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Utilization of Image Processing to Detect Hair Length According to SOP at IPB Vocational School Using Region-Based Segmentation

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Abstract *. This study utilizes image processing technology to detect student hair length in accordance with the Standard Operating Procedures (SOP) at IPB Vocational School. Manual supervision is often inefficient and prone to subjectivity, leading to the development of an automated detection system using a region-based segmentation approach. This method identifies the forehead area as a reference point, where hair is considered long if it exceeds specified limits. The system is implemented in a web-based application called Rambot, enabling students to verify their compliance with SOPs more easily. This technology aims to improve the accuracy and consistency of hair length monitoring.*

Keywords *: Image Processing, Hair Length Detection, , SOP Compliance, Web-Based Application*

1. BACKGROUND

Image processing is a type of technology to solve problems related to image processing (Darujati, 2021). This technology has been applied in various fields, ranging from medicine, as shown in the research of Hermawati and Safii (2021) entitled " *Lung Cancer Malignancy Detection System on CT Scans Using the Mask Region-based Convolutional Neural Network (Mask R-CNN) Method* ", to agriculture as in the research by Suryadi, Putri, and Febrianti (2022) entitled " *Digital Image Processing and Fuzzy Logic in Identification of Fruit Ripeness Level* ". In the context of education, image processing can be integrated to help the supervision process more accurately and efficiently. One of its applications is detecting student compliance with applicable regulations, such as standard operating procedures (SOPs) set by the institution.

Standard Operating Procedures (SOP) are a series of written instructions that have been standardized regarding how and when to do, where and by whom the SOP is carried out and the process of implementing the organization's activities (Sanoto, 2020). SOPs function as guidelines to ensure that each stage is carried out according to established standards. In higher education, such as at the IPB Vocational School, compliance with SOPs is important to create a disciplined and structured academic environment.

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IPB Vocational School as a higher education institution that focuses on developing practical skills, sets various written rules including rules regarding hair length that must be obeyed by students. However, violations of these rules still often occur for various reasons. Manual supervision is often inefficient and prone to subjectivity. To overcome this problem, an image processing-based technology was designed to detect hair length automatically. This system was then developed using the *Region-Based Segmentation method* .

Region-Based Segmentation is one of the main approaches in image segmentation that aims to separate an image into several regions that have similar characteristics such as intensity, color, or texture (Khalid, 2022). In a study by Khalid (2022), *Region-Based Segmentation methods* , including DAS (*Dynamic Adaptive Strategy*) and *Region Growing* , have been applied to remote sensing and medical applications to recognize objects of interest in images. The results of the study showed that this method is accurate in object analysis, making it an effective solution for various needs. Therefore, the use of the region-based segmentation method is an innovation that has great potential to increase the effectiveness of surveillance.

This study aims to develop an image processing-based system using the *Region-Based Segmentation method* that automatically detects the hair length of students at the IPB Vocational School and ensures compliance with applicable SOPs. This study is also expected to help improve the effectiveness of supervision while ensuring that the established SOPs can be applied consistently and objectively in the campus environment.

2. THEORETICAL STUDY

Region Based Segmentation

Region-based segmentation is one of the main approaches in image segmentation that aims to separate an image into several regions that have similar characteristics such as intensity, color, or texture (K halid, 2022) . This approach works by grouping pixels that have similarities and separating them from other different regions. This technique facilitates further analysis of objects in the image by producing a more structured representation (K halid, 2022) . This method is very effective when objects have distinct boundaries and well-defined properties. (*Region-Based Segmentation* , nd)

Python

Python is a simple, easy-to-learn, and very popular programming language, especially in the fields of artificial intelligence and machine learning, thanks to its ability to facilitate work with higher productivity. This language is *open source* and has a large community, so it continues to grow and offers libraries that can help solve various problems. Python also supports portability, integration with other languages, and has support for object-oriented programming, making it an ideal choice for beginners and professionals who want to create various types of applications with high efficiency (Rawat, 2020) .

NumPy

NumPy is the primary library for *array programming* in Python that plays a vital role in a variety of research fields. Despite the emergence of new array libraries that take advantage of modern hardware, NumPy remains the standard because a large ecosystem relies on it. To maintain relevance and support new technologies, NumPy has become the primary coordination mechanism with a clear and flexible API for custom array implementations (Harris et al., 2020) .

MediaPipe

MediaPipe is *an open source framework* developed by Google Inc. to facilitate the development of multimodal applications involving video, images, audio, and various other types of data. This *framework* is designed to make it easier for developers to build applications that focus on computer vision, such as artificial intelligence and image processing (Amanda Muchsin Chalik et al., 2021) . This *framework* supports cross-platform development, because it is built using time series data (Priyonggo et al., 2022) . In addition, MediaPipe has various *packages* or *frameworks* such as face mesh, MediaPipe objects can be installed on Python via the syntax pip install mediapipe via the terminal device used, you can also install packages on the IDE, namely pycharm automatically (Amanda Muchsin Chalik et al., 2021) .

OpenCV

OpenCV (Open Source Computer Vision Library) is an open source library based on Python developed by Intel, with the aim of simplifying programming related to digital image processing (Amanda Muchsin Chalik et al., 2021) . OpenCV was first introduced in 1999 as part of Intel's research program to support applications that require a lot of CPU processing (Zebari & Sallow, 2021) . OpenCV has many features, including: face

recognition, face tracking, face detection, Kalman filtering and various types of AI (Artificial Intelligence) methods (Amanda Muchsin Chalik et al., 2021) . When combined with other libraries, such as Numpy, which is a high-performance library for data processing, OpenCV can achieve optimal performance (Zebari & Sallow, 2021) .

Flask

Flask is a simple Python-based *micro-framework because it is not equipped with many tools and libraries. The use of Flask aims to increase development efficiency. Flask was chosen because it is able to run on programs with low power and memory consumption, so it does not require many resources. Although lightweight, Flask is still able to carry out its functions according to needs* (Bota & Setiyawati, 2022) .

3. RESEARCH METHODS

Research Object

This study aims to support discipline among male students at the IPB Vocational School, by focusing on the implementation of rules related to hair length. This rule is based on the Regulation of the Rector of the Bogor Agricultural University Number 32/IT3/KM/2020, CHAPTER II Article 5C, which states that "Male students are prohibited from having untidy hair, long hair, namely hair length that passes the eyebrow line at the front, ears on the side, or touches the shirt collar at the neck.".

Research Flow

region-based segmentation approach was chosen to achieve the research objective, which is to detect whether the area above the head is covered with hair or not. This approach uses the Python programming language, which was chosen because of its flexibility and extensive library support for image processing. One of the libraries used is MediaPipe, used to specifically recognize the forehead area as a reference point. After the forehead point is identified, the program will create a frame with the forehead point as the lower boundary. Based on this frame, the program will determine the length of the hair: if the hair covers more than 60% of the forehead area, then the hair will be considered long. In addition, if the hair rises more than 5 cm upwards, the hair will also be considered long. After the Python program is completed, the Flask *framework* will make the program run on *the website* . Overall, this program will be named Rambot.

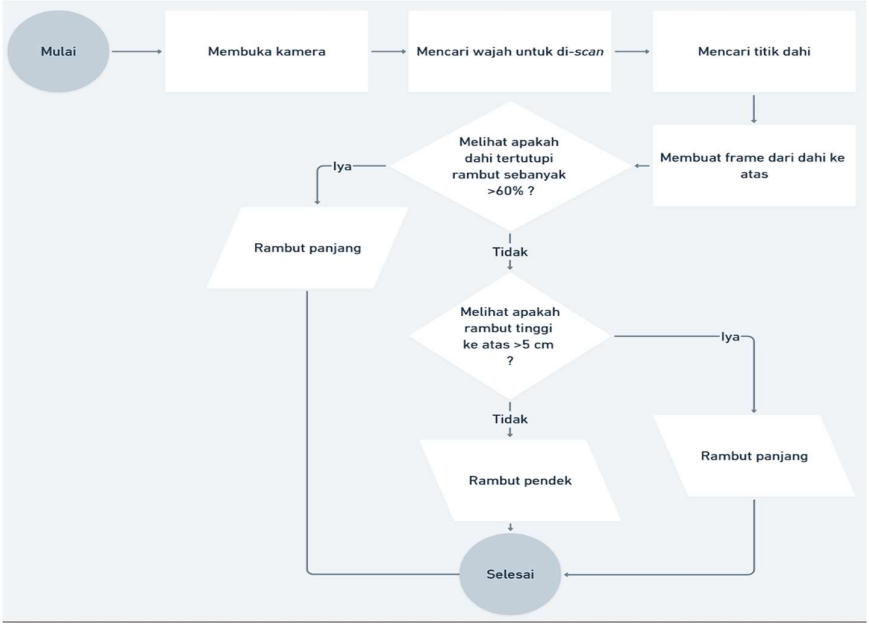

Figure 1. Rambot workflow

4. RESULTS AND DISCUSSION

Research Products

This research produces output in the form of the Rambot *website* , which contains information about the programs used, current limitations, and also how to use them. The following is a picture of the appearance of the Rambot *website* to make it clearer.

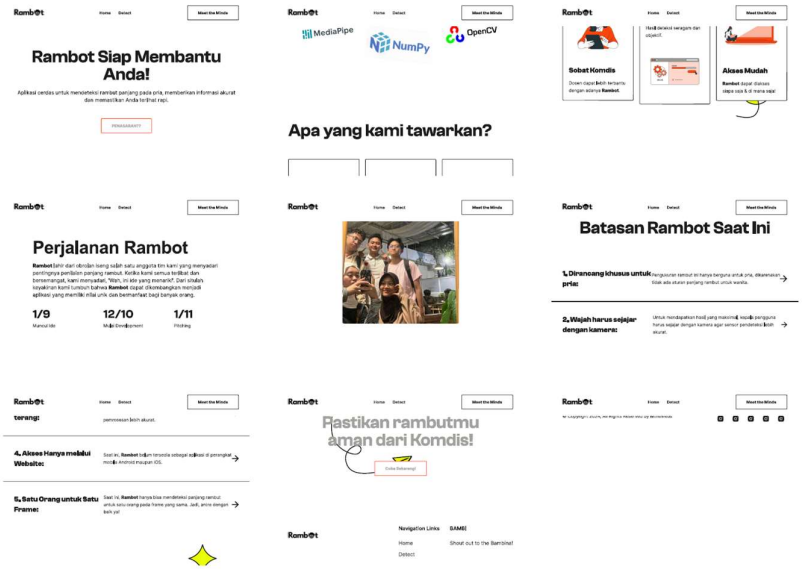

Figure 2. Rambot home page

On the home page, there is brief information about Rambot, starting from *the libraries* used, its advantages, and current limitations.

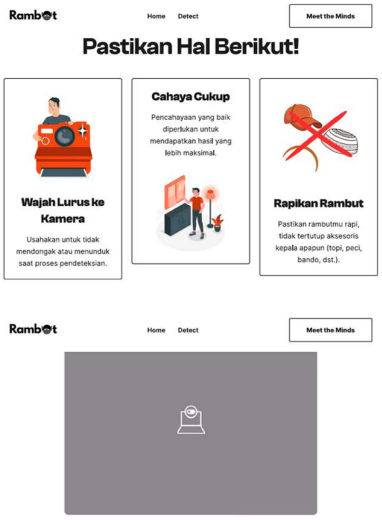

Figure 3. Detect Rambot page

On the detect page, there are *reminders* for users before using Rambot, starting from face placement, lighting, to ensuring hair is neat. On this page, users need to grant camera access, and Rambot will be ready to use.

Implementation

The results of the experiments conducted on the Rambot system show that this technology has a number of successes and failures in its actual application. The following is a detailed explanation of the results of the experiments conducted:

1. **Detection Successful**

Figure 4. Rambot detection in individuals

In the detection result image, the system successfully identified the individual's hair length accurately. Rambot showed the detection of 'long' hair when the hair exceeded the limit set in the forehead area, and detected 'short' hair

when the hair was within the limits according to the SOP rules. This success reflects the accuracy of the algorithm in distinguishing hair length, thus allowing consistent monitoring of student compliance.

2. Detection Failed

Detection fails when environmental conditions or user position do not meet the requirements set by the system. Factors such as poor lighting, the presence of more than one person in the frame, or the use of headwear can affect the accuracy of hair length detection. Here are some examples of cases where detection results are not optimal due to non-ideal conditions.

Figure 5. Rambot detection if there is more than one person

Rambot cannot detect more than one student if there are many students in the frame. Therefore, it must be ensured that only one student will appear in front of the camera for certainty of detection.

Figure 6. Rambot detection when using head accessories

Rambot cannot detect if students are wearing head accessories. In this case, wearing a black hat is considered hair.

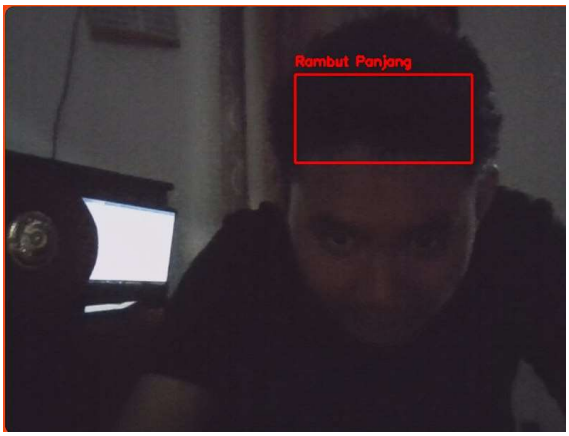

Figure 7. Rambot detection when there is a lack of light

Rambot cannot detect when in *low-light conditions* . In this case, the student's face is still detected, therefore a frame will appear on his head, but the hair is considered long because it is black.

Therefore, every user must fulfill the requirements and pay attention to Rambot's limitations before using it to get maximum results.

5. CONCLUSION AND SUGGESTIONS

This research successfully developed a web-based automatic hair length detection system called Rambot, using a region -*based segmentation approach* to support the implementation of Standard Operating Procedures (SOP) related to student hair length at the IPB Vocational School. This system is able to detect hair length accurately and consistently by basing detection on the forehead area as the main reference point. With Rambot, the supervision process becomes more efficient and objective, reducing the possibility of subjectivity that often occurs in manual supervision. This program also provides flexibility for students to verify their compliance with the rules independently and quickly through a web platform.

However, this system has some limitations, including the need for optimal lighting and proper user positioning for maximum detection results. External factors such as accessories or more than one person in the frame also affect detection accuracy. For further development, it is recommended to improve the segmentation algorithm to be more adaptive to variations in lighting conditions and user position, so that the system can operate better in dynamic environments . With these improvements, it is hoped that Rambot technology can be applied more widely in other educational institutions and support effective discipline improvement.

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