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Face Detection and Verification Using Machine Learning Techniques of Local Binary Pattern Histogram

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ABSTRACT: Face detection, recognition and gender estimation are one of the most significant research areas in computer vision, not only because of the challenging nature of faces as an object but also due to the countless applications that require the application of face detection, tracking and recognition. Although many significant types of research on face detection, recognition and gender estimation problems have done in the last few years separately, there is no particular research on face detection, recognition and gender estimation together from a real-time video for person identification. So, we feel that these types of significant research are still needed to work. The main contributions of our paper are divided into three parts, namely face detection, recognition and gender estimation for person identification. In our research work, we use Local Binary pattern Histogram (LBPH) method and Convolution Neural Network (CNN) to extract the facial features of face images whose computational complexity is very low. By calculating the Local Binary Patterns Histogram (LBPH) neighborhood pixels and Convolution levels, we extract effective facial feature to realize face recognition and gender estimation. Class attendance is an important means in the management of university students. Using face recognition is one of the most effective techniques for taking daily class attendance. Recently, many face recognition algorithms via deep learning have achieved promising results with large-scale labeled samples. However, due to the difficulties of collecting samples, face recognition using convolutional neural networks (CNNs) for daily attendance taking remains a challenging problem.

I. INTRODUCTION

In the past decade, a number of research works have been done for automatic face detection, recognition (Zhao et al., 2003; Hjelmas and Low, 2001; Yang et al., 2002) and gender estimation separately. But separate detections, recognition and gender estimation does not provide sufficient information when no appearance information is available. Nobody has been completed any of the research work for face detection, recognition and gender estimation jointly. It can provide better results by sharing information when combining it into a single framework. In addition, a number of methods have been applied for face detection, recognition and gender estimation separately. Most of the researchers follow and use the boosted cascade framework because it has advanced features. The features of the boosted cascade framework help to compute and construct the classifier which performs more accurately. However, this rate of accuracy is required a number of cascade stages that will help to reduce the similar achievement in the detection and recognition accuracy. Hence, we can reduce few cascade stages to not to achieve similar accuracy in face recognition. We can apply more advanced feature and a more advanced algorithm that will detection, recognize and

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estimate the gender the person more accurately to identify the person. To solve texture classification problem (Ojala et al., 1996), Local Binary Patterns (LBP) was actually developed (He et al., 2011), LBP was introduced in the field of facial recognition for the first time by Ahonen et al. (2006).

The algorithm has been used to detect the face and recognize the face. LBP is combined with the histogram strategy. Arashloo (2015) had suggested multi-scale LBP that will describe the face variations and the classification is done based on Linear Discriminant Analysis (LDA). To recognize the face, this method uses a static image and thus the accuracy rate of recognition is higher; however, the main drawback is that it isn't used in a video. Kalal et al. (2010) have proposed a Tracking Learning Detection (TLD), the method can track an object for a long time and they have combined this method for faces to recognize, this module track the faces based on TLD. But the complexity of computation is very high for this model, the model takes more time to track the face because of computational power. Hence the LBP is a well-defined method for face recognition and to the image analysis. In their works, the Local Binary Pattern Histograms (LBPH) are used to extract the facial features from facial areas and describe the whole face based on that extracted features. However, LBPH uses more time to compute all the bins. All the bins are necessary to recognize the face of the person. In this paper, our main objectives are to design and build a complete system to detect, recognize and estimate gender for person identification. This complete system is divided into two parts; first to create the face database where each individual faces is captured and stored. Then, to test the video (Chrysos et al., 2015; Vasisht and Chen, 2017; Alqahtani et al., 2018) scene where people can be reliably detected, recognized, estimated and identified.

We propose a new method to describe the facial feature by LBPH and CNN. We calculate the neighborhood pixels to express face through the regression of local binary features (Chung et al., 2017). We compute the LBP operator of these neighborhood pixels. According to these operators, we use a histogram to express the whole face. By comparing the LBPH between the test video and train database, we obtain the results of face detection, recognition and gender estimation for person identification.

Taking class attendance in university classes is one of the commonly used methods to improve the performance of students studies in many universities. Louis et al. [1] highlights a strong relevance between student's attendance and academic performance; low attendance is usually correlated with poor performance. To guarantee the correctness of a student's attendance record, a proper approach is required for verifying and managing the attendance records. The traditional attendance-taking approach is to pass an attendance sheet around the classroom during class, and to request students sign their names. Another popular approach is roll call, by which the instructor records the attendance by calling the name of each student. One advantage of these manual attendance-taking methods is that they require no special environment or equipment. However, there are two obvious disadvantages in these manual methods. First, these methods not only waste a lot of valuable class time, but also have the risk of including imposters. Second, the form of class attendance records is hard to manage and easy to be lost if not careful.

II. RELATED WORKS

Face recognition is one of the commonly used biometric identification methods in the field of computer vision. An attendance-taking system based on face recognition generally includes image acquisition, creating a dataset, face detection, and face recognition. Unlike a fingerprint, a face can be recognized easily by a human. Thanks to its convenience in acquisition and reliable and friendly interaction, human face recognition systems have become an important tool in automatic attendance-taking systems. Rathod et al. [27] develop an automated attendance-taking system based on face detection and recognition algorithms. After installing the camera in a classroom, it captures the

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frames containing the faces of all students sitting in the class. Then the student's face region is extracted and preprocessed for further processing. Later, this system can automatically detect and recognize each student. After recognizing the faces of students, the names are updated into an Excel spreadsheet. In addition, an antispoofing technique, like the eye blink detector, is used to handle the spoofing of face recognition.

Manual class attendance-taking methods are time-consuming and inaccurate, especially in large classes. As a result, automated attendance system can help improve the quality and efficiency of class attendance. Modern attendance-taking systems generally consist of hardware and software. There are many successful cases of using automated attendance-taking systems. Mittal et al. [23] propose an attendance-taking system based on a fingerprint recognition device. To attend a class, students are recognized based on their fingerprints. As well, the fingerprint recognition device can be connected to a computer through an USB interface so that the instructor can manage the attendance records. This system provides a simple method to generate the attendance record automatically and reduces the risk of fraudulent attendance by imposters. However, students need to line up to get their fingerprints recognized, which is consuming for a large class. In addition, the fingerprint recognition device is usually very sensitive, and a sweaty finger or a finger with cut may fail to be recognized as a legitimate registered student. Nguyen et al. [24] develop an attendance-taking system using Radio Frequency Identification (RFID). Each student is issued a unique RFID card. To register for attendance, students only need to place their RFID cards by an RFID tag reader. The attendance information is kept on a website, allowing instructors to view or modify the records easily. Recently, some instructors use smartphones to capture class attendance. Pinter et al. [25] design an application for smartphones based on the bluetooth technique.

When taking attendance, students turn on the bluetooth of their smartphones and choose a class from a class list for registering. Finally, instructors can login to their apps and see the IDs and names of students who have attended the class. Allen et al. [26] use smartphones as a QR code reader to speed up taking attendance. At the beginning of a class, the instructor displays an encrypted QR code on a screen for students to scan it using a special app installed on their smartphones. Along with the student's geographical position at the time of scan, the application will then communicate the information collected with the server to confirm attendance of the student automatically. These automated attendance-taking methods are faster than traditional manual methods. In addition, the operation is simple and the attendance record is easy to access or manipulate. With an automated attendance-taking system, instructors can save lecture time and, thus, enhance student learning experience. However, these methods also have some drawbacks. First, most of the above methods require special equipments such as the fingerprint recognition device or an RFID tag reader. If all the classrooms were equipped with these devices, the total cost would be high for schools with many classrooms. Second, any damages to the equipment, such as an RFID card or the reader, may create incorrect attendance records. Third, some methods still cannot avoid imposters. For example, a student can bring other students' phones or RFID cards to help them fake their attendance.

III. METHODS

Cross Validation In Table 2, we compare the different combinations of levels and factors on data augmentation methods, where Kl denotes the sum of the lth current factor and kl denotes the average of Kl. Table 2 shows that the largest range value is image rotation, which indicates that image rotation is the primary factor, and the effect of factors is listed in descending order as follows; image rotation > image zoom > image brightness > image translation. According to this table, we also can determine the best combination of geometric transformation and image brightness is to use the 3rd level of image zoom, 1st level of image translation, 1st level of image rotation, and 3rd level of image brightness. The results of orthogonal experiments on filter operation are shown in Table 3. We can see that the largest

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range is bilateral filter, in other words, the bilateral filer has the most impact. The order of factors' effect is bilateral filter > median filter > Gaussian filter > mean filter. To compare the effect of bilateral filter and image translation factors, we utilize bilateral filter and image translation for augmenting the same original samples and compare the accuracy of face recognition. The accuracy of training the samples with bilateral filter is 74.1%, and the accuracy of image translation is 79.6%. Thus the order of these factors' effect is image rotation > image zoom > image brightness > image translation > bilateral filter > median filter > Gaussian filter > mean filter. For data augmentation, the factor which has a better effect is recommended for augmentation. Thus, the best data augmentation method is the 3rd level of image zoom, 1st level of image translation, 1st level of image rotation, and 3rd level of image brightness.

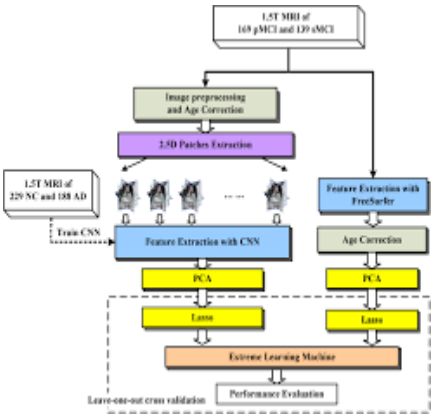

Fig1: Work Flow

In this section, the experimental results of the implementation are presented. We have already discussed the program works in the methodology sections. In this section, we have provided the details about the results obtained by us while using this program against some of the test cases. We have explained the output of each and every test case using the screenshots of the output provided by our program. While making this project, we faced a lot of challenges and we have tried to minimize it as much as possible of these problems. As mentioned above, we used our own created database. The database consisted of total 2345 images that are 4 different people. The average feature vector for each person was extracted then the system was loaded by the extracted feature. To identify a person, we performed our experiments face detection and recognition based on the above mentioned LBPH algorithm. In the proposed algorithm, different types of face images have been recognized. Based on the algorithm, the face image of unknown identity is compared with face images of known individuals from a large database. During testing, we recognize the face for which there exists a weighted combination of basis images that is the closest to the test face image. Figure 17 we can see the input facial images used to create databases for face recognition are given.

IV. RESULT AND DISCUSSION

The analysis of our class attendance-taking method consists of three parts. Part 1 demonstrates the effect of fine-tuning. In the second part, the performance of the face recognition with data augmentation and VGG-16 network is compared to the traditional methods. Part 3 investigates the relationship between the number of training samples and the recognition performance. To get better results with less time, fine-tuning is used in the training process. Instead of training a CNN from scratch, a pretrained VGG-16 model for face recognition on the VGG-Face dataset is used. Fine-tuning is then used to refine the weights. Before fine-tuning the VGG-16 model, we keep the weights before the fully

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connected layers fixed, i.e., weights obtained in pretraining. The weights of the fully connected layer are initialized from zero mean Gaussian distribution with standard deviation of 0.01. As shown in Figure 2, we fine-tune the VGG-16 network; the accuracy of the model without fine-tuning is 70.4%, whereas with fine-tuning 79.6%. Additionally, the model with fine-tuning achieves a higher accuracy with fewer iterations. Thus, fine-tuning can improve the efficiency of training and get a better result with fewer iterations

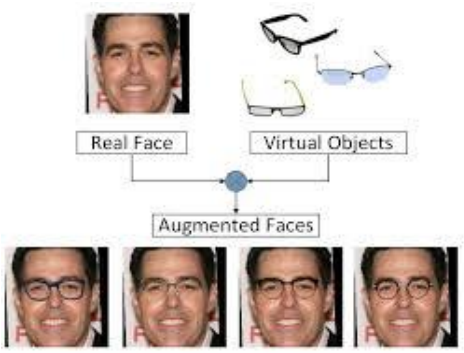

Fig2: the accuracy of the model without fine-tuning

In our experiment, different data augmentation methods are used to enlarge the number of original training samples for fine-tuning the CNN model. To verify the effectiveness of our CNN model, which is based on the augmented training samples, our methods are compared with traditional face recognition methods such as PCA and LBPH. PCA is often used to reduce the dimensionality of datasets while keeping the values which contribute most to variance. It decomposes the covariance matrix to obtain the principal components (i.e., eigenvector) of the data and their corresponding eigenvalues. The LBPH method is based on the Local Binary Patterns (LBP), which is proposed as a texture description method. For texture classification, the occurrences of the LBP codes in a face image are collected into a histogram. The classification is then performed by computing the similarity between histograms. In terms of the accuracy for face recognition, our methods are better than the PCA and LBPH methods (see Table 4). The experimental results show the effectiveness of the prediction approach with various virtual samples. This approach is an effective and robust method for class attendance taking. In terms of face recognition with a small number of samples, our method using CNN with data augmentation has more advantages than that of the PCA and LBPH methods.

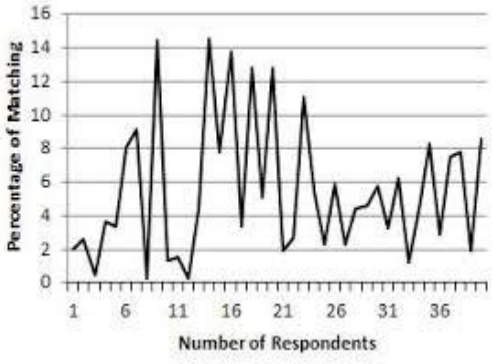

Fig3: Result in PCA and LBPH methods

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The screenshots of the output provided by the program for the first video are shown in Fig. 19a and b. For the first video, only one person will be seen. We have trained the machine to recognize him and label him as ANWAAR. Similar to video 1 in the second video too, only one person will be seen. We have trained the machine to recognize her and label her as TINA. Initially, the frame is empty. When the person enters the frame, the program correctly detects the presence of a person and draws a rectangle around them. The program has correctly recognized the presence of person 1 and 2 as seen in Fig. 19a and b and it continues to track their face and correctly label it as ANWAAR and TINA. Figure 20 shows the result of the number of recognized and uncognized images.

However, there are still some drawbacks compared with other CNN models. Our dataset is small and acquired in a natural uncontrolled environment, whereas nearly all of the state-of-the-art approaches are developed using large datasets acquired in well-controlled environments. The quality of our training samples is lower than that of standard face datasets. First, compared with other data-driven based methods, the number of our training images is still insufficient. Second, only a single viewpoint is available in our original training samples. Third, some students may be occluded by others in the photos.

V. CONCLUSIONS

To identify a person, in this paper we have proposed both proposed Convolution Neural Networks (CNN) and Local Binary Patterns Histograms (LBPH) approach for extracting the features and matching the process for face detection, tracking and recognition. Note that the same methodology had been applied to any other task that builds on localization, such as face tracking, face detection separately and the same CNN methodology had been applied to gender estimation separately. We have first shown that current measures used in face detection, tracking and recognition jointly. We have proposed this method to identify a person specified by the use of particular facial feature extraction. A training model was considered as a collection of training images and a testing model was then obtained by our proposed technique. Experiments were performed on our own created two databases namely A and B. Results have shown that the proposed LBP-based face recognition approach performs better (positive rate of recognition 87%) and is much faster for both databases. Even though our experimental results on both databases show that our method was performing very well for face detection, tracking and recognition jointly to identify people, in the future study we will apply deep learning techniques for doing this research work to improve the positive rate of recognition to identify the person. we propose a novel method for class attendance taking using a CNN-based face recognition system. To acquire enough training samples, we analyze different data augmentation methods based on the orthogonal experiments. According to the orthogonal table, the best data augmentation method can be determined. Then, we demonstrate that the CNN-based face recognition system with data augmentation can become an effective method with sufficient accuracy of recognition. The experimental results indicate that our method can achieve an accuracy of 86.3%, which is higher than PCA or LBPH method

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