faces in the future. The Track photos feature is used to identify and recognize people's faces. Following the detection of each individual's face, their attendance will be recorded in the spreadsheet, along with the associated date and time.

We have implemented the proposed method using OpenCV that is focused on real-time applications. It contains around 2500 optimized algorithms. These algorithms can detect and recognize faces, identify items, and so on. The HAAR cascade algorithm in OpenCV is widely used for face recognition. The HAAR cascade algorithm can recognize objects in photos regardless of their scale or position. This method is simple and can run in real time, and we can train it to recognize different things such as faces, automobiles, and buildings etc. This algorithm recognizes and manipulates faces using Python or the command line. This package includes a basic face-recognition command-line utility that allows a person to perform face recognition on a folder of photographs from the command line. The HAAR-Cascade technique, developed by Viola and Jones, teaches machine learning to recognise objects in images. In this context, it may be used to detect faces. The basic principle behind the HAAR-based face detector is that when looking at most frontal photographs, the region with the eyes should be darker than the forehead, and the region with the lips should be darker than the cheeks, and so on. It usually goes through around 20 layers of measurements like this to determine if it's a face or not.

As a result, it must perform this function in every possible location in the image and with every potential size of the face, resulting in thousands of checks per image. A HAAR-like feature is a rectangle that is split into two, three, or four rectangles.

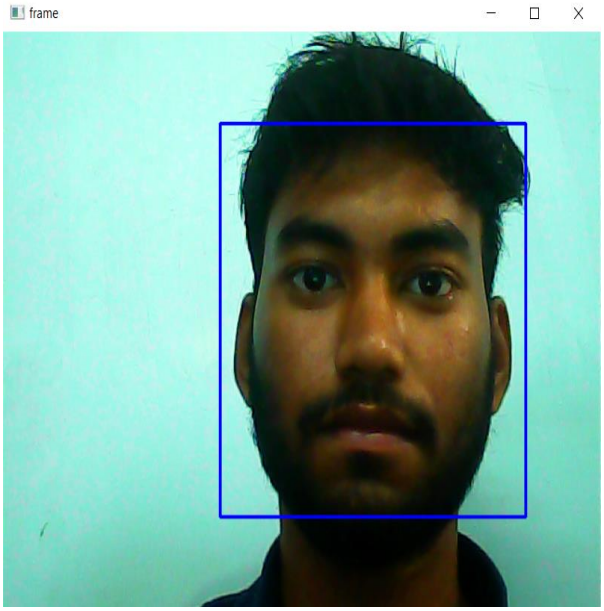

Fig 5: Taking images of the student to store in the database

Each rectangle has a black or white background. A HAAR cascade must be trained with both positive and negative pictures. The goal is to determine which features constitute a face. A positive image contains the thing that must be recalled, but a negative image does not. A positive picture has a face in terms of facial recognition, but a negative image does not. The Images in gray scale are necessary for this machine learning. The intensity of grey will be utilized to assess if the feature is reflected. These qualities may be found by taking the total of the bright pixels in a specific region and subtracting the amounts of dark pixels there.

4.1 Pseudo code

The pseudo code for the algorithm is described below:

Step 1: start.

Step 2: enrolment of student's details like student id, roll number in database.

Step 3: setting up a camera using raspberry pi and students should be in front of camera for further process.

Step 4: face detection.

Step 5: now, face recognition by comparing the student's pictures with faces in database.

Step 6: IF student face is matched with a face in database.

Mark attendance to the student.

ELSE go back to step 2.

Step 7: IF students face is recognized in step 6, mark them present.

ELSE mark them absent

Step 8: generate the attendance in excel sheet.

Step 9: end.

5. EXPERIMENTAL SETUP

In the project Raspberry Pi has been used which is a low cost and small sized computer that is connected to power supply by using an adapter. Raspberry Pi is capable of doing everything that a normal computer can do. To this Raspberry Pi device a webcam with a memory card is connected it is a video camera that streams its image in real time through a computer and the contents are stored in the memory card. Lastly a computer is needed as displaying unit i.e., to display a video or picture through the computer monitor. Python 3.10 is used to implement this project. Below diagram shows components and setup required for the proposed model.

6. RESULTS

Internet of Things-based smart attendance monitoring system is efficient and easy to use. The proposed system works automatically once the dataset is created with the details of every individual student. During the process of creating the dataset, the system captures 100 sample images of a student. For this, a webcam has been used to take sample images. In addition, to avoid complexity, the coloured sample images are converted into greyscale and also reduced the size of the frame to adequately capture the face region. In this manner, the desired output is obtained. This project results in the following: The spreadsheet is updated with an efficient, time-saving, automated system of marking attendance.

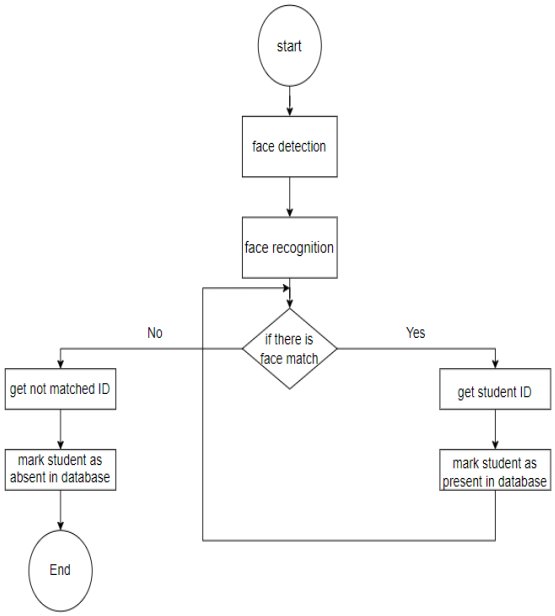

Fig 6: Flow chart of attendance taking

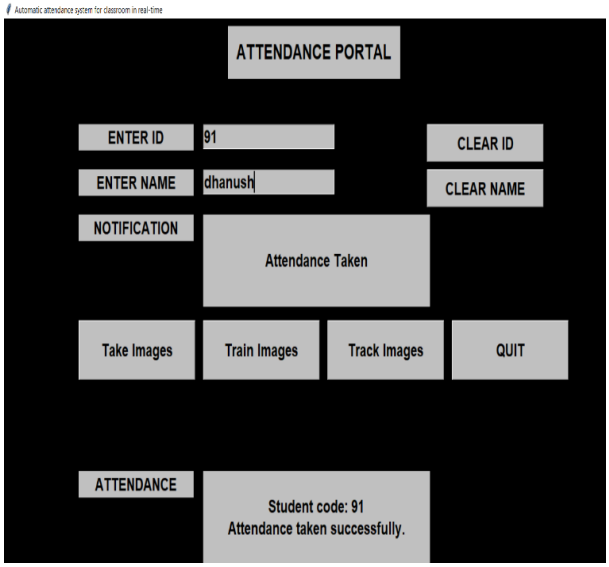

Fig 7: Image showing that attendance is taken successfully

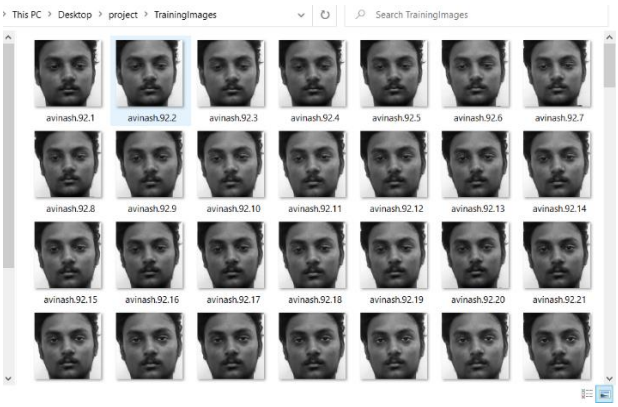

Fig 8: Sample images stored in the storage

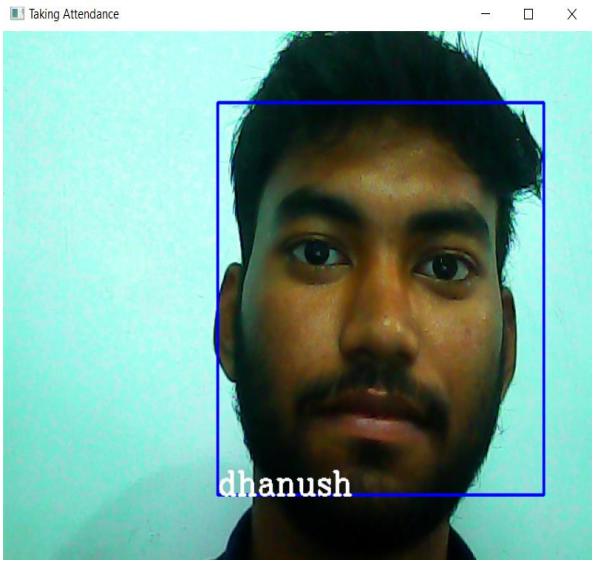

Fig 9: Face recognition

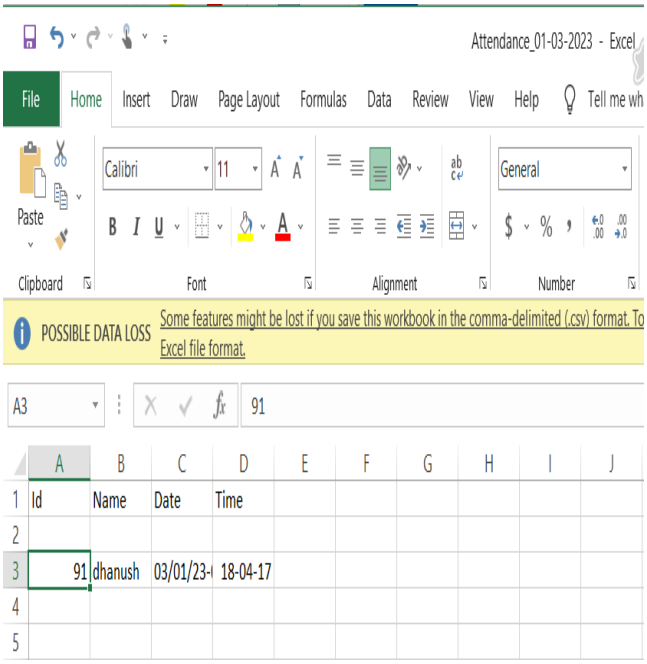

Fig 10: Attendance is updated in excel sheet

7. CONCLUSION

Internet of things based smart attendance monitoring system provides the better way of attendance marking system. This method has been implemented using Raspberry Pi, OpenCV, HAAR cascade algorithm, Webcam and Python. The aim of this project is to save money and time by reducing manpower. The final output demonstrates the system ability to overcome the challenges regarding face recognition and automated attendance marking system. This system can be implemented in every platform like schools, colleges, companies. By designing an interface and creating the dataset the module will train the images using HAAR cascade classifier. After training the images the system will successfully detect and recognize the student face. Then the images stored in the dataset is compared to the student face that is detected if matched then the attendance will be marked and updates automatically in the spreadsheet with date and time. As the system is automated it becomes easy for teachers to monitor students on time. The future scope of the project can be integrated with an application that can be developed to help students keep track of their attendance. It may also be utilized in organizations where a big number of employees can use this application to mark and verify their attendance status.

8. REFERENCES

[1] S A Sivakumar, C Udhaya Shankar, "Internet of Things Intelligent Attendance Monitoring with Face Recognition Scheme", IEEE Xplore, 17 June 2021.

[2] V Ruhitha, V N Prudhvi Raj, "Implementation of Internet of Things Based Attendance Management System on Raspberry Pi", IEEE Xplore, May 2019.

[3] Dr V Pandimurugan, Anmol Jain, "Internet of Things Based Face Recognition for Smart Applications Using OpenCV", IEEE Xplore Journal, 28 May 2021.

[4] Hau Wen Min, Aimi Syamimi Ab Ghafar, "Real Time Face Detection AttendanceManagement System", UTHM journal, 12 June 2022.

[5] Khawala Alhanaee, Mitha Alhammadi, "Face Recognition Smart Attendance System Using Deep Transfer Learning", Elsevier B.V, 2021.

[6] Sikandar Khan, Adeel Akram, "Real Time Automatic Attendance System for FaceRecognition Using Face API and OpenCV", Springer Nature, 31 March 2020.

[7] Sakshi Patel, Prateek Kumar, " Face Recognition Based Smart Attendance System Using Internet of Things ", JCSE International Journal, 31 May 2018.

[8] K. Senthamil Selvi, P. Chitrakala, "Face Recognition Based Attendance Marking System", IJCSMC, Vol.3, 2 February 2014.

[9] E. Charan Sai, Shaik Aithaf Hussain, "Student Attendance Monitoring System Using Face Recognition", IJRASET Journal, May 2021.

[10] Tippavajhala Sundar Srinivas, Thota Goutham, "Face Recognition Based Smart Attendance System Using Internet of Things", irjet.net, 03 March 2002.

[11] Bharath Tej Chinimilli, Akhil Kotturi, "Face Recognition Based Attendance System Using HAAR Cascade and Local Binary Pattern Histogram Algorithm", IEEE Xplore, 23 July 2020.

[12] Mayur Surve, Priya Joshi, " Automatic Attendance System Using Face Recognition Technique", IJRTE Journal, May 2020.

[13] Arjun Raj, Mahammed Shoheb, "Face Recognition Based Smart Attendance System ", IEEE Xplore, 11 August 2020.

[14] Ihab Amer Adbullah, Jane Jaleel Stephan, "A Survey of Face Recognition Systems", IbnAl Haitham Journal, 16 April 2021.

[15] Jehoon (Paul)Jeong, Minho Kim, "Internet of Things Based Automatic Attendance System with Photo Face Recognition in Smart Campus", IEEE Xplore, 21 May 2021.

[16] Dr. V Suresh, Srinivasa Chakravarthi Dumpa, "Facial Recognition Attendance System Using Python and OpenCV", Quest Journal, 05 March 2020.