User-Friendly Interface Attendance System Based on Python Libraries and Deep Learning

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ABSTRACT

The old methods used to manage attendance for students, employees, or even teaching staff using a paper attendance record are considered tiring methods that take time. In addition to errors and repetitions or forgetting to register attendance, even with the presence of manual fingerprinting, due to the diseases that the world has experienced in previous years, it has become undesirable for some because it is considered a means of transmitting infection. In this research, we propose a method to record attendance relying on face recognition technology with real-time video processing by using multi-layer perceptron algorithm with two of python libraries, where the camera device is accessed, a picture of the person is taken, and the image is processed and framed, comparing captured faces with images within the stored database, performing face recognition, then dealing with file operations, and managing time-related tasks. Once the desired person is found, attendance is recorded with the actual time entered into an Excel file, and the file is saved with the date of the day on which attendance was recorded. The designed system works efficiently in the real-time implementation of counting and detection, proven to combine high face-detection accuracy and performance.

1. Introduction

The attendance system is a monitoring system to monitor the attendance of employees, and it is one of the necessary and required things in most institutions, whether educational, government departments, or others, to ensure accountability and compliance with the general laws [1].

The traditional methods known to register attendance include manual paper registration, which is characterized by complexity, errors, and the time it may take to register each individual. Apart from the obvious drawbacks, there's also the possibility of losing or damaging the sheets [2]. Recent developments in artificial intelligence and technology have led to the emergence of computer vision by using numerous facial recognition-based technology that provide a rapid and secure means of tracking people [3]. Computer vision is a subfield of computer science works to enable machines to identify and understand objects and people in images and videos. Like other AI applications, computer vision seeks to automate and perform tasks that resemble human capabilities. Here, the goal is to replicate human vision as well as the way that humans perceive and process visual data [4].

Face recognition is one of the fields of computer vision, to identify a person's face, a facial recognition system compares the face to a database of faces in a digital image or video frame [5]. Usually employed for user authentication via identity verification services, this technology recognizes and quantifies facial features from an image [6].

In order to locate a match, this is accomplished by drawing face features from a photo or an image captured by a camera, then matching the information with an existing database. Many different sectors, including fraud detection, electronic security, border and airport monitoring, banking services, and healthcare, have made use of this technology [7], [8], [9].

In the field of record attendance, whether schools, universities, or other institutions, researchers have used different techniques based on facial recognition. in the article [10]. Researchers presented a new face recognition system, which combines Support Vector Machine (SVM) for classification, VGGFace for feature extraction, and Multi-task Cascaded Convolutional Neural Networks (MTCNN) for accurate face detection. By combining MobileNet and Haar-cascade for detection and VGG16 and Triplet Loss FaceNet for identification, The study [11] improved face mask recognition. it also produced person names and ID numbers even when wearing masks by using cosine distance and FIFO approaches.

A four-phase face feature extraction approach was developed by the research [12]. Using a Faster Region Convolutional Neural Network was their method for identifying landmarks. In addition, they extracted features using CNN and wavelet scatter techniques, and then used DNN and SVM classifiers for further categorization. In [13] the researcher develops a system that records attendance via a live video broadcast. To extract the frames from the video, OpenCV is utilized. In this kind of system, face detection and facial recognition for which dlib is used are the primary implementation processes. Following this, a comparison with the database holding the faces of the students will render the connection between the recognized faces possible. Within [14] the suggested system uses Gabor filters, generative adversarial networks, CNN, SVM, KNN, and Haar classifiers. After facial recognition, attendance reports will be generated and saved in Excel format. The system is assessed in a range of conditions, such as changes in the student-camera distance, head movements, and lighting.

The YOLO V3 (You only look once) face detection algorithm and Microsoft Azure's Face API face recognition (facial database) are the foundations of the research's framework [15]. The classroom has a camera installed that takes two pictures one at the beginning and one at the end to make sure all kids have attended. In order to track student attendance, this research [16] creates a model to categorize each character's face from a taken image using the LBP (Local Binary Pattern) technique. The image will be taken by the suggested ASAS (Automated Smart Attendance System) and compared to the image that is kept in the database. After a student enrols, the database is updated automatically with the student's name and roll number.

Our contribution to this research is the development of an entirely user-friendly interface intended to facilitate seamless record-keeping and tracking of visits. Based on a set of Python libraries, in addition to use the MLP classifier (multi-layer perceptron) to train the neural network classifier for its high performance, particularly in image classification, requires little training time, and is simpler to use than other deep learning algorithms. OpenCV with the face recognition library was used for image processing and face detection. And to recognize faces during runtime, the MLP classifier is trained on known face encodings and corresponding names.

2. Materials and Methods

In this section, the proposed method for the attendance registration system will be presented, which includes a set of stages based on a database of photos taken of a group of members of the College of

Veterinary Medicine at the University of Basrah. The program was written using the Python program. The following fig. 1 illustrates the work.

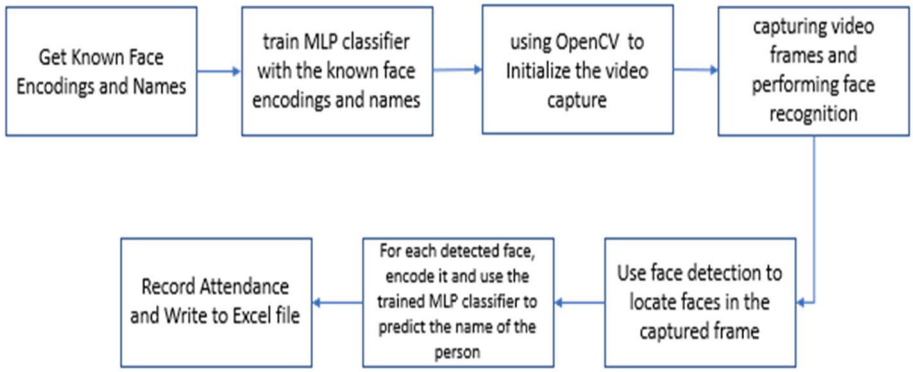

Figure 1. Flowchart of the proposed work.

2.1 OpenCV library

It is a large open-source library for computer vision, machine learning, and image processing [17]. Many different programming languages are compatible with OpenCV. It identifies faces, objects, and even handwritten text by analyzing images and videos [18].

In 1999, the Intel Research program presented 2500 algorithms to advance CPU-intensive applications, which are now part of the OpenCV library. A multitude of programming languages, including C, C++, Java, and Python, can be used to build the OpenCV library. It includes sample code for real-time computer vision and supports a number of operating systems, including Windows, Linux, Mac OS, iOS, and Android [19].

With over 500 functions covering many aspects of vision, OpenCV aims to create an easy-to-use computer vision infrastructure that enables anyone to quickly develop complex vision applications. The fields of medical imaging, security analysis, robotic vision, stereo vision (3D vision), camera calibration, human-machine interface, and factory product inspection frequently use OpenCV [20].

The extensive image processing capabilities facilitate various picture pre-processing activities, camera calibration, video stream processing, and image stitching (combining numerous cameras). OpenCV includes a comprehensive, general-purpose machine learning library with an emphasis on statistical pattern recognition and clustering, since machine learning is crucial to computer vision [21].

2.2 Face recognition library

Face recognition library is a technology that needs high accuracy. It operates by utilizing data from a picture to identify a person's face. The data is transformed into a digital picture that resembles a face that was taken with a digital camera [22].

A face recognition system's high accuracy is mostly dependent on the size and quality of the image, as well as the system's ability to recognize and highlight each person's distinctive traits based on this information. The eyes have this trait. The technique measures the depth of the eye socket, the breadth of the nose, the angle of the jaw, and the distance between the eyes when determining the placement of the face and eyes. All this information is used to create a face fingerprint and personal identification data stored in the database [23].

2.3 Multi-Layer Perceptron Neural Network (MLP)

MLP classifiers, which are made up of several layers of interconnected artificial neurons, or perceptron, are a sort of artificial neural network that has shown to be successful in handling challenging classification tasks [24].

There are three common layers in this hierarchy: an input layer, an output layer, and one or more hidden layers. Following the application of a non-linear activation function to each input signal, each neuron in the network transmits the altered output to the subsequent layer. The final layer, which generates the categorization output, defines when the process ends [25], the fig. 2 shows the Architecture of a Multi-Layer perceptron Neural Network.

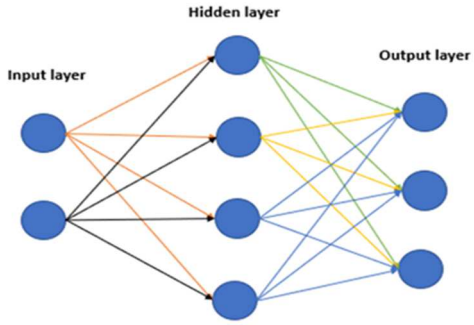

Figure 2. The architecture of multilayer perceptron algorithm.

The two primary processes in MLP classifier training are forward propagation and backpropagation. The input data is sent across the network during forward propagation, and each neuron's output is calculated [26]. Following a comparison between the estimated outputs and the genuine labels, an error metric such as cross entropy loss is produced. Gradient descent optimization is used in the backpropagation step to modify the weights of the neurons as the error spreads backward through the network. Until the network achieves a performance level that is satisfactory, this iterative procedure is continued [27].

The basic concept of MLP is the calculation of a neuron's value in a current layer as the active summation of its previous layer's weighted outputs, which are coupled to the neuron. A function known as the "activation function" uses the sums of weighted inputs as inputs and maps the input to the output either directly (identity activation), within a range of values (sigmoid or tanh), or while removing unwanted values (ReLU, for example, removes negative values and maps positive values directly) [28]. The backward propagation procedure, in which the error for a forward propagated of the MLP findings gets back-propagated through and weights are changed proportionally to the error, first causes the weights of the neuron connections to be random [29].

Equation (1) include the computation of input values, bias values, and output of input variables.

$$Si=\sum_{i=1}^{n} wijIi + \beta i \quad (1)$$

where Ii is the input variable I, βi is a bias value, and ωij is the weight of connections at the j level. N represents the total number of inputs.

Equation (2) can be used to derive the sigmoid function, which is typically employed as the activation function in MLP.

$$Fj=\frac{1}{1+e^{-sj}} \quad (2)$$

S is the activation function in this case.

Thus, Equation (3) may be used to measure the final output neuron j:

$$yi=fi\ (\sum_{i=1}^{n} wijIi + \beta i) \quad (3)$$

y displays the MLP method's output value [30].

In our proposed method, the first step includes reading the images from the folder, finding the faces, extracting the facial encodings by using the face recognition library, and connecting them to their file names for identifying the known face encodings and their names. Then the MLP is trained using a single hidden layer of 100 neurons. The classifier iterates up to 1,000 times using names and face encodings that are known.

The next step included integrating OpenCV with face recognition libraries to build an attendance system with face recognition technology. The OpenCV library was used to capture video from the camera, in addition to displaying the video and captured frames, reducing their size to a smaller size, converting them to the BRG color space, and then using the face recognition library to detect faces in captured frames in addition to extracting features from them, as shown in fig. 3. Then, by using the trained model, it is possible to predict the names of people in the video based on their facial features. Once the face is identified, the name and time of the person's appearance are recorded on camera in Excel file, and this file is saved with the date of the day on which the attendance was recorded.

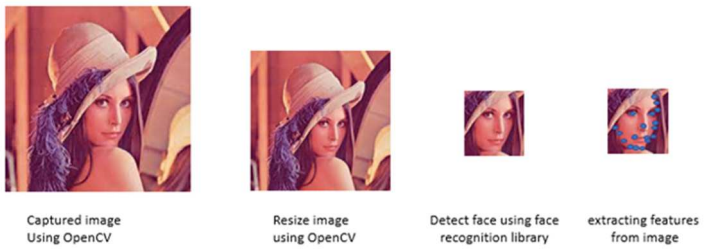

Figure 3. Illustration of the OpenCV and face recognition libraries work.

3. Results and Discussion

The results are explained in this section. Python 3.9.13 was used to conduct experiments with 12.0 GB of memory and 64 operating systems. The first step includes reading the images in the database, identifying them by writing down their names, and providing more details for the images that are recognized. As can be seen in fig. 4, ten pictures of ten lecturers from the University of Basra's College of Veterinary Medicine were added in a database, and the software only identified nine of them. As a result, we can determine whether the program has read all the images or not. Therefore, a new picture can be taken of the person who was not recognized and added, this step is necessary to ensure that it recognized all the images. Then the images it recognizes are then trained using an MLP classifier.

Figure 4. Reading the images from the database.

The next step is taking an image from the camera, processing it, and comparing it to the database. If the image that was taken matches the image that is stored in the database, attendance is then recorded as in fig. 5 even with a single image of each face, recognition was made in a matter of seconds. The information that is recorded is then stored in an Excel file along with the date of the recording as in fig. 6.

Figure 5. Recording the attendance.

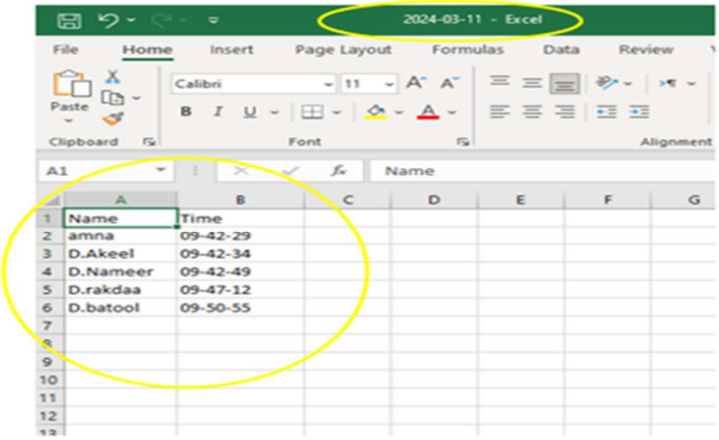

Figure 6. Save the recorded information in excel file

4. Conclusion

The present study involved the design and implementation of a real-time system for the purpose of automating and monitoring the attendance system. The primary aim of automatic attendance tracking is to reverse the trend of the outdated approach, which wastes time, leads to agent attendance, and generates paper waste. In this study, we designed a simple and efficient system for automatically identifying attendance, in an effort to remove any obstacles. Facial recognition occurs in a matter of seconds when employing the Python programming language and its libraries in conjunction with the MLP algorithm, which is known for its excellent classification efficiency and short training period.

To capture every possible facial expression, a database including photos of people with their names on them can be made available. Additionally, other facial expressions, such as those with glasses, beards, or different hairstyles, can be photographed. Every case is examined and finds to have excellent accuracy and efficiency. Thus, it is clear from the explanation above that our suggested system is quick, safe, dependable, and affordable.

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