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Artificial Intelligence System for Face Detection to Identify Passenger Identity at the Airport

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***Abstract*— Facial biometric technology is widely used in various fields such as bank security, border crossings, airport check-in, home surveillance, remote meetings in offices, prisons, and factories. This makes facial recognition an important field to study and develop. In countries like the United States and Germany, trials have begun for the implementation of Face Recognition technology in airport areas. This technology is used for airport check-in systems to address the issue of long queues, especially during holiday seasons, which is a common occurrence in airports worldwide. Although online check-in methods already exist, they still do not resolve this issue. Unfortunately, this technology has not yet been implemented or discussed for application in Indonesian airports. Therefore, the researchers intend to conduct a study on this technology to ensure that Indonesia does not fall behind other countries in facial detection technology. Based on the test results of the developed system, it can be concluded that the facial detection system is quite effective in identifying faces, but there are some limitations, such as lighting and facial accessories. The system works optimally at light intensities ranging from 806 lumens to 161 lumens, and if the person to be detected is wearing a mask or sunglasses, the system will not be able to recognize the face.**

Keywords—Detector, Face, Check-in, Airport, Artificial intelligence

I. INTRODUCTION

Long queues, especially during the holiday season, are a common problem at airports around the world, including in terms of security. Although the bold check-in method is available, this problem has not been completely resolved [1]. To improve efficiency in the check-in system, the German government began implementing facial recognition technology in 2023, with the aim of accelerating the passenger verification process and minimizing errors in identity data [2], [3]. Meanwhile, in the United States, a similar technology is known as the CAT-2 machine, which is an automatic identification system that combines facial recognition technology to capture real-time images of travelers, then biometric data occurs with an image ID card to verify identity quickly and accurately [4], [5]. Unfortunately, until now this technology has not been implemented at airports in Indonesia, which raises questions about the readiness to adopt this technology domestically. Based on the description above, several main problems can be formulated in this study, namely: first, how high is the level of accuracy of the system built in recognizing human faces; second, how much influence does lighting variation have on the accuracy of the facial recognition system; and third, how does the use of facial accessories such as glasses and masks affect the level of system accuracy. To answer these questions, researchers set several limitations in the implementation of the study, namely: (1) the facial database used is limited to offline data from individuals in the researcher's environment; (2) the facial recognition process is tested in a laboratory environment with controlled lighting; and (3) the data displayed is limited to general information such as name, age, and web address, without involving official population data from the government [6]–[15]. Facial recognition technology has made significant progress in the last decade, especially with the use of deep learning algorithms that are able to outperform conventional approaches [6], [7]. Several approaches such as FaceNet [8], DeepFace [9], and IJB-A Benchmark [10] have pushed the limits of the system's ability to recognize faces in various conditions. However, challenges such as uneven lighting, variations in facial expressions, camera angles, and the use of facial accessories remain major obstacles to improving facial recognition accuracy [11], [12]. Previous research has also shown that image quality and human judgment of facial images have a significant impact on system performance [13]. In addition, accurate and consistent data labeling processes, as facilitated by tools such as VIA (VGG Image Annotator), are an important aspect of dataset construction [14]. Influential variables such as age, gender, and ethnicity have also been shown to significantly affect the performance of facial recognition systems [15].

II. RESEARCH METHODS

A. *Face Recognition*

ace recognition is also one of the biometric technologies that has been studied and developed by experts, as it uses facial recognition algorithms to distinguish one individual from another based on existing data in the face database. Biometric technology is one of the distinctive features that can be used in a security system, with face recognition serving as a form of identity data. The human face contains a wealth of information and has the most distinctive characteristics, making it widely used for identifying individuals. In addition to reflecting mood and attention, the face can also be used to identify a person [18].

B. *Python Library OpenCV*

OpenCV (Open Source Computer Vision Library) is an open-source Python library primarily intended for real-time computer vision. It is also available in C++ and Java. It is an open-source machine learning software library. It uses Numpy, which is a Python library used to implement multidimensional arrays and matrices along with high-level mathematical operations on these arrays. OpenCV is primarily used for capturing data from live video, so its main focus is on image processing and video capture. In this paper, OpenCV is primarily focused on video capture. OpenCV is also used for applications such as face detection, OCR, vision-guided robotic surgery, 3D human organ reconstruction, QR code scanning, etc. Using OpenCV, we can perform detection of specific objects such as eyes, faces, etc. We can also analyze videos, such as estimating motion in the video or reducing video background, and tracking objects within it. OpenCV includes basic data structures such as Scalars, Points, etc., which are used to build OpenCV applications. The OpenCV library is imported into Python using the code 'import cv2' [22].

C. *Python Programming Language*

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D. *Airport*

An airport is a designated area on land or water (including buildings, installations, and equipment) intended, either entirely or partially, for the arrival, departure, and movement of *aircraft.*

E. *Airport Check-In System*

Based on the statistics described earlier, Juanda International Airport in Surabaya is the second busiest airport in Indonesia, managed by PT. Angkasa Pura I (Persero). Currently, with technological advancements, there are 5 types of check-in systems: conventional check-in, online or web check-in, mobile check-in, self-baggage drop, and self check-in. The conventional check-in system is done through counters attended by human resources. This system still has drawbacks, such as long queues at the check-in counter. Online or web check-in and mobile check-in follow a similar check-in process, but differ in that online or web check-in uses a browser, while mobile check-in uses an app available on the Google Play Store. Self-baggage drop is a facility/area designed to complete various check-in procedures, including baggage drop, using a machine.
The self-check-in technology system is a facility/area designed to complete various procedures and security and service requirements using a machine, excluding baggage drop. This self-check-in system has a very simple procedure, where passengers only need to scan a barcode or enter their e-ticket number, select a seat, and print the boarding pass. Due to the ease of the check-in process, 83% of passengers prefer the self-check-in system. Currently, the self-check-in system in Indonesia is only available for passengers without baggage [4].

III. RESEARCH RESULT

A. *Flowchart*

Fig .1 Flow Chart process

In general, the operation of the face detection system built can be understood through the flowchart diagram in Figure 1. When the system is activated, the webcam will scan for the presence of a person's face, which is indicated by the appearance of a box marking the location of the face. The computer will automatically process the image captured by the camera and then match it with the database

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on the computer. If the scanned face is not recognized or not in the database, the screen will not display the passenger's identity. When the computer's database contains the passenger's facial identity, the computer will automatically display the passenger's identity on the screen.

B. *Variables and Operational Definitions of Variables*

1. Independent Variable

   This variable is used to assess the accuracy of the camera scanning system, determine the effective scanning face recoqnation with accecories, and evaluate the response of the phyton library with image change.

2. Dependent Variable

   This variable measures the system's ability to read a face recoqnation with data, its response to camera to phyton library , and its ability to display a identity from the Passanger.

C. *Data Analysis Methods*

The method used in this research is the statistical method, which involves repeating tests and drawing conclusions from the statistical calculations of the data, in terms of accuracy and the success percentage of the device in scanning human faces.

IV. RESULT AND DISCUSSION

A. *Product Result*

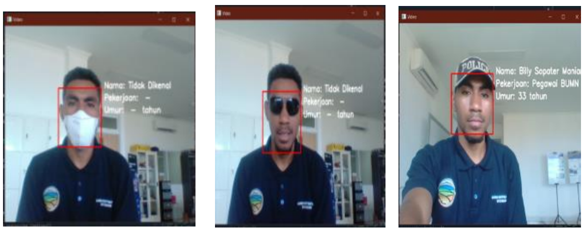

Fig 2 Front view of face with mask, glasses, hat, and application display on screen.

B. *Data Presentation System Accuracy Testing in Recognizing Human Faces*

In this test, the system was tested by scanning the faces of five individuals to determine whether using only one recognized face in the database would cause any face recognition errors. Below is the data from the trial with five individuals recognized in the database.

TABLE 1. ACCURACY DATA

No.	Wajah dalam Database	Variasi Wajah Penumpang (Mengenali/Tidak Mengenali)				
		Orang 1	Orang 2	Orang 3	Orang 4	Orang 5
1	Orang 1	√	×	×	×	×
2	Orang 2	×	√	×	×	×
3	Orang 3	×	×	√	×	×

From the data, it is evident that the system only recognizes an individual's face if it has already been registered in the face recognition system.

The test on the effect of light variation on face recognition accuracy is conducted to determine the minimum threshold at which the system can function normally when the room's light intensity reaches certain levels. Below are the test results with eleven different light intensity variations, from the brightest to the darkest.

TABLE 2. EVALUATION OF TOOL SUCCESS

No.	Intensitas Cahaya Lampu (%)	Besar Intensitas (lumen)	Keberhasilan Identifikasi Wajah (Berhasil/Tidak)
1	100	806	Berhasil
2	90	725	Berhasil
3	80	644	Berhasil
4	70	564	Berhasil
5	60	483	Berhasil
6	50	403	Berhasil
7	40	322	Berhasil
8	30	241	Berhasil
9	20	161	Berhasil
10	10	80	Tidak
11	0	0	Tidak

C. *Discussion*

Based on the experimental data, it can be generally analyzed that the system built has functioned well as expected. A person who wishes to have their information displayed must first be registered in the system to be recognized. If the person's data has not been entered, they will be identified as an unknown individual. However, through several types of testing, additional information was obtained regarding the limitations of the developed system.

In the light intensity test, it was found that the lighting level in a room significantly affects the face recognition system. With a lighting intensity of 806 lumens, or the maximum lighting from the lamp used, the system can easily recognize a person's face. This also holds true for lighting down to 161 lumens, or 20% of the lamp's brightness. However, when the lighting is at 10-0% or around 80-0 lumens, the system struggles with face identification. This is due to the fact that the face image captured by the camera is not clear enough, preventing the system from performing accurate calculations based on facial features.

The use of accessories, especially those that cover the eyes and mouth, such as sunglasses and masks, greatly affects the system's identification ability. This is because, in identifying a human face, the system needs to read facial patterns such as the position and size of the eyes, mouth, nose, and so on in order to recognize an individual. Masks and sunglasses can cover up to 50% of the face, preventing the system from determining the identity due to a lack of facial pattern references.

In practice, the face recognition video displayed by this system still experiences a noticeable delay, causing the video output to appear choppy. Although it is not overly disruptive, some people may find it uncomfortable to view the video due to its choppy appearance.

CONCLUSION AND SUGGESTION

Based on the results of the research and testing carried out, several conclusions can be drawn. The face identification system developed demonstrates a high level of accuracy, successfully recognizing human faces with a 100% success rate. However, the system's performance is influenced by lighting conditions; it can accurately identify faces within a light intensity range of approximately 30% to 100% (806 lumens to 161 lumens). When the light intensity falls below 30%, specifically in the range of 10% to 0% (80 lumens to complete darkness), the system is no longer able to recognize faces. Additionally, the presence of facial accessories significantly impacts the system's ability to identify individuals. Accessories that cover a substantial portion of the face, such as glasses and masks, hinder the system's recognition capability.

REFERENCES

[1] Akhmad Solikin (2020). Drowsy detection from video driver face based on eye and mouth features extraction using the convolution neural network method. This research was conducted in an effort to minimize traffic accidents on the road. https://doi.org/10.36456/best.vol2.no1.2584

[2] Hastuti, D., Zukro Aini, R. S., & Musthofa, A. N. (2024). Implementation of face detection login system using Python. BEST: Journal of Applied Electrical, Science, & Technology, 6(2), 31-35. This research highlights the advantages and potential vulnerabilities of the system while proposing mitigation strategies to improve security. https://doi.org/10.36456/best.vol6.no2.9880

[3] Anwar, L. A. (2023). Efficiency, Frankfurt Airport Scans Passenger Biometric Face. Kompas.id. https://www.kompas.id/baca/internasional/2023/11/02/efisiensi-Bandar-Udara-frankfurt-pindai-biometrik-wajah-penumpang

[4] Ardiansyah, M. I., & Ahyudanari, E. (2017). Comparison of Self Check-In Service Performance with Conventional Check-In for Citilink and AirAsia Airlines at Juanda International Airport Surabaya. Jurnal Teknik ITS, 6(2), E108–E113. https://doi.org/10.12962/J23373539.V6I2.26889

[5] Bongga, J. D. (2009). INTERNATIONAL AIRPORT IN YOGYAKARTA.

[6] Chung, H. Y., Hou, C. C., & Liang, S. J. (2017). Face detection and posture recognition in a real-time tracking system. 2017 IEEE International Symposium on Systems Engineering, ISSE 2017 - Proceedings. https://doi.org/10.1109/SYSENG.2017.8088265

[7] Duan, N., Liu, L. Z., Yu, X. J., Li, Q., & Yeh, S. C. (2019). Classification of multichannel surface-electromyography signals based on convolutional neural networks. Journal of Industrial Information Integration, 15, 201–206. https://doi.org/10.1016/J.JII.2018.09.001

[8] Fan, L., Wang, Z., Cai, B., Tao, C., Zhang, Z., Wang, Y., Li, S., Huang, F., Fu, S., & Zhang, F. (2017). A survey on multiple object tracking algorithm. 2016 IEEE International Conference on Information and Automation, IEEE ICIA 2016, 1855–1862. https://doi.org/10.1109/ICINFA.2016.7832121

[9] Giovanni, A., Indrasari, W., & Firmansyah, H. (2023). FACE DETECTION AS A ROOM SECURITY SYSTEM. NATIONAL PHYSICS SEMINAR PROCEEDINGS (E-JOURNAL), 11. https://doi.org/10.21009/03.1101.FA06

[10] Hendrianto Pratomo, A., Florestyanto, Y., & Sari, N. I. (2019). Face Recognition for Employee Attendance Monitoring Using the Viola-Jones Method and Euclidean Distance. National Seminar on Communication and Informatics, 69–78. https://jurnal.kominfo.go.id/index.php/snki/article/view/2575

[11] Huang, B., Huan, Y., Xu, L., Zheng, L., & Zou, Z. (2018). Automated trading systems statistical and machine learning methods and hardware implementation: a survey. Enterprise Information Systems, 13, 1–13. https://doi.org/10.1080/17517575.2018.1493145

[12] Huang, C., Cai, H., Xu, L., Xu, B., Gu, Y., & Jiang, L. (2019). Data-driven ontology generation and evolution towards intelligent service in manufacturing systems. Future Generation Computer Systems, 101, 197–207. https://doi.org/10.1016/j.future.2019.05.075

[13] Kreuzer, T., Papapetrou, P., & Zdravkovic, J. (2024). Artificial intelligence in digital twins—A systematic literature review. Data & Knowledge Engineering, 151, 102304. https://doi.org/10.1016/J.DATAK.2024.102304

[14] Kuhlman, D. (2013). A Python Book: Beginning Python, Advanced Python, and Python Exercises. A Python Book, 1–227. http://www.davekuhlman.org

[15] Kumar, S., Kumari, S., Patro, S., Shandilya, T., & Acharya, A. K. (2015). Adaptive visual tracking on Euclidean space using PCA. 2015 International Conference on Advances in Computing, Communications and Informatics, ICACCI 2015,

1626–1630. https://doi.org/10.1109/ICACCI.2015.7275846

[16] Kuroki, M. (2021). Using Python and Google Colab to teach undergraduate microeconomic theory. International Review of Economics Education, 38, 100225. https://doi.org/10.1016/J.IREE.2021.100225

[17] Lan, X., Xiong, Z., Zhang, W., Li, S., Chang, H., & Zeng, W. (2016). A super-fast online face tracking system for video surveillance. https://doi.org/10.1109/ISCAS.2016.7538968

[18] Munawir, M., Fitria, L., & Hermansyah, M. (2020). Implementation of Face Recognition in Student Attendance Using the Haar Cascade Classifier Method. Journal of National Informatics and Network Technology, 04(02), 314–320.

[19] Puspaningrum, E. Y., & Saputra, W. S. J. (2018). FACE DETECTION WITH BOOSTED CASCADE CLASSIFIER. Scan: Journal of Information Technology and Communication, 13(3), 15–18. https://doi.org/10.33005/SCAN.V13I3.1367

[20] Shi, F., Wang, J., Shi, J., Wu, Z., Wang, Q., Tang, Z., He, K., & Shi, Y. (2020). Review of Artificial Intelligence Techniques in Imaging Data Acquisition, Segmentation, and Diagnosis for COVID-19. IEEE Reviews in Biomedical Engineering, PP, 1. https://doi.org/10.1109/RBME.2020.2987975

[21] Syafira, A. R., & Ariyanto, G. (2017). Face Detection System with Modified Viola-Jones Method. Emitor: Journal of Electrical Engineering, 17(1), 26–33. https://doi.org/10.23917/EMITOR.V17I1.5964

[22] Varun, K. S., Puneeth, I., & Jacob, T. P. (2019). Virtual mouse implementation using open CV. Proceedings of the International Conference on Trends in Electronics and Informatics, ICOEI 2019, 435–438. https://doi.org/10.1109/ICOEI.2019.8862764

[23] Xu, L. Da, Lu, Y., & Li, L. (2021). Embedding Blockchain Technology into IoT for Security: A Survey. IEEE Internet of Things Journal, 8(13), 10452–10473. https://doi.org/10.1109/JIOT.2021.3060508

[24] Xu, L., Tan, W., Zhen, H., & Shen, W. (2008). An Approach to Enterprise Process Dynamic Modeling Supporting Enterprise Process Evolution. Information Systems Frontiers, 10, 611–624. https://doi.org/10.1007/s10796-008-9114-3

[25] Yilihamu, D., Tuerxun, P., Dawut, A., & Hamdulla, A. (2020). A Real-time Face Tracking and Recognition System Based on SeetaFace. Journal of Physics: Conference Series, 1673, 012043. https://doi.org/10.1088/1742-6596/1673/1/012043

[26] Zhang, C., & Lu, Y. (2021). Study on artificial intelligence: The state of the art and future prospects. Journal of Industrial Information Integration, 23, 100224. https://doi.org/10.1016/J.JII.2021.100224