AUTOMATIC STUDENT ATTENDANCE SYSTEM USING FACE RECOGNITON

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Abstract

In this digital era, the face recognition system plays a significant role in almost every sector. Face recognition is one of the foremost used biometric. It is used for security, authentication, identification, and possesses many advantages. Also, the facial recognition system is one of the most convenient ways to attend university today. A big portion of the time allocated to a college for teaching purposes is consumed on the task of taking attendance of the scholars. A student attendance system is required to live student participation in a very course. This is often a problem because it takes the precious time of teachers which may well be spent on more productive tasks like teaching and interacting with students. This paper presents the detailed implementation of a real-time roll call system supported by face recognition and its results.

This paper proposed the Automatic Student Attendance System Using Face Recognition which keeps track of scholars attending a specific class. To acknowledge a student's face, the system must first, take and save an image of the code as a reference in an exceedingly large database. During the roll call, the photos take face pictures for a student to be recognized, so the pc automatically detects the face and identifies a student name who possibly matches the images, and eventually, an Excel file is exported for attendance records to support the face recognition results. Within the system, a pre-trained CODESYS model is employed to detect faces from photos. A survey has been conducted to research the pros and cons of the attendance system on college education management.

Keywords: - Facial recognition, Deep learning, and Neural Network, KNN, Machine Learning, LFW, FaceNet, CODESYS, CNN

Introduction:-

Every institute requires an attendance system to sustain a record of attendance of students and

employees. They have their system to do the similar. Nearly do physically and some use automated attendance system. The manual method includes pen and paper which consumes a lot of time and waste of properties. Also, it has a risk of substitutions and human error. An automated attendance system includes numerous methods like – face recognition is one of the best-organized methods of all existing ones for ID of people. It can be used in schools, colleges, or any organization. To evade the trouble of captivating the attendance of large numbers, there is a need for an automated attendance system that is fast and decreases the chance of fake attendance. This machinery, which the system is developed for organizing a tranquil and secure way of taking down attendance. This attendance is verified, by endlessly identifying faces of staff or students via camera as they enter the classroom. The software first senses the faces and instantaneously matches them with the predefined database [2][3].

In this paper, we developed the framework using FaceNet and a KNN classifier. FaceNet uses a deep convolutional neural network pattern to generate optimized face embeddings and achieves 99.63 percent accuracy on the dataset of Labeled Face in the Wild (LFW) and 95.12 percent on the YouTube Faces DB. Instead of the bottleneck layers intermediary used in former network architecture patterns, we teach this network to generate optimal 128 face vectors as the model's performance. Euclidean distance is used to assess face similarities by measuring the distance between vectors of a particular face. In other words, the same individual has a shorter distance between them, while another individual has a greater distance between them.We also use the K-Nearest Neighbors (KNN) method for distance measurement and people classification. In comparison with former deep learning algorithms, FaceNet has trained the performance to 128-D embedding, therefore the size of representation for each face would be smaller. After having made an alignment cropped the area of the face in preprocessing stage, we feed a dataset of faces into the network[8]

Related Work

A. RFID based attendance system

Radio-Frequency Identification (RFID) refers to small electronic devices made up of a chip and an antenna [13]. RFID is mostly used for a variety of activities, including monitoring supply chains, monitoring livestock in the agriculture sector, regulating building entry, parking lot access and regulation, promoting electronic checkout, the medical industry, communication systems such as

Bluetooth and Wireless Sensor Networks, and residential and business protection solutions [14,15,16]. RFID also has a growing market in home and business security systems. The use of RFID technologies in university tracking applications allows university administration to prevent attendance records being damaged, lost, or misplaced.

Fig. 1 RFID based attendance system

The system eliminates spending excess time and resources, as well as labor work when it comes to keeping track of attendance. Universities are constantly conscious of the necessity of making Fingerprint-based and less time-intensive. In a variety of fields, such as parking, attendance, class entry, and others, RFID can help to accelerate processes and thereby minimize processing time [17,18].

Fingerprint based attendance system

Fingerprint verification is integrated into the mechanism of attendance control for students with an electronic attendance management scheme. Enrolment and verification are the two stages that make up this system. [19]

Fig. 2 Fingerprint based attendance system

A person's biometric details are collected during enrolment, and the personal data is extracted and recorded in a database with a personal ID [19]. After feature extraction, the enrolment module aims to accept a person with an ID number and fingerprints into a database.

These characteristics form a blueprint for determining the user's identity and formulating the authentication mechanism. A supervisor of the attendance control scheme does the enrolment process. During verification, the user's biometrics are collected once again, and the collected features are compared to those already stored in the database to see if they fit. Following a good match, attendance is recorded using the user's id that was used to match the models. [20]

THE MAIN CONTENT

Deep Learning

Deep Learning is a subset of ML (Machine Learning) in which as a human brain, the algorithm learns on its own. An artificial neural network is a basement for deep learning architecture. Moreover, there are 3 types of learning: supervised, semi-supervised, or unsupervised. The deep neural network is another name for it. The word "deep" means how many neural networks' have layers that are hidden. Compared to conventional neural networks, the deep neural network may have more than two or three hidden layers. To extract features, deep learning employs a flow of several layers of neurons that are not linear. In this case, the result of the former layers is submitted as an input for the next layers. It learns several layers of representation which are related to various levels of abstraction as processing flows from one layer to another[9].

Deep learning architectures such as convolutional neural networks, deep belief networks, deep neural networks, and recurrent neural networks have been being implemented in a variety of fields. Today, the most prominent application of deep learning are autonomous cars, which can

identify all signs, a person, pedestrians, traffic lights, and other objects[9].

Face Recognition

Face Recognition is a technique for detecting or confirming human faces in video or photos taken. It derives facial features from a photo or video clip, then the algorithm compares these features with other facial features that are stored in a database.

There are two stages in Face Recognition. The first one is extraction and selection while the second stage is classification. From a picture, face recognition algorithms extract patterns and attributes of the face. The size, position, and shape of the eyes, mouth, nose, jaw, and eyebrows are analyzed by an algorithm. Then these characteristics will be combined with other characteristics.

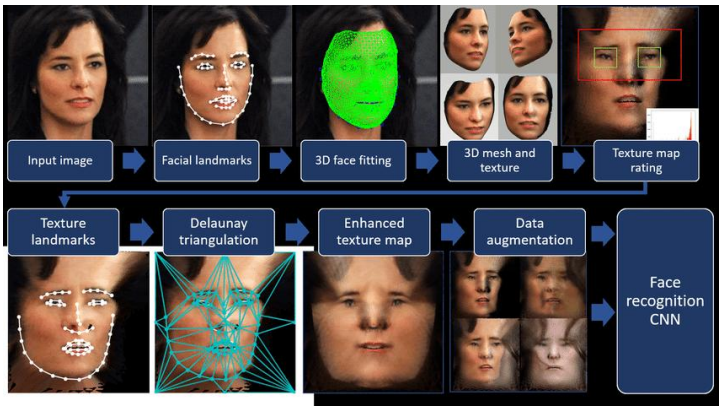


Fig. 3 Face Recognition

In each stage of the deep learning process, source data is transformed into an increasingly abstract and structured representation. The raw inputs for face recognition are pixel matrices. Each layer has its method. For example, the initial layer of representation derives pixels and encodes edges while the second layer composes and extracts edge arrangements. The next, third layer extracts eyes and nose while the fourth one extracts eyebrows. And finally, the last layer recognizes the photo includes a face[1].

Convolutional Neural Network

In computer vision, convolutional neural networks (CNNs) are commonly utilized. It is a useful machine learning tool for extracting the best characteristics from faces in facial recognition. It is a

form of Feed-Forward Neural Network that is trained using the Back-Propagation algorithm. Handwritten character recognition and extracting features may also be done using convolutional neural networks [11].

CNN learns characteristic features from source pictures utilizing 2D convolutional layers, and this design is well adapted to manipulating 2D data such as pictures. CNN can retrieve attributes without having to manually identify attribute descriptors to distinguish files. Using automatic feature descriptors obtained by training the network on a vast number of images, CNN can derive optimal features from photos. As a result, utilizing this automatic feature extraction, a deep learning algorithm will derive attributes for computer vision applications with high accuracy.

In Face Recognition pipeline and in this pipeline, the most important step is CNN that extracts 128-d facial embeddings. To identify various attributes of an image, CNNs utilize ten or even more secret layers. Any secret layer contributes to the sophistication of the picture features that have been studied. To detect the particular object in an input image, a CNN model uses multiple filters to distinguish edges or portions of the image. In facial recognition, for example, the initial secret layer learns to identify the curve and edge of the face, the second learns to identify eyes, and subsequent layers learn complicated sections of the provided picture when looking for a face[11].

FaceNet

Google Inc. created FaceNet [8] in 2015. Similarities of faces were measured using Euclidean distance. FaceNet embedding makes it easy to incorporate a facial recognition scheme. FaceNet is equipped to achieve optimal embedding. It trained the network with triplets of roughly matched / non-matched face patches created using a new online triplet mining platform.

The human face is taken as input data to FaceNet produces 128 vectors that reflect the most significant facial features. This vector is known as embedding in machine learning[12].

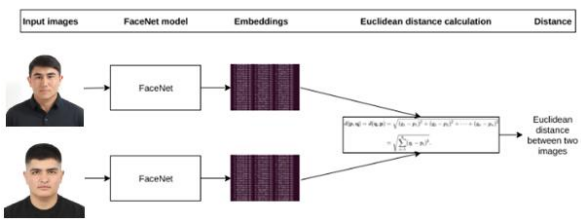


Figure 4. FaceNet extracting distance of two images.

To learn a Euclidean embedding in each picture, this method employs a deep convolutional network. The network has been taught that the embedding space of faces belonging to the same individual has limited distances and that the embedding space of faces belonging to various people has wide distances. The length from one embedding to another is referred to as a KNN classification challenge. FaceNet conditioned its performance to be a small 128-D embedding using a triplet loss function centered on LMNN. Loss helps to distinguish the positive pair from the negative by a distance difference when two positives are similar to each other, and triplets include a pair of contrasting face images and a non-matching face image. It's critical to choose the right triplets to practice the network with if getting decent results is highly required

FaceNet Method Overview: FaceNet is an Inception-style network that uses a deep convolutional network. Figure 3 depicts a model black-box structure.

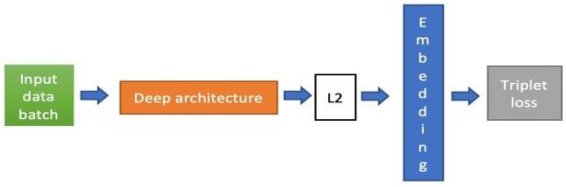


Figure 5. Structure of Model

Data batch is fed into a deep CNN, which is then L2 normalized to produce a face embedding. Following that, there is a loss of triplets while the network is training.

$$\sum_{i}^{N}\left[\|f(x_i^a)-f(x_i^p)\|_2^2-\|f(x_i^a)-f(x_i^n)\|_2^2+\alpha\right]_+$$

Equation 1. Triplet loss function

In Equation 4, the Triplet loss function decreases the distance between the anchor and positive while it increases the distance from anchor to negative. In this function:

- **f(a)** is the anchor output encoding
- **f(p)** positive output encoding
- **f(n)** negative output encoding
- **alpha** is constant that prevents network from not to make optimization towards **f(a) — f(p) = f(a) — f(n) = 0.**
- **[…]+** is equal to **max (0, sum)**

End-to-end learning is a critical component of the overall framework. Finally, triplet failure is used to produce the best face recognition performance. We take an image's embedding and use Equation 4 to measure the square distance between all of the faces; a pair of face images with the same identities is small, while a pair of face images with different identities is big. Rather than comparing all pairs, we decided to compare pairs of positives and negatives[12].

METHOD

To check the attendance with the FaceNet algorithm, we need a mobile application, which is very convenient and fast when it comes to performing attendance. We developed CODESYS application on the Android platform. The reason why we chose Android OS is the smartphones with Android OS are quite popular all over the world and are offered at a wide range of prices. We developed the application with Kotlin programming language on Android Studio IDE (Integrated Development Environment). Kotlin is considered a native programming language to Android OS. CODE SYS can be installed on smartphones with Android OS versions starting from 8.1

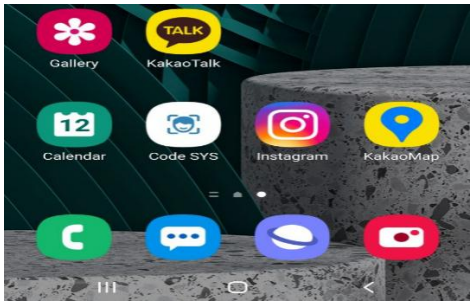


Fig. 6 CODESYS application on the Android platform

In the next stages, we used opencv4nodejs because it helps to use the OpenCV library in NodeJS. Our backend is written with NodeJS framework, which was developed with JavaScript programming language. OpenCV, in turn, is a machine learning and computer vision library. This helps us to process images taken with the camera.

Besides, we need the database of students, teachers, groups and courses in a particular university. The database is created and managed with KeyStone, a powerful tool for creating and operating admin panels. Image, name, id, group and section student are entered into the database with the admin panel. These input data are required to compare with images taken with a camera. The CODE SYS is linked with the backend, in which there is an OpenCV library, in which the FaceNet algorithm is imported.

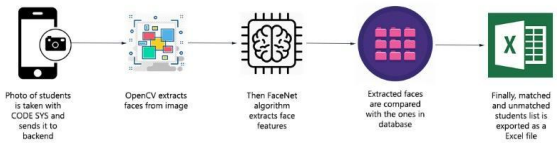


Figure 7. Steps of checking attendance with CODESYS

In Figure 5, all stages of using CODE SYS and checking attendance are illustrated. The teacher takes a photo of the students sitting in auditory. CODE SYS takes the image as an input and sends it to backed. OpenCV library processes the image and with FaceNet. The algorithm extracts face features and compares them with the ones on the database. If features are matched with each other, it identifies with whose face it was matched and sends back to application. CODE SYS accepts response and parses it into UI of application, marking absent and participating student. Finally, if there is a need, teachers can export the attendance form as an Excel version.

EXPERIMENT

Using an application requires authentication. The teacher or student should log in to the system. After the teacher signed in there are six elements of the attendance system in Figure 6:

Timetable – timetable that was implemented at the beginning of each academic semester.

Notification – users receive notifications about important events, surveys, and announcements.

Surveys – university administration and teachers can organize surveys to make a better university lifestyle. Moreover, students are also able to take surveys related to their studies.

Attendance – teachers can check attendance which taking photos of students. Students can also check their attendance condition.

Library – teachers can upload image and homework to this library

Profile – there are teachers' and students' details on this screen. They can also sign out on this screen.

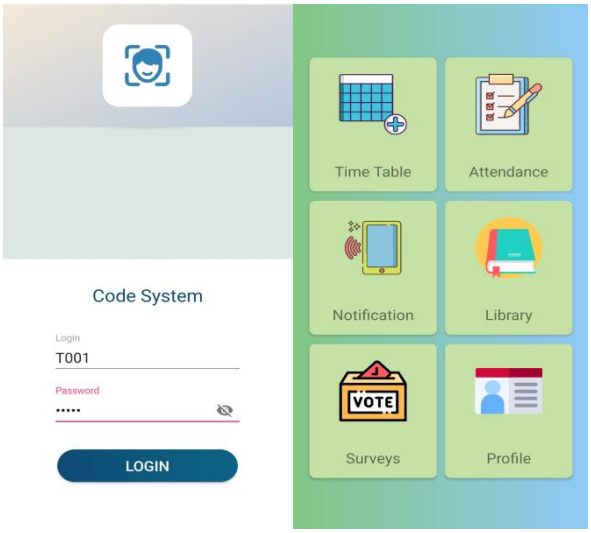


Figure 8. Login Screen and Home Screen.

Below, testing our face detection module is illustrated. We take the personal photo and send it to the written API [22] with the Postman software tool [21]. This tool helps us to check whether our API is working or not without executing the whole application.

The face detection process is executed in the backend. Therefore, this part of our face recognition model is not visible to the user. We capture the image with application and CODESYS application sends it to the backend and receives a response (Figure 8).

Figure 9. Response of function in Figure 10 with detected facial areas.

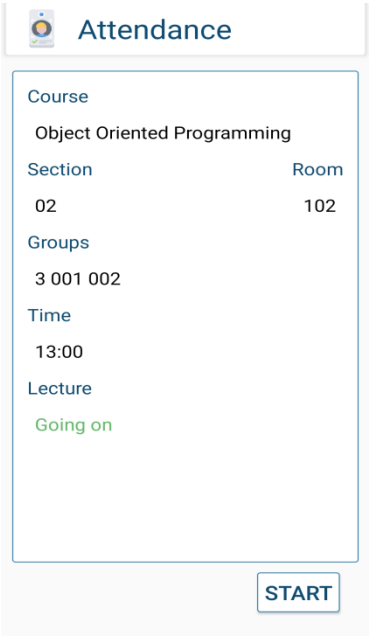


Figure 10. Attendance Screen

In Figure 7, there is information about Section 1 from the course “Special Topics in Regression Analysis”. The class is going in room 101. There are 3 groups, namely 1, 001, and 002 are in this

class, and starting time of the lecture is 10:00 a.m. This screen is visible on the teacher's application.

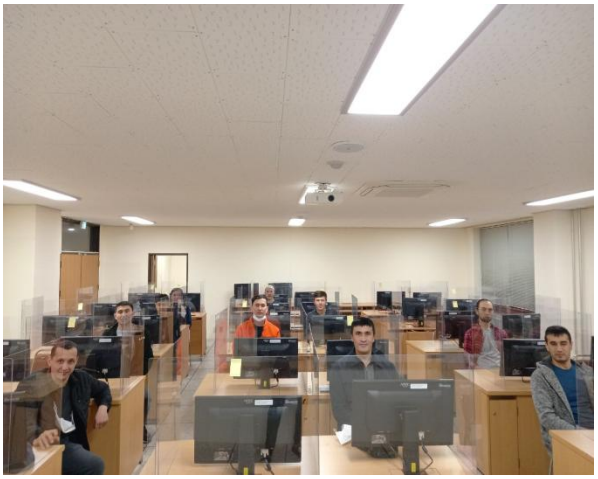


Figure 11. Accomplished attendance check (1)

In Figure 8, 30 students are taken with photos to experiment with the application. The images are 3x4 photos and they are taken from the personal computer screen.

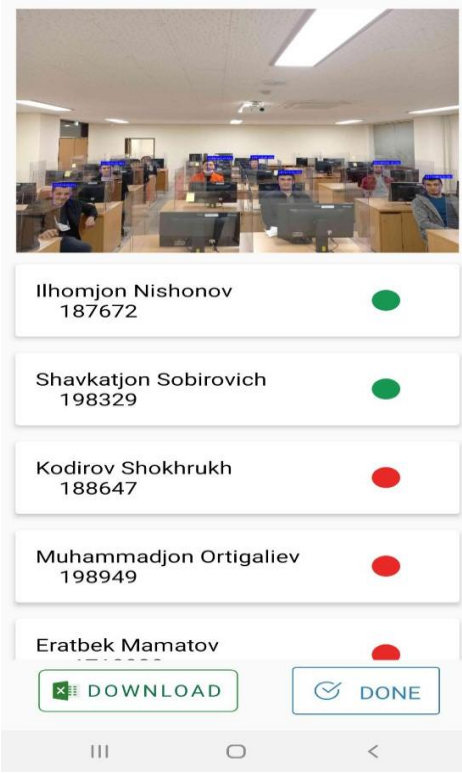


Figure 12. Accomplished attendance check (2)

The screen shown in Figure 10 is continuation of Figure 11, 12, 13.

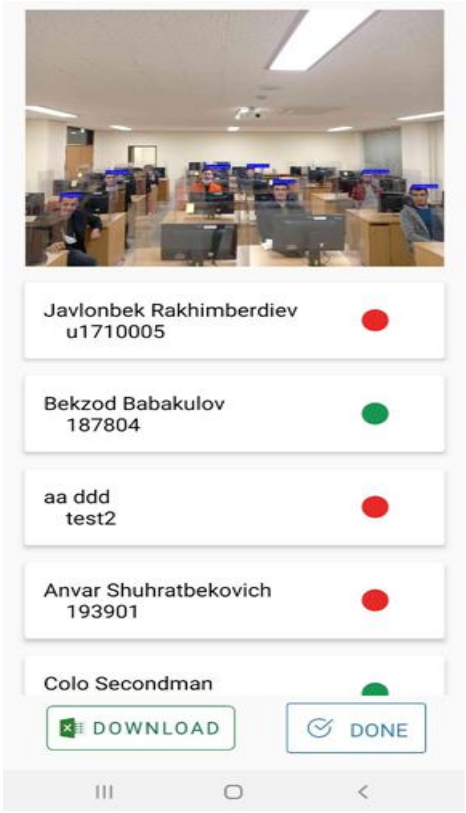
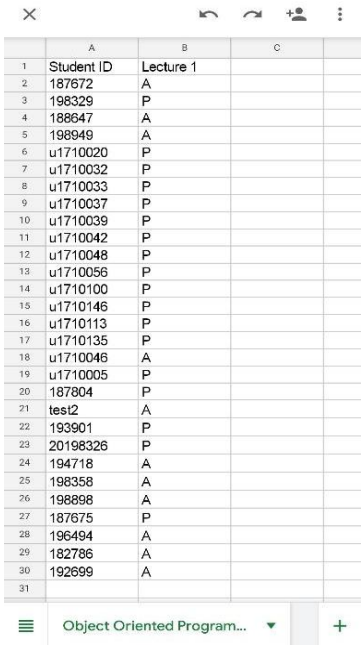


Figure 13. Accomplished attendance check (3)

There are overall, 30 students (and those who do not attend class) are captured to experiment with the application. The images are 3x4 photos and they are taken from the personal computer screen. In image there are 10 students and they all are checked as a present while the rest of students are absent as their face were not in the photo. The “Done” button finishes the attendance checking part and the “Download” button exports attendance to Google Sheet program in xlsx (Excel) format and can be easily downloaded to storage. (Figure 10).



	A	B	C
1	Student ID	Lecture 1	
2	187672	A	
3	198329	P	
4	188647	A	
5	198949	A	
6	u1710020	P	
7	u1710032	P	
8	u1710033	P	
9	u1710037	P	
10	u1710039	P	
11	u1710042	P	
12	u1710048	P	
13	u1710056	P	
14	u1710100	P	
15	u1710146	P	
16	u1710113	P	
17	u1710135	P	
18	u1710046	A	
19	u1710005	P	
20	187804	P	
21	test2	A	
22	193901	P	
23	20198326	P	
24	194718	A	
25	198358	A	
26	198898	A	
27	187675	P	
28	196494	A	
29	182786	A	
30	192699	A	
31			

Object Oriented Program...

Figure 14. Downloaded attendance list in Excel

CONCLUSION

In this proposed model, we have done research on deep learning, CNN and the FaceNet algorithm. We also studied that currently, the FaceNet face recognition algorithm is the most efficient one. Implementing it on our attendance checking mobile application algorithm enabled to identify and compare images of faces and presented output with the Android application, CODE SYS. In Uzbekistan, traditional attendance checking method in universities and high schools takes much time. This is mainly because teachers check attendance manually, which is reading names of all students and marking them as present or absent. By using Automatic Student Attendance System Using Face Recognition and CODESYS, teachers will be able to reduce the amount of time spent on attendance.

The CODESYS is advanced way of automatic attendance checking system. Compared to other attendance checking method mentioned above, particularly, RFID-based and fingerprint-based attendance system, the CODESYS is more straightforward and easier to use software. There is no need for special equipment purchase and installation, which require significant amount of spending [23] for covering whole university or school. Only thing need to be done is installing the CODESYS application on mobile smartphone and entering information about students, teachers, classes, sections and courses to database.

In future, we are going to upgrade CODESYS and there will be several changes. First of all, UI will be changed completely in order to create a convinience for users. Secondly, There will be also personal cabinet for students. They login with their ID number and can easily use library, timetable, fill surveys and etc. Moreover, students will be able to check their attendance history. Finally, after some time, application for iOS operating system will be launched.Once CODESYS is fully launched and implemented, the new method of attendance checking helps not only to decrease time-wasting but also creates an opportunity to exchange information among students and teachers andCODESYS will be the best assistant to both of them.

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