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DEEP LEARNING-BASED FACE RECOGNITION SYSTEM FOR ATTENDANCE SYSTEM

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Abstract. *The paper presents our research progress in the development of face recognition using deep learning based on camera. The purpose of our research is to reduce fraud committed in the absence process and maximize the level of accuracy. Therefore, we need face recognition module that can detect image that is in the video that will be taken live from camera. Program will be designed using OpenCV with Python that uses combination of Haar Cascade and deep learning to train the image in database which will be implemented to the camera as the main tool in the attendance process for fast and efficient process. By using our method, the program can identify a person's face with an accuracy rate of 95.23%.*

Keywords: Deep learning, Face recognition, OpenCV, Haar Cascade classifier, Computer vision

1. **Introduction.** We are now in an era where technology has become a massive part of our daily lives. The development of technology is something that we cannot avoid in this life because technological progress will go according to the progress of science. Technology has created amazing tools and resources that help us greatly in our work. Technology is advancing every day, and currently, the world has entered the era of the 4th industrial revolution or known by the name "Industry 4.0", which marks the occurrence of the "Industry 4.0" era. Artificial Intelligence technology already plays an essential role in the development of future innovations. In Industry 4.0, manufacturers and producers will use the data that will be collected using the Internet of Things (IoT) and sensors. The data can then be used to analyze and improve their work. The most crucial thing in Industry 4.0 is automation. AI will be used by many factories to automate many things that can be operated without any human interference.

Artificial Intelligence, or commonly called AI, is science in the field of computer science that studies the manufacturing of computer systems with the ability to have intelligence like humans. AI technology allows a computer to learn something through experience by itself. This experience is usually in the form of data, and then the data is studied by a computer using an algorithm called a *machine learning* algorithm. A computer system implanted with AI will then be implemented on computer machines or devices to carry out personal work the way humans do it; this is what drives researchers to develop automation systems, to make a machine that thinks and does a thing like a human.

In general, student's attendance is taken manually by using an attendance list given by the teacher in class. Using an attendance list makes it very difficult and time consuming to verify the student one by one in a large and crowded classroom. There are other

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methods of attendance, such as fingerprints and ID cards, both of which still have their own weaknesses: for example, for fingerprint if the finger of the attendant is dirty then the fingerprint attendance system may not detect the fingerprint of the attendant correctly; for the ID card attendance system even though it is simple and fast to record the attendance, the student might find a way or two to sabotage the system such as the student can sabotage the attendance list by giving the other attendant their ID card to help them pass through the attendance list. To solve the existing problems, we intend to use face recognition attendance systems to replace the other attendance systems.

Face recognition is slightly similar to the fingerprint attendance system because both of the methods require the data of the attendant, the system could work properly. Still, there is some advantage of using face recognition compared to the fingerprint system; for example, using face recognition technology is quite effective and safe because the computer will detect a person's face through the contour of his/her face. The other advantage of face recognition systems is that it will still be able to detect the face of the attendant if there is a scratch or a scar on the attendant face. With the way the face recognition system works it is almost impossible to fake other people's identity because every human being is born with different facial contours, both in terms of the distance between the eyes, eye depth and jaw width.

In this paper, we will use deep learning and OpenCV for image training, detection and processing, and Haar Cascade for the image classifier. We use this method because OpenCV can be used in many platforms such as Windows, Linux, and Mac OS X and provide at least a 95% successful recognition rate [1], and it will get better if we combine it with deep learning. Although Eigenfaces is the simplest method of accurate face recognition, by using this method, it will be more accurate. The initial progress will be used in our future research in taking attendance using the face recognition system.

2. **Literature Review.**

2.1. **Computer vision.** Computer vision is defined as one of the branches of science that studies how computers can recognize observed objects. This branch of science, together with Artificial Intelligence, will be able to produce a Visual Intelligence System. The difference is that computer vision studies more about how computers can recognize observed objects. Computer vision is a combination of computer recognition techniques and image processing. Image processing is a field that is related to the process of transformation of images, and this process aims to get a better image quality. While pattern recognition deals with the process of identifying objects in images or interpreting images, this process aims to extract information/messages conveyed by images. Deep learning is one of many function types of Artificial Intelligence and branches of computer vision.

Deep learning tries to mimic how the human brain processes data, and it will create patterns that will be used in decision making. Deep learning is also capable of learning unstructured data on its own. This type of deep learning is known as deep neural network or deep neural learning. The way Convolutional Neural Networks (CNNs) operate is fascinating because it is pretty close to how the human brain processes the sense of sight [2,3]. DeepFace [4] and FaceNet [5] are the two best applications of CNNs in face recognition.

2.2. **OpenCV library.** OpenCV (Open Source Computer Vision Library) is a software library intended for real-time dynamic image processing created by Intel and now supported by Willow Garage. Intel launched the first version of OpenCV in 1999 and initially needed a library from the Intel Image Processing Library. Then the dependency was finally removed so that OpenCV was created as it is now a standalone library. OpenCV supports multiplatform, can support both Windows and Linux, and now supports macOS and Android.

OpenCV uses a type of face detector called a Haar Cascade classifier. Given an image, which can come from a file or live video, the face detector examines each image location and classifies it as "Face" or "Not Face". The Haar classifier that is included in OpenCV is a supervised classifier. In this case, we typically present histogram and size-equalized image patches to the classifier, which are then labeled as containing (or not containing) the object of interest, which for this classifier is most commonly a face [6]. According to Viraktamath et al. [7], the time taken to detect the face by using OpenCV is less than 1 second which means that it can be used in real time.

2.3. **Face recognition.** Face recognition is a biometric approach that employs automated methods to verify or recognize the identity of a living person based on his/her physiological characteristics. In general, a biometric identification system makes use of either physiological characteristics (such as a fingerprint, iris pattern, or face) or behavior patterns (such as handwriting, voice, or key-stroke pattern) to identify a person. Because of human inherent protectiveness of his/her eyes, some people are reluctant to use eye identification systems. Face recognition has the benefit of being a passive, non-intrusive system to verify personal identity in a "natural" and friendly way [8]. According to Kar et al. [9], face recognition can be implemented by these three basic steps. First, the system will detect and save the face image in an XML file. Second, it will learn and train itself using the image that has been taken. Lastly, it will try to match the face in real time with the one in its database.

2.4. **Deep learning.** Deep learning or often known as deep structured learning or hierarchical learning, is a branch of machine learning that consists of high-level abstraction modeling algorithms in data using a set of non-linear transformations functions arranged in layers and depth. Techniques and algorithms in deep learning can be used both for the needs of directed learning (supervised learning), unsupervised learning, and semi-directed learning in various applications such as image recognition, voice recognition and text classification.

According to Sun et al. [10], many variations within the same identity could overwhelm the variations due to identity differences and make face recognition challenging, especially in unconstrained conditions. Through machine learning models with multi hidden layers and massive training data, could learn more useful features, and improve the accuracy of classification and prediction [11]. Deep learning allows computational models of multiple processing layers to learn and represent data with multiple levels of abstraction mimicking how the brain perceives and understands multimodal information, thus implicitly capturing intricate structures of large-scale data [12].

Face recognition has become an important issue in many applications such as security systems, credit card verification, criminal identification, and even the ability to merely detect faces, as opposed to recognizing them, can be important [13]. According to Agarwal et al. the performance of face recognition systems depends heavily on facial representation, which is naturally coupled with many types of variations, such as views, illuminations, and expressions [14].

3. Proposed Method.

3.1. **Model architecture.** To implement our work, we have four essential components needed for our work to be appropriately performed, namely, cameras, faceprints, databases, and subsequently algorithms for comparing faceprints of people's faces with face print from a database as shown in Figure 1.

3.2. **Cascade classifier.** Cascade classifier is needed to contain the features of the face and its use is to determine where the face is. To use it, we make a Cascade classifier object and path to the xml file which contains the face features.

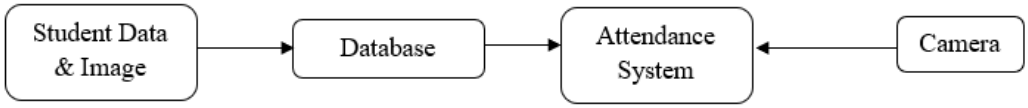

FIGURE 1. Diagram of the system

3.3. **Image detection.** OpenCV will read the image and feature files which exist in the Cascade classifier and convert it into NumPy Array. After that it will search for the row and column values of the faces and then it will display the image within the rectangular face box. According to Turk & Pentland [15], from a database of over 2500 face images they do a training set to 16 random images that were chosen from the database. All the 16 images went through the same training set all images trained with the same lightning, image size, and head orientation. None of these faces were rejected as unknown. The system reached a 96% succession rate over lightning, 85% over orientation variation and 65% over size variation.

3.4. **Algorithm.** The program's design is made with Python and used to get the input and output. First, the program will accept input in the form of images taken by the camera. Then, the program will identify the face in the image and compare it with the image in the database that we have obtained before. After that, the program will read the attendance time based on the input the program received and the percentage of attendance from the database. After that, the program will display output in the form of the name, NIM, time of attendance, total attendance percentage, and attendance status (present/late) based on the student in the image.

Before our system can work, we need to have some image to use as reference in our database as shown in Figure 2. They will be taken from various angles, so the system can detect and compare them easily.

FIGURE 2. Dataset image in system database

After that, we need to change the directory to where the program is located. Next, we train the system using the image in the database in order to make the image recognized by the system. Then we open our webcam so the system can take the input from the image shown in webcam. After that the system will compare the inputted image with the image in database and display the output.

4. **Experimental Result.** The system programmed using OpenCV and deep learning based on Python and work following the model as shown in Figure 3 and Figure 4. At first, our application works by detecting faces detected by the camera to get input in the form of faceprints. For the stage of making faceprints, we chose to use facial texture analysis because this method is more accurate in detecting someone's face, especially in distinguishing identical twins who mostly have almost identical faces. After that, our system will compare the inputted image with the faces that are in the database. After successful identification, our application will display the output.

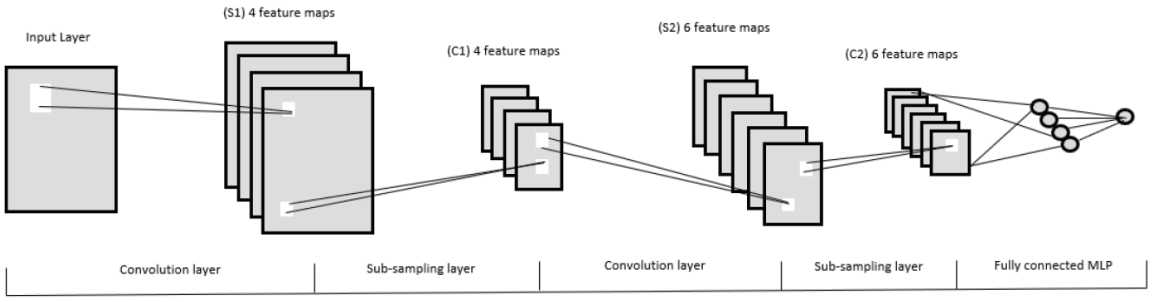

FIGURE 3. Deep learning model based on CNN for sample image [16]

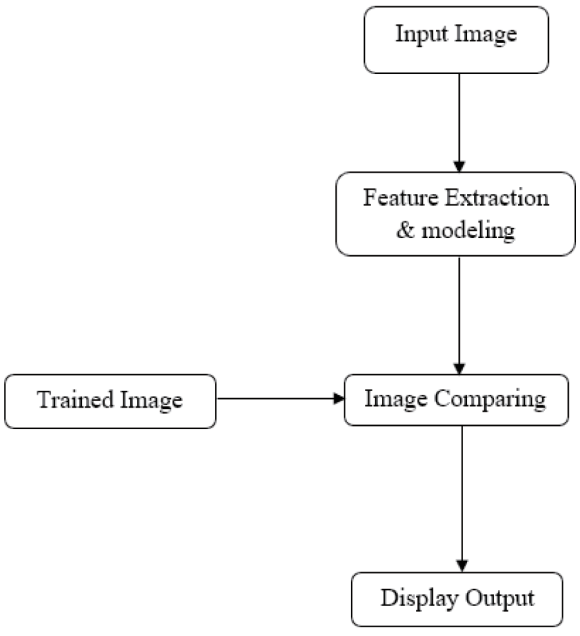

FIGURE 4. System procedure diagram

To experiment with the face detection system, we use OpenCV 4.20 and Python 3.8. The experiment result is shown in Figure 5 using webcam.

Example images in database systems are shown in Table 1.

Further experiment is tested by training all the images in the database. Subjects who participated in the test were four subjects with a total number of 21 images. The number of images correctly recognized is 20 out of 21 images with a 95.23% success rate as shown in Table 2.

FIGURE 5. Experiment using webcam could correctly recognize subject.

TABLE 1. Images in database system

Name	Image in database
Ghani	6
Ibrahim	5
Martin	5
Rico	5

TABLE 2. Experimental result

Inputted image	Output	Status
ghani1.jpg	ghani-2201799404	Success
ghani2.jpg	ghani-2201799404	Success
ghani3.jpg	ghani-2201799404	Success
ghani4.jpg	ghani-2201799404	Success
ghani5.jpg	ghani-2201799404	Success
ghani6.jpg	ghani-2201799404	Success
ibrahim1.jpg	ibrahim-2201751871	Success
ibrahim2.jpg	ibrahim-2201751871	Success
ibrahim3.jpg	ghani-2201799404	Failed
ibrahim4.jpg	ibrahim-2201751871	Success
ibrahim5.jpg	ibrahim-2201751871	Success
martin1.jpg	martin-2201789675	Success
martin2.jpg	martin-2201789675	Success
martin3.jpg	martin-2201789675	Success
martin4.jpg	martin-2201789675	Success
martin5.jpg	martin-2201789675	Success
rico1.jpg	rico-2201829735	Success
rico2.jpg	rico-2201829735	Success
rico3.jpg	rico-2201829735	Success
rico4.jpg	rico-2201829735	Success
rico5.jpg	rico-2201829735	Success

5. **Conclusion.** This paper presents the implementations of deep learning technology and computer vision for face recognition. Using Python, we use OpenCV library and Haar Cascade classifier to use as face detection and face/feature extraction to get the input. After that, we compare it to the image that is within our database to get the output. We choose to use Haar Cascade as the facial texture analysis to get more accuracy on detecting faces. The experiment result is engaging. By using this method, the program can identify a person's face with an accuracy rate of 95.23%.

Furthermore, the purpose of the paper is to develop a face recognition system for recognizing attendance, so the student cannot cheat the attendance list to skip the class, and the student does not have to fill the attendance list for a fast and efficient process. For future work, we will expand the usage of our face recognition system to be used as the main attendance system in our university, along with some improved features mainly for image detection and recognition.

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