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Face Recognition Based Attendance System Using Haar Cascade Algorithm with Histogram Equalization and Median Blur Filter

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ABSTRACT

The attendance system is one of the mandatory activities in teaching and learning activities in an educational environment. Unfortunately, many still use a manual attendance system, which is inefficient, and fraud often occurs by manipulating attendance data. In this research, a face recognition-based attendance system was created. The face detection and recognition system use the haar cascade method with image preprocessing, namely histogram equalization and median blur filter. This system can provide output in the form of CSV documents containing attendance data that has been done in real time so that attendance data recording becomes more efficient than before. There is a significant difference in face recognition without and with image preprocessing. Without image preprocessing, the average face recognition accuracy rate is 71.2%. In face recognition with image preprocessing, the face recognition accuracy rate is 91.5%. Therefore, the use of image preprocessing can improve image quality and significantly increase the accuracy of face recognition. In addition, the CSV document is successfully generated automatically after the attendance process is carried out, which is equipped with user data, attendance date, and time when the user makes attendance to avoid fraud in the form of manipulation of attendance data by users.

1. INTRODUCTION

The attendance system is a mandatory teaching and learning activity in educational environments such as schools and universities. Lecturers check attendance by calling students' names individually and then giving attendance status. The process of collecting student attendance data is quite time-consuming because students are called one by one. Accuracy is needed in filling in the presence status because there can be missed or even human error in filling it in. It often makes lecturers lazy to check attendance (Andri Nugraha Ramdhon, 2021). Based on these problems, a solution is needed that uses an innovation related to lecture attendance to save time in filling out the attendance list and the effectiveness of student data processing using a presence system with the face recognition method.

The presence system with the face recognition method is a mechanism with facial recognition biometric techniques as a symbol of identity using computerized tools (Xue, 2009). The application of the attendance system with the face recognition method uses the concept of computer vision, which is the spearhead of the field of computer science to enable computers to understand what is happening to an object in an image. The face recognition model in real-time will make it easier for users to take attendance and avoid manipulation of attendance data, preventing students from falsifying their attendance and saving more time in taking attendance (Fadhillah Azmi, 2023).

One of the methods used in face recognition is the Haar cascade. The term Haar indicates a box-shaped mathematical function (Haar Wavelet). Initially, image processing only looked at the RGB value of each pixel. However, it turned out that this method was not effective [7]. Then, researchers Viola and Jones developed a way to process images and formed the Haar-Like feature. Haar-like feature will process images in boxes with several pixels in one box. The box will then be processed and will produce different values that indicate the existence of dark and light areas. These values will later be used as the basis for image processing.

Several similar studies make face recognition attendance systems using the Haar Cascade method—research conducted by Moh. Wahyu Septyanto et al. have created a face recognition attendance application using the Haar Cascade Classifier algorithm (Moh Wahyu Septyanto, 2019). This research shows that the system can identify faces with reasonable accuracy. Tests were conducted on 13 employees from the Starcross Store, where each employee performed 30 attendance trials. Out of a total of 390 attempts, 87% succeeded, and 13% failed. The test results show that this application still has weaknesses in terms of lighting. Suppose the light in the reference image differs slightly from that captured in real time. In that case, the face cannot be recognized, and the application can still recognize more than one face object.

Banu Santoso and Ryan Putranda Kristianto conducted related research titled Implementation of the Use of OpenCV on Face Recognition for Student Lecture Attendance Stems (Banu Santoso, 2020). This research uses the Haar Cascade Classifier method and Local Binary Patterns Histograms (LBPH). The results showed that face recognition could be detected with several facial objects in one frame registered in the attendance application system, with the optimal range of face recognition being detected up to 150 cm. In addition, Face Recognition is not successfully detected if there are obstacles on the face and the range exceeds 150 cm.

In research conducted by Rastri Prathivi, a class attendance system using face recognition with the haar cascade classifier method was created (Rastri Prathivi, 2020). This research uses a prototype development system and system creation using Raspberry Pi. This system consists

of 3 phases: face detection and data collection, face recognition training, and face recognition. Based on the test results using the haar cascade classifier method, this system achieved a 75% success rate in face detection. However, the shortcomings of this system are its inability to recognize student faces well in low light conditions, and the system can only detect faces within a distance of about 1 meter.

In research conducted by Raden Isum Suryani Maryati and Burhanuddin Tryatmojo with the title Accuracy of the OpenCV Face Recognition System Using Raspberry Pi with the Haar Cascade Method (Burhanuddin Tryatmojo, 2019). in this study, the authors developed a FaceTrix system that focused on knowing the accuracy of the face recognition detection system using the Haar Cascade method by testing the system using the Single Board Computer Raspberry Pi using the OpenCV library. After testing the system, the author found that the system accuracy rate reached 97%, with an error rate of 3% in the detection process with the total average speed of the entire FaceTrix system in FPS units was 1,779 at a minimum distance of 40cm and a maximum distance of 80cm. This result is influenced by facial images that cannot be clearly recognized due to objects moving too much during detection. In addition, changes in light during recognition and detection also significantly impact the FaceTrix system so that objects can be recognized as other objects, and errors in face recognition occur due to uneven lighting.

Based on the above references, there are differences between this research and previous research. Namely, this study built a face recognition-based attendance system using Haar cascade with histogram equalization and median blur filter. In addition, the difference from other studies is the addition of image processing in the form of histogram equalization and median blur filter before the recognition process is done to improve the image to be detected so that it is expected to produce good accuracy and reduce errors due to extreme lighting changes or disturbances in facial images. Often, our image has decreased quality, for example, because it contains defects or noise, the colour is too contrasting, less sharp, blurry, and so on. In such conditions, image improvement is needed to get an image display with better visualization (Bo Tang, 2022). Many techniques or methods are used in image enhancement. Among others, median filtering and histogram equalization methods were used. The median filter is a method that focuses on the median value or the middle value of the total value of all surrounding pixels (Wang, 2017). Histogram equalization is a histogram smoothing process in which the distribution of grey degree values in an image is flat (Sihotang, 2019). The displayed graph describes the distribution of pixel intensity values, determining whether the image is dark or light. Suppose the image is said to be dark or light. In that case, histogram equalization changes the sharpness values of the image so that the distribution is uniform (Nithin K Shine, 2022). In this study, the Haar cascade method, which functions for face recognition classifiers, is used. The output results of this system are stored in CSV file format to facilitate the management of attendance data.

2. METHODS

The methodology in this research starts from planning, collecting datasets, conducting experiments, implementation, and testing to achieve research objectives. The following is an explanation of the methodology carried out:

A. Dataset

The system uses the dataset for training and face recognition to achieve high accuracy. The dataset is in the form of photos of faces taken when registering attendance users, and then training is carried out. The more datasets used, the higher the system's accuracy in face recognition. In this system, research used as many as 450 datasets of facial photos of each attending user.

B. Image Processing

Image Preprocessing is used in the system through Histogram Equalization (HE) and Median Blur Filter methods. Image processing in the form of Histogram Equalization and median blur filter is done before the face recognition process. In image processing, Histogram Equalization helps improve the contrast of facial images by flattening the pixel intensity distribution and overcoming uneven lighting problems (Peter Pangestu, 2017). In addition, the median blur filter is used to reduce noise, smooth the face image before recognition, and remove distractions that may affect the recognition process (WIyono, 2010). Image preprocessing is applied to facial photographs that have been stored in datasets before. The following examples of datasets that have been pre-processed are contained in Figure 1 and Figure 2.

Figure 1. Dataset After Histogram Equalization

Figure 2. Dataset After Median Blur Filter

C. System Implementation and Testing

In the implementation, the internal camera on the laptop is used as hardware in image capture and face recognition. In addition, a trial was conducted by comparing the results of face detection without and by using image preprocessing to determine and analyse the comparison of system accuracy in face recognition.

3. RESULTS AND DISCUSSION

The program is executed, or the process is run to get results. When the program is run, several results are obtained and tested to achieve the goal. Here are some analysis results from the program or system run.

A. User Interface Display

After the program is run, the user interface appears as a display for interaction and data input for system users. The user interface section contains empty data columns of Name, NIM, Class, and Course, which must be filled in as student data during registration and attendance activities. Registration is carried out at the earliest stage as a student data registration so that the system stores data and can recognize the faces of registered students. The following displays the user interface design listed in Figure 3.

Figure 3. User Interface Display

B. Take Picture, Face Detection, and Training

After filling in the student data in the empty column during registration, students must take a picture as a face photo by pressing "Take Picture." Then, a camera display will appear that detects the face marked with a square around the face, as shown in Figure 4 below.

Figure 4. Image-taking process

Data in the form of photos of student faces after the "Take Picture" stage will be stored in several photos to become a dataset. During the registration stage, there is a training stage after taking photos of student faces for system training to recognize and identify student faces. The training stage takes a dataset that has been stored so that it can recognize faces and detect when attendance is carried out next. The training stage can be seen in Figure 5 below.

Figure 5. Completed Training Process

C. Detection Results and Accuracy Level

When taking attendance, students first fill in the data in the empty column according to the data that has been registered. After all is filled in, the system automatically displays the camera to record and detect faces. The system will show the level of accuracy of the face similarity during attendance with the existing dataset during the registration stage. Suppose the face recorded during attendance is the same as that recorded during registration. In that case, the percentage (%) accuracy rate will be high and display the user's name according to the detected face on the square around the face, as shown in Figure 6 below.

Figure 6. Face Recognition Accuracy Level

If the user takes attendance using someone else's data or the face recorded is not the same as the data at the time of registration, the system cannot recognize the face by displaying a low accuracy rate, and there is an "unknown" notification on top of the square around the face as in Figure 7 below.

Figure 7. Systems Do Not Recognize Faces

D. Comparison of Accuracy Level Without and With Image Preprocessing

After a series of attendance processes were successfully carried out, an accuracy level test was carried out with and without the image preprocessing process to determine the effectiveness of using the image preprocessing process in this attendance system and whether the accuracy level increased. The test results are recorded and contained in Table 1 below.

Table 1. Facial Recognition Accuracy Test Without Preprocessing

Experiment	Accuracy Rate (%) Without Preprocessing	
	Face recognized	**Face not recognized**
1	74	8
2	71	9
3	74	11
4	73	7
5	68	5
6	70	7
7	70	5
8	69	7
9	71	7
10	72	11

Table 1 above shows the results of testing face recognition without image preprocessing with 10 experimental samples. The resulting accuracy rate is 68% to 74%, averaging 71.2% when the face is recognized. Meanwhile, when the face is not recognized, the accuracy rate is relatively small, in the range of 5% to 11%, with an average of 7.7%.

Table 2. Face Recognition Accuracy Test

Experiment	Accuracy Rate (%) With Preprocessing	
	Face recognized	**Face not recognized**
1	92	16
2	94	19
3	93	27
4	95	19
5	94	14
6	97	24
7	75	21
8	89	22
9	97	24
10	89	24

Table 2 above shows the results of testing face recognition with an image preprocessing process with 10 trial samples obtained. The resulting accuracy rate is 75% to 97%, averaging 91.5% when recognizing the face. Meanwhile, when the face is not recognized, the accuracy rate is still relatively small, in the range of 14% to 27%, with an average of 21%.

The experimental results of Table 1 and Table 2 show a comparative analysis that the accuracy value of face recognition using image preprocessing is more excellent than without image preprocessing, with a significant difference. In image processing, histogram equalization helps improve the contrast of facial images by flattening the pixel intensity distribution and overcoming uneven lighting problems. In addition, the median blur filter is

used to reduce noise, smooth the facial image before recognition, and remove distractions that can affect the recognition process.

E. CSV Output

The system records student attendance data from a series of attendance processes and stores it as a CSV document. The CSV document is in the form of student attendance information data in the form of a table containing Name, NIM, Class, Course, Date, and Hours when students make attendance. The form of the CSV document can be seen in Figure 2. 6 below.
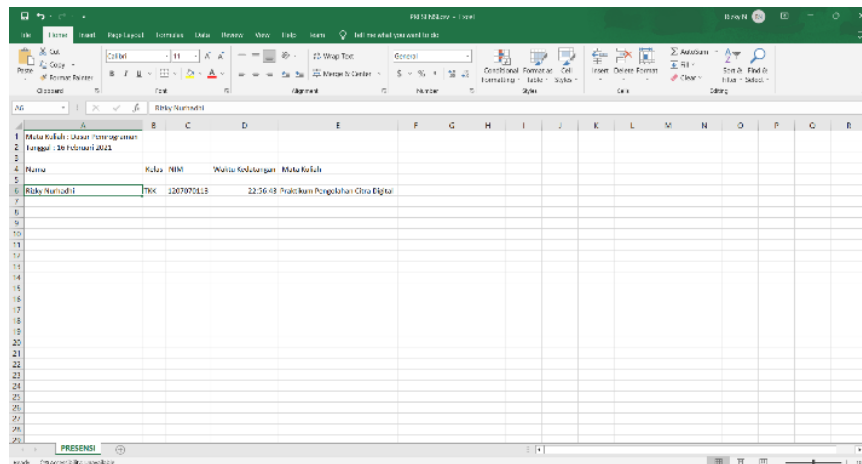

Figure 8. Presence Process Completed

Figure 9. Presence Data Output in CSV Form

4. CONCLUSION

A face recognition-based attendance system using Haar cascade with histogram equalization and median blur filter was successfully created. The system successfully detects and recognizes faces without preprocessing and image preprocessing, but there are significant differences. In addition, the system successfully provides output in the form of CSV documents from the attendance process that has been carried out in real-time.

In face recognition without preprocessing, the accuracy rate of recognized faces is 71.2% on average. In face recognition with image preprocessing, the average accuracy rate of recognized faces is 91.5%. From this difference, using image preprocessing can increase the accuracy rate because histogram equalization helps improve the contrast of facial images by flattening the pixel intensity distribution and overcoming uneven lighting problems. In addition, a median blur filter is used to reduce noise, smooth the facial image before recognition, and remove distractions that can affect the recognition process.

AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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