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Automatic Presence System with Face Recognition Based Smartphone Camera Using the Haar Cascade Method

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***Abstract*—The technology developed in this century has made it possible to create an automatic presence system. The focus of this research is on the system's presence using face recognition by applying the Haar cascade method. The Haar Cascade Classifier, also known as haar-like features, utilizes rectangular features (square function). By utilizing the DroidCam application on a smartphone to obtain the IP camera feed, the system can be programmed to detect presence using the smartphone's camera. The program is created using IDLE, a Python-based language. Tests have been conducted, including face registration, automatic detection of unknown objects, and system database verification. The Haar cascade algorithm is known for its speed in capturing objects, resulting in real-time processing. However, there are several factors that can affect its performance, such as distance and lighting conditions. The ideal distance for presence detection is within the range of 20cm to 40cm and light level within range of 100 to 20.**

***Keywords*—Droidcam, Face Recognition, Haar Cascade, IDLE, Python**

I. Introduction

Lecture presence is the process of recording attendance during teaching and learning activities in lectures. It involves recording not only students but also lecturers as teaching staff [1].Automated Attendance Management System performs the daily activities of attendance analysis, for which face recognition is an important aspect [2]. The focus of the upcoming research is on the system's presence using face recognition through the application of the Haar cascade method [3]. The Haar cascade algorithm is capable of quickly and accurately detecting objects, including human faces, in real-time [4]. Haar Cascading is the machine learning method where a classifier is drilled from a great deal of positive and negative photos [5] [6]. The Haar Cascade Viola-Jones method is the oldest method and is claimed to still have relevance for detecting faces accurately [7]. Many face recognition methods have been developed and each has its own strengths [8]. This method utilizes rectangular features known as haar-like features, which are based on the square function. The aim is to develop an effective presence system using the Haar cascade method that provides accurate results. The main goal of the system is to offer attendance recording solutions in lectures, promoting a conducive and effective learning environment [9].

Based on the issues mentioned above, we require solutions that employ innovative approaches to address absenteeism, minimize fraudulent activities in attendance records, and enhance the efficiency of student data processing. One potential solution is to implement a presentation system utilizing face recognition technology [10]. Face recognition is one of the few biometric methods that possess the merits of both accuracy and low intrusive-ness [11].

There have been numerous studies conducted on automatic presence systems, exploring various methods such as utilizing laptop webcams or microcontrollers like Arduino with RFID technology as the means of recording attendance [12].

In this study, a very practical presence system will be presented by simply using a smartphone camera, by taking an IP address from using a mirror camera application such as a droid cam which will later connected via the source code on the smartphone camera IDLE used will also be displayed on the laptop used to run the system. Students will be given a name, NIM, and class form which will be input into Microsoft Excel. The face of a student doing presence will be recorded and stored in a folder that has been made before. If accuracy level below 50% then the system will detect there are people who do not registered is doing presence but the recap data can still be seen in the folder capture.

II. Design System

A. Flowchart System

The automatic presence work system begins by opening the DroidCam application, which can be downloaded from the Google Play Store. Then, note the IP address in the main view of the application. After that, create the IDLE program along with the GUI display and synchronize the Microsoft Excel folders and files, camera IP address, haarcascade frontalface default.xml, haarcascade eye.xml, and training.xml files. The haarcascade frontalface default.xml, haarcascade eye.xml, and training.xml files can be downloaded from the GitHub website as in Fig. 1.

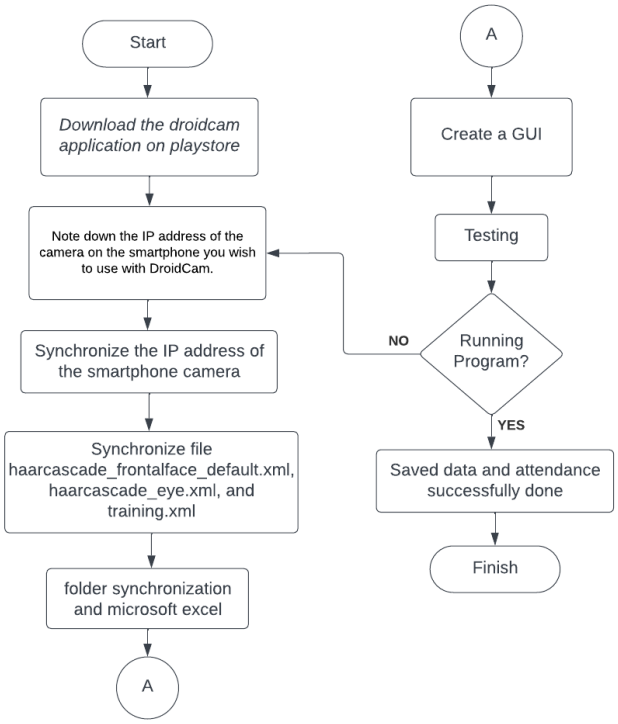


Fig. 1. Flowchart System.

B. Droidcam Configure

The DroidCam application can be downloaded on a smartphone. When you open DroidCam, you can find the Wi-Fi IP address and port displayed within the application. This IP address and port correspond to the IP address of the smartphone you wish to use. After obtaining the IP address, it needs to be entered into the program in IDLE. The smartphones currently in use have the Wi-Fi IP address 192.168.43.100 and the port 4747 as in Fig. 2.

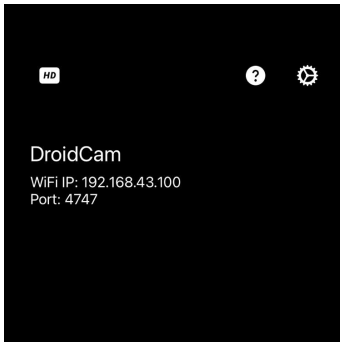


Fig. 2. Droidcam Display.

C. GUI Design

In the program that will be created, the GUI will be included within the same program. The GUI display will consist of an input menu which enter the name, NIM (student ID), and class information. Additionally, there will be menus for presence, a list of absences, and automatic presence. If you do not wish to use the automatic presence feature, you can close it by pressing the 'Q' button on the keyboard as in Fig. 3.

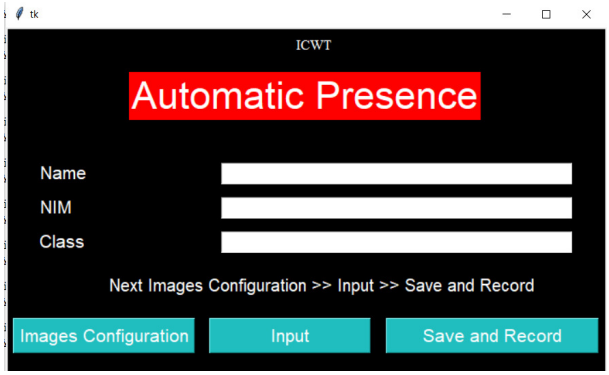


Fig. 3. GUI Display.

This system features a GUI display with three buttons that serve as functions for the next steps. It also includes three entry boxes for inputting data such as name, NIM (student identification number), and class. Additionally, there are some additional information elements within the GUI to enhance clarity and ease of understanding.

D. Face Registration

This automatic presence system utilizes two function files from the Haar cascade method: haarcascade frontalface default.xml and haarcascade eye.xml. Each of these files serves a distinct purpose. The haarcascade frontalface default.xml file is responsible for detecting facial features, specifically the circular contours of the face. On the other hand, the haarcascade eye.xml file is designed to detect human eyes. These two function files work in tandem, allowing the automatic presence system to detect both faces and eyes effectively. By combining these functionalities, the system can accurately identify the presence of individuals. as in Fig. 4.

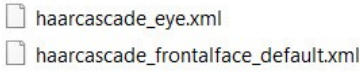


Fig. 4. Haar Cascade Algoriithm.

III. Result and Analysis

A. Face Registration

Before taking attendance, the individual who will be present needs to register their face within the GUI menu. During the face registration process, the system will present a detection box to identify faces and both eyes. Even if the individual is wearing glasses during the face and eye registration, the system will still be able to detect the eyes. Additionally, the process of registering faces includes recording a video that captures the time of attendance and the date. Detailed instructions for using the DroidCam application can be found

in the description mentioned above. The timing information is connected to the operating system's function library, which is integrated into the source code. This function allows the system to display the current time of the laptop or device being used as in Fig. 5.

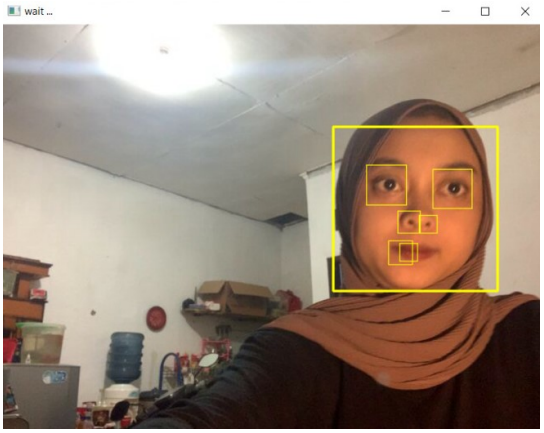


Fig. 5. Grayscale Process.

B. Haar Cascade Process

In the analysis of Haar Cascade process, this automatic presence system utilizes a Microsoft Excel file to store the required data such as name, NIM, and class. Once the personal data is filled in, the system proceeds with training the face using the automatic presence system. During the facial training process, the system records and saves approximately 30 facial photos per second, which are automatically stored in the designated folder as in fig 6.

Fig. 6. Crop Process.

After the facial training process is completed and the system captures the face of the person being trained, the haar cascade method performs as a face detector. The haar cascade method automatically captures grayscale images and quickly processes them in the source code of the presence system. This ensures that users do not experience significant delays during attendance activities as in fig 7.

Fig. 7. Registration Process.

By converting the images to grayscale, the haar cascade method proceeds to the next step, which involves cropping the presenting person's face. Fig 7 illustrates a box that appears around the face of the individual participating in attendance. The system then crops the image within this face box as in fig 8.

Fig. 8. Registration Process.

Once the face squares are cropped, the haar cascade method applies haar-like features, which are based on the presence of rectangles (light and dark) within the image. The haar-like features come in three types, determined by the number of rectangles: two, three, and four. Haar-like features are calculated by subtracting the average pixel value in the dark area from the average pixel value in the bright area. If the difference exceeds the threshold value, it is considered a valid feature. The value of the haar-like feature is determined by the difference between the sum of the gray level pixel values in the black box area and the white box area as in fig 9.

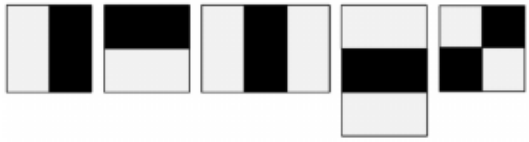


Fig. 9. Haar-like features.

With these haar-like features, the next step after cropping the face square using a grayscale image is to proceed with the haar cascade feature, which involves dividing the cropped image into dark and light parts as in fig 10.

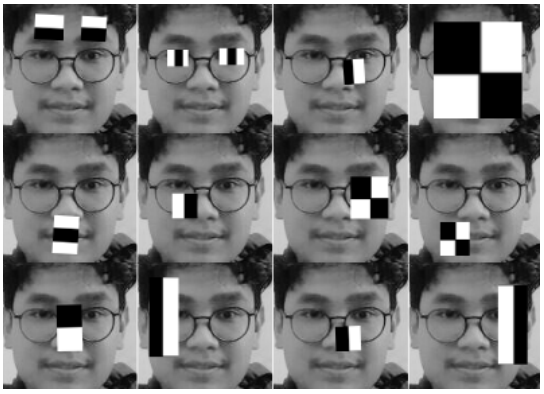


Fig. 10. Haar Cascade process.

This feature-based training process using the haar cascade method enables the system to accurately recognize the faces of individuals participating in attendance. The haar cascade method excels in face detection, allowing for precise identification of human face shapes. Therefore, attendance activities can be efficiently carried out using this reliable method within the system.

C. Unknown Object

In the process of taking attendance, there are individuals who may attempt fraudulent activities by being absent while falsely claiming attendance. However, in this automatic presence system, the system has the capability to efficiently detect various forms of fraud. This enables the system to minimize fraudulent incidents and ensure a smooth attendance process. Unfortunately, I am unable to view or analyze the picture you mentioned as an unknown person being absent in the system as in Fig. 11.

Fig. 11. Not Registered Person.

In addition to detecting unregistered individuals, the system is also capable of identifying instances where fraudsters attempt to use a picture of a person who has previously registered their face. In such cases, the system assesses the match with a lower accuracy value, indicating potential fraud. The evidence of fraud can be observed in the captured results, which are automatically stored in the designated folder. This allows for further investigation and prevention of fraudulent activities within the automatic presence system.

D. Automatic Detection

In the automatic detection process, face registration is initially performed within the face list menu. Once the system is executed, it will swiftly detect objects, specifically faces. When a face is successfully detected, it will be displayed on the automatic interface, and the system will provide information about the accuracy level of the detection. The accuracy level can be influenced by factors such as distance and lighting conditions, which can affect the quality of the detection during automatic attendance taking as in Fig. 12.

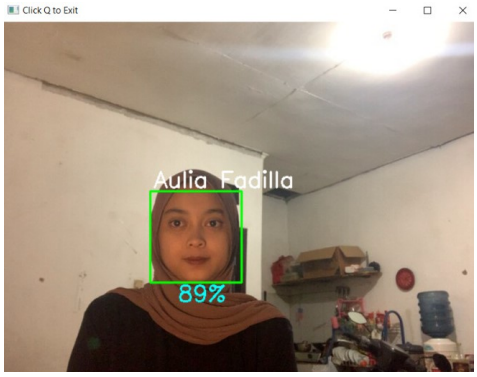


Fig. 12. Automatic Detection.

In the automatic detection process, the system conducts facial training using LBPH (Local Binary Pattern Histograms). In the source code of the automatic presence system, the LBPH function is incorporated. The role of LBPH in the system is face recognition. LBPH is a method utilized in texture-based face recognition.

E. Distance Variation

Testing with varied distances is indeed an important aspect when conducting automatic attendance activities. It is crucial to determine the ideal distance for the system to effectively recognize faces and detect individuals who are present. By testing with different distances, the system can be optimized to ensure accurate face recognition and detection during the attendance process. As in fig. 13.

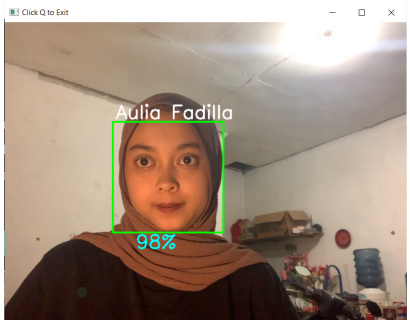


Fig. 13. Distance of 30cm.

Based on the distance variation test that has been carried out, with variations distances of 30cm, 50cm, 70cm, 90cm, and 120cm as shown in table 1.

TABLE I
DISTANCE VARIATION.

Distance(cm)	Accuracy(%)
30	98
50	94
70	89
90	80
120	57

Based on the information provided, the best distance for conducting the attendance activity with an accuracy above 90% falls within the range of 30cm to 50cm. At distances up to 120cm, the system can still detect faces, but with an accuracy below 60%. While presence can still be registered if the system recognizes faces below 60%, it is recommended to perform the activity at a distance of less than 70cm as it is considered the ideal distance for attendance.

It's worth noting that the haar cascade method is capable of detecting human faces up to 120cm away and operates in real-time. However, to ensure higher accuracy, it is advisable to maintain a distance within the recommended range for optimal results.

F. Light Variation

During attendance, the lighting or brightness of the room plays a significant role in determining the accuracy and detection of faces. In order to achieve the best results, this study also conducted tests to determine the ideal brightness level for attendance. To control the brightness or darkness of the room, a Xiaomi Yeelight lamp was utilized, which can be connected to a smartphone. By connecting the lamp to a smartphone, it becomes possible to turn the lamp on or off and adjust the brightness of the lights being used. This allows for precise control over the lighting conditions during attendance, ensuring optimal accuracy and face detection. In fig. 14 dsiplay of lamp application.

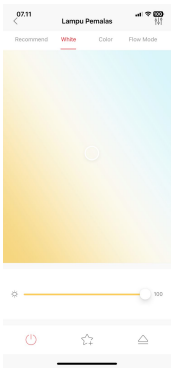


Fig. 14. Light variation app.

after setting the light level to 100, the automatic recording results are obtained as shown in fig. 15.

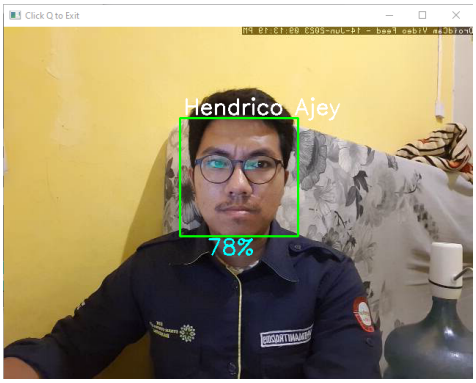


Fig. 15. Light level 100.

Furthermore, experiments were conducted using different light levels: 100, 80, 60, 40, 20, and 1. The results can be observed in the following table 2.

TABLE II
LIGHT VARIATION.

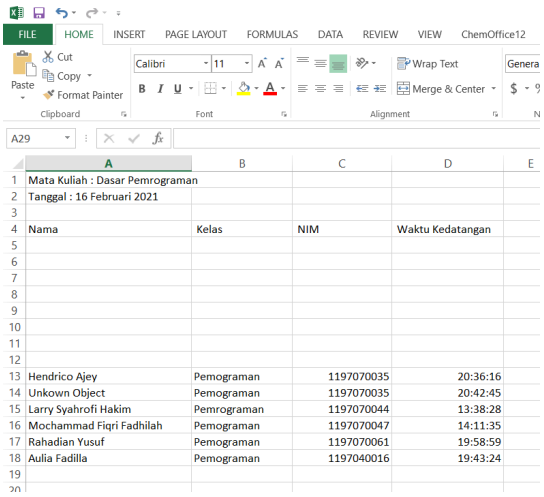
Light Level	Accuracy(%)
100	78
80	74
60	78
40	76
20	69
1	not detected

The brighter the lighting in the room, the higher the accuracy value produced, resulting in better detection. Conversely, when the lighting is darker, the accuracy value decreases, and the system may even fail to detect the face during attendance. The haar cascade method relies on adequate lighting to detect faces effectively. Insufficient lighting leads to blurry or unclear images, making it challenging for the haar cascade method to capture the curves of the face and eyes accurately.

Therefore, it is crucial to have ideal lighting conditions and avoid conducting attendance activities in minimal lighting situations. The system cannot detect faces when the lighting is below a minimum threshold. It is recommended to maintain at least a 20% light level, and if it drops below this level, even reaching 0, the system will struggle to detect faces effectively.

G. Database Systen

Once the entire flowchart process is completed, the results of the automatic presence system are directly saved into the database in two forms: a Microsoft Excel file and a folder on the laptop. The Microsoft Excel file contains various data, including the information inputted from the GUI display such as name, NIM, and class. Additionally, the database system also records the date and time of the presence, providing insights into the timeliness of the individuals. However, in the event of an unknown object or unauthorized presence, it will be recorded separately in Microsoft Excel under a different category, distinguishing it from legitimate presences as in Fig. 16.



	A	B	C	D
1	Mata Kuliah : Dasar Pemrograman			
2	Tanggal : 16 Februari 2021			
3				
4	Nama	Kelas	NIM	Waktu Kedatangan
13	Hendrico Ajey	Pemograman	1197070035	20:36:16
14	Unkown Object	Pemograman	1197070035	20:42:45
15	Larry Syahrofi Hakim	Pemrograman	1197070044	13:38:28
16	Mochammad Fiqri Fadhilah	Pemograman	1197070047	14:11:35
17	Rahadian Yusuf	Pemograman	1197070061	19:58:59
18	Aulia Fadilla	Pemograman	1197040016	19:43:24

Fig. 16. Personal information.

Apart from the database from Microsoft Excel. This system also stores capture information that was carried out during the presence process, as many as 30 images will be captured automatically by the system so that you can also see the best level of image quality and also the level of truth of the person making the presence, because there have been several cases of fraudulent presence as in Fig. 17.

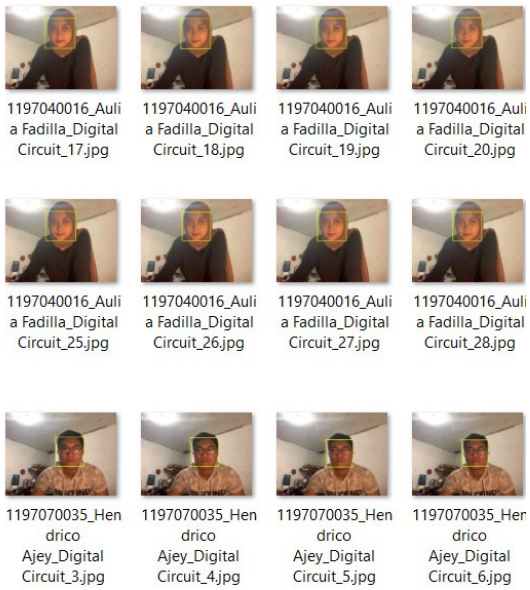


Fig. 17. Image Strored.

IV. Conclussions

The primary objective of this automatic presence system is to simplify the process of recording attendance for both students and teaching staff within the education system. The system employs the haar cascade method as it offers fast and real-time object detection, particularly human faces. One of the advantages of using the Haar Cascade Classifier algorithm is its computational speed, which depends solely on the number of pixels in the image square.

Using the haar cascade method allows the absence test results to be obtained in under 1 second. However, there are certain factors, such as light intensity and distance, that can impede the haar cascade method's performance. To ensure optimal functionality, it is crucial to consider ideal distance and light level. In the case of ideal distances, a range between 30cm to 70cm and light level in 100-20 has been found to work well for the haar cascade method.

By taking these considerations into account, the automatic presence system aims to provide an efficient and effective means of recording attendance within the education system.

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