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HAAR CASCADE CLASSIFIER METHOD FOR REAL TIME FACE DETECTOR IN 2 DEGREE OF FREEDOM (DOF) ROBOT HEAD

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Abstract

Robotics technology is growing and advancing. The robot is a very important work for modern human life today to facilitate all human work. This era of robotics advances began to replicate the form and was able to mimic almost all human activities entirely, from robots that have a vision, deportations, and human-like movements. Research Robot Head 2 degree of freedom (DOF) for face detector in real-time use. The results obtained in the servo movement are angles to determine the detection of the captured face. For the real-time accuracy of the face detector in this study, the 3-student sample testing with the greatest precision was 95.25% with the fastest detection response time of 7 seconds.

Keywords: Raspberry Pi, face detector, Degree of freedom, Haar Cascade classifier, Robot head

1. Introduction

Robotics technology is growing. Robots are very important work for modern human life today to facilitate all human work. The Robot is created to replace the human role in work that requires speed and accuracy. The development of the robot world today will be focused on being a robot that has human-like features. In fact, it is hoped to have the ability to interact and behave like humanoid robots(Kumra & Kanan, 2017).

The world of robotics enters various facets of human life ranging from military, industrial, automation, entertainment, education as well as the medical field. The humanoid robot is one of the implementations in the world of robotics that can mimic various human activities. In research efforts to analyze the movement of the robot's head that detects the motion of the interlocutor and responds(Lee, 2012)(Prasetya et al., 2019a). Sensors are the senses for robots that can recognize various parameters around the environment, such as robots that can see using the camera or can be called with robot vision(Lasmono, Sari, Kuncoro, & Mujahidin, 2019).

The robotic advances to mobilize like a human being, the robot must have a human-like joint designed with a movement mechanism composed of several parts in a series that is connected to a shaft that moves and shifts that have a Degree of Freedom (DOF)(Marasco, Kim, Colgate, Peshkin, & Kuiken, 2011)(Prasetya et al., 2019b). In accordance with its function in the joint humanoid robot is very important because it uses the servo motor so it appears to resemble the human movement. The development of the robotics World Head Robot design is designed to combines branches of robotics science and computer vision with various methods used to detect or object recognition. The method to be used is the Haar Cascade Classifier for the face detector as the object captured by the camera with the 2 degree of freedom Movement on the servo motor as the control of the head movement to follow the camera's captured face(Mujahidin, Prasetya, Setywan, & Arinda, 2019)(Hidayatulail & Mujahidin, 2019). This humanoid robotic head robot's device can interact like a human in general by using face detection and implementing the Haar cascade classifier method on the robot head.

2. Research methods

In the design and manufacturing of robotic head tools there are several steps in testing that aims to determine the quality of the design that will be researched and in the analysis with the expectation of data on the performance of tools Useful for the future(Siswanto, Prasetya, Rachman, & Hidayatulail, 2019)(Mujahidin & Hidayatulail, 2019).

2.1 Block diagrams

The diagram block used for the face detection system for the design is divided into three stages as shown in Figure. The first image input was made resulting in an integral image of the new call, in the second stage of extraction characteristic was carried out using the Haar-based filter, and finally increased use for the development of the Cascade classifiers.

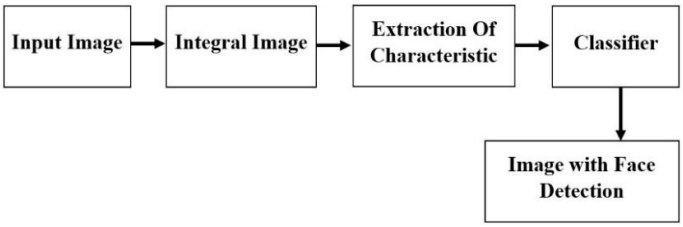


Fig. 1: Face Detection Diagram block

2.2 Integral Image

Integral Image is used to determine whether or not the sample exists within hundreds of features in an image quickly and with different scales efficiently.

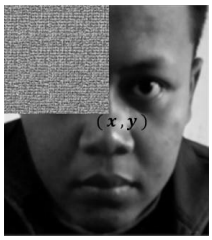


Fig. 2: Integral Image

Figure. 2 is the x, y location, contains the number of pixels from the top left of the image and can be counted as shown below:

$$ii(x,y) = \sum_{x' \le x, y' \le y} i(x', y') \quad (1)$$

Where II axis (x, y) is an integral image and I axis (x, y) is an original image.

2.3 Feature Extraction

In the image, the characteristic of the object is extracted by applying a specific function that allows the representation and description of the object to be interesting, this filter can be efficiently calculated on an integral image. In Figure. 3, for a two-dimensional object, which consists of light and dark, the next combinations of the box-shaped combinations will be used when detecting visual objects for better(Gerber et al., 2013)(Mujahidin et al., 2019).

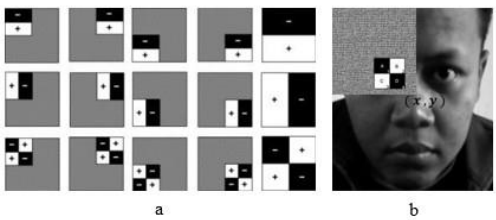


Fig. 3: (a). Haar Like Features (b). Haar Like Features with Integral Image

In Figure. 3, the Haar filter convolution with an integral image is displayed. From this operation, a characteristic can be extracted in a constant time on an integral image by adding and decreasing the vertex values for each rectangle(Sugiarto, Mujahidin, & Setiawan, 2019)(Mujahidin, Pramono, & Muslim, 2018). For greater clarity, on the image the number of pixels that make up a rectangle D can be counted as,

$$SumD = (4 + 1) - (2 + 3) \quad (2)$$

Where 1, 2, 3, 4, is the value given in the image that is integrated in that location.

2.4 Classifier

Analysis of an object in the form of an image in the Classifier detection stage defines a given set of characteristics this is a classification method that combines several basic classifications to form a more complex and accurate one the application of the Cascade classifications allows obtaining good results in Figure. 4, is a cascade classifications scheme.

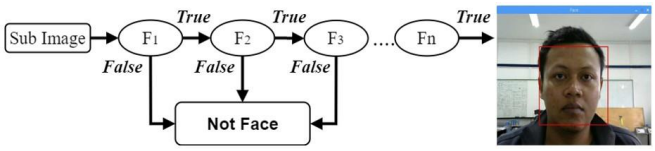


Fig. 4: Cascade Classifier

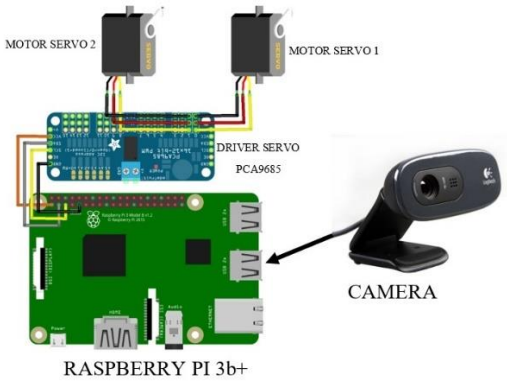
Figure. 4. is a classification process by using Cascade Classifier, the sub image is a picture image to be used will be done image detection does loop looking for a face model as much as Fn the loop process is performed as much as Fn if it is worth it Then immediately found the face model, otherwise the loop process will continue until the Fn(Otte, 2008)(Sugiarto et al., 2019).

2.5 Operation Planning.

In the Operation Planning that Indicates the whole system starts from the program start and initializing the Raspberry Pi port used, after which digital image data is detected by the camera, after the direct input image will be in process for determining the image detection area that has been Captured camera(Omran, Riha, & Dutta, 2013)(Mujahidin & Arinda, 2019). Object detection will be processed by face detection by using the Haar cascade classifier method to identify the object, directly after the object is detected otherwise the process repeats at determining the detection area if yes, the Raspberry Pi receives Data and sending head movement data. To move the servo part of the neck and head, on the neck if the detected object moves to the X axis if yes the servo motor moves towards the X axis and the head moves towards the left, otherwise the servo motor moves towards the x-axis and the head moves towards the right, on the head if the detected object moves to the Y axis if yes the servo motor moves towards the Y axis and the head moves towards the top otherwise the servo motor moves towards the y-axis and the head moves towards the bottom(S, Rabi', Minggu, & Mujahidin, 2019)(Kusuma, Prasetya, Kholid, & Mujahidin, 2019). The servo motor movement positions the camera that detects the object at the center position wherever the object is detected. Once the data processed output from the Raspberry Pi will be displayed on the monitor screen to display the camera captured image(Zhang, Y., Yasuno, T., D A Prasetya, 2013)(Pambudi, Maajid, Rohman, & Mujahidin, 2019).

2.6 Schematic Series

A network schematic that connects all the components designed in Figure 3.



Gambar. 5 Schematic Perancangan Sistem kendali Kepala Robot

Figure. 5 shows the Raspberry Pi hardware design as a mini PC, a camera connected to the available Raspberry Pi USB port, the PCA9685 motor driver for servo control connected to the GPIO pins on the Raspberry Pi and the servo motor for the drive on Humanoid robot head pre-installed on the servo driver PCA9685(Ardiansyah, Minggu, & Dirgantara, 2019)(Wibowo, Suprayogi, & Mujahidin, 2019) (D A Prasetya, T Yusano, 2012).

3. Results and analysis

This research performs analysis focusing on the tools implemented by retrieving data from the camera capture using the Haar Cascade Classifier method for the face detector and the position of the robot head.

3.1. Results

The Data that will be used for testing detects faces in real-time using the camera with a sampling of 3 different students to detect faces in table 1.

Table 1: Testing conducted with 3 students

No	Sample Testing	Distance (meters)	Time	Results	Accuracy
1	1st Student	1	7	Detected	95,25%
		2	7	Detected	
		3	7,79	Detected	
		4	7,83	Detected	
		5	7,89	Detected	
		6	16,36	Not Detected	
2	2nd Student	1	7,09	Detected	80,95%
		2	7,85	Detected	
		3	7,86	Detected	
		4	8,14	Not Detected	
		5	8,67	Not Detected	
		6	20,75	Not Detected	
3	3rd Student	1	7,34	Detected	85,71%
		2	7,49	Detected	
		3	7,64	Detected	
		4	7,99	Detected	
		5	8,72	Not Detected	
		6	9,81	Not Detected	

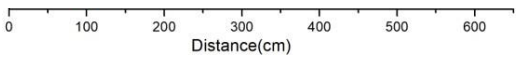


Fig. 6: Face Detection response graph

In Figure. 6 shows a face detection response from a table that shows the difference.

Fig. 7: Face Detection student Testing (a) results. Student 1st (a). Student 2nd (c). 3rd Student.

Figure. 7 is a result of facial detection on different students with the Haar cascade classifier method for robotic head detector(Kahn, Lum, Rymer, & Reinkensmeyer, 2006)(Alhamzawi, 2018)(Yuwono & Mujahidin, 2019)(D A Prasetya, EFA Phong Thanh Nguyen, Rinat Faizullin, Iswanto Iswanto, 2020)

3.2. Analysis

Trials of 1, 2 and 3 tests have the same high success rate that the 1st test has a face detection rate of 95.25%, the 2nd test has a face detection rate accuracy of 80.95%, and testing The 3rd has a face detection rate of 85.71%.The success rate of face detection is influenced by the face detection distance, for a 6-meters distance per student test of the 1.2, and 3 undetectable in each test. In the table, the time required to detect faces at a distance of 6 meters in each test is the longest. Failure in detection is also due to many factors Lighting, distance factor when detecting faces, and some images also have noise.

4. **Conclusion**

Based on analysis, the design and implementation of the face detection software can be concluded as follows:

- System can detect faces by using the Haar Cascade Classifier method well and quickly.
- Maximum detection rate is 6-meter with a longest face detection response of 20.75 seconds.
- The specifications the camera uses will affect the accuracy and speed of the system detecting.
- Highest accuracy rate is 90.25% of all experiments.

5. **References**

Alhamzawi, H. A. M. (2018). Faces and eyes Detection in Digital Images Using Cascade Classifiers. *Computer Engineering and Applications Journal*. https://doi.org/10.18495/comengapp.v7i1.222

Ardiansyah, N. F., Minggu, D., & Dirgantara, W. (2019). Computer Vision Untuk Pengenalan Obyek Pada Peluncuran Roket Kendaraan Tempur. *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*, *1*(1), 28–37.

Gerber, N., Gavaghan, K. A., Bell, B. J., Williamson, T. M., Weisstanner, C., Caversaccio, M. D., & Weber, S. (2013). High-accuracy patient-to-image registration for the facilitation of image-guided robotic microsurgery on the head. *IEEE Transactions on Biomedical Engineering*. https://doi.org/10.1109/TBME.2013.2241063

Hidayatulail, B. F., & Mujahidin, I. (2019). Potential OF 77, 78 mW Red Diode Laser For Photodynamic. *JEEMECS (Journal of Electrical Engineering, Mechatronic and Computer Science)*, *2*(2).

Kahn, L. E., Lum, P. S., Rymer, W. Z., & Reinkensmeyer, D. J. (2006). Robot-assisted movement training for the stroke-impaired arm: Does it matter what the robot does? *Journal of Rehabilitation Research and Development*. https://doi.org/10.1682/JRRD.2005.03.0056

Kumra, S., & Kanan, C. (2017). Robotic grasp detection using deep convolutional neural networks. *IEEE International Conference on Intelligent Robots and Systems*. https://doi.org/10.1109/IROS.2017.8202237

Kusuma, D. F. C., Prasetya, D. A., Kholid, F., & Mujahidin, I. (2019). Evaluasi Database Senjata Untuk Sistem Keamanan Menggunakan Fuzzy Logic. *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*, *1*(2), 111–116.

Lasmono, J., Sari, A. P., Kuncoro, E., & Mujahidin, I. (2019). Optimasi Kerja Peluncur Roket Pada Robot Roda Rantai Untuk Menentukan Ketepatan Sudut Tembak. *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*. https://doi.org/10.26905/jasiek.v1i1.3149

Lee, J. D. (2012). Image Noise. In *Brigham Young Robotic Vision Class*.

Marasco, P. D., Kim, K., Colgate, J. E., Peshkin, M. A., & Kuiken, T. A. (2011). Robotic touch shifts perception of embodiment to a prosthesis in targeted reinnervation amputees. *Brain*. https://doi.org/10.1093/brain/awq361

Mujahidin, I., & Arinda, P. S. (2019). Antena Compact Double Square Marge 2, 6GHz Dengan Output Perbedaan

Fase 90 Derajat Untuk Aplikasi LTE. *JEECAE (Journal of Electrical, Electronics, Control, and Automotive Engineering)*, *4*(2), 273–278.

Mujahidin, I., & Hidayatulail, B. F. (2019). 2.4 GHz Square Ring Patch With Ring Slot Antenna For Self Injection Locked Radar. *JEEMECS (Journal of Electrical Engineering, Mechatronic and Computer Science)*, *2*(2).

Mujahidin, I., Pramono, S. H., & Muslim, A. (2018). *5.5 Ghz Directional Antenna with 90 Degree Phase Difference Output*. https://doi.org/10.1109/eeccis.2018.8692872

Mujahidin, I., Prasetya, D. A., Setywan, A. B., & Arinda, P. S. (2019). Circular Polarization 5.5 GHz Double Square Margin Antenna in the Metal Framed Smartphone for SIL Wireless Sensor. *2019 International Seminar on Intelligent Technology and Its Applications (ISITIA)*, 1–6. IEEE.

Omran, Y., Riha, K., & Dutta, M. K. (2013). Automatic estimation of the arterial parameters in Ultrasound video sequence. *2013 36th International Conference on Telecommunications and Signal Processing, TSP 2013*. https://doi.org/10.1109/TSP.2013.6614056

Otte, M. W. (2008). A Survey of Machine Learning Approaches to Robotic Path-Planning. *International Journal of Robotics Research*. https://doi.org/10.1109/ICALIP.2016.7846622

Pambudi, A. E., Maajid, L., Rohman, J., & Mujahidin, I. (2019). Aplikasi Penggunaan Joystick Sebagai Pengendalian Remote Control Weapon Station (RCWS) Senjata Mesin Ringan (SMR). *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*, *1*(2), 98–105.

Prasetya, D. A., Sanusi, A., Chandrarin, G., Roikhah, E., Mujahidin, I., & Arifuddin, R. (2019a). Community Culture Improvisation Regarding Waste Management Systems and Per Capita Income Increase. *Journal of Southwest Jiaotong University*, *54*(6).

Prasetya, D. A., Sanusi, A., Chandrarin, G., Roikhah, E., Mujahidin, I., & Arifuddin, R. (2019b). Small and Medium Enterprises Problem and Potential Solutions for Waste Management. *Journal of Southwest Jiaotong University*, *54*(6).

S, T. A., Rabi', A., Minggu, D., & Mujahidin, I. (2019). Frequency Hopping Video Real Time Untuk Pengamanan Data Pengintaian Operasi Inteligence TNI. *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*. https://doi.org/10.26905/jasiek.v1i1.3146

Siswanto, S., Prasetya, D. A., Rachman, N., & Hidayatulail, B. F. (2019). Pengendali Robot Beroda Berbasis Sensor Telemetri Voice Pattern Recognition. *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*. https://doi.org/10.26905/jasiek.v1i1.3147

Sugiarto, S. K., Mujahidin, I., & Setiawan, A. B. (2019). 2, 5 GHz Antena Mikrostrip Polarisasi Circular Model Patch Yin Yang untuk Wireless Sensor. *JEECAE (Journal of Electrical, Electronics, Control, and Automotive Engineering)*, *4*(2), 297–300.

Wibowo, M., Suprayogi, S., & Mujahidin, I. (2019). Rancang Bangun Sistem Pengamanan Rak Senjata M16 Menggunakan Rfid Dan Fingerprint. *JASIEK (Jurnal Aplikasi Sains, Informasi, Elektronika Dan Komputer)*, *1*(2), 134–142.

Yuwono, R., & Mujahidin, I. (2019). Rectifier using UWB microstrip antenna as electromagnetic energy harvester for GSM, CCTV and Wi-Fi transmitter. *Journal of Communications*. https://doi.org/10.12720/jcm.14.11.1098-1103

D A Prasetya, EFA Phong Thanh Nguyen, Rinat Faizullin, Iswanto Iswanto, "Resolving the Shortest Path Problem using the Harversine Algoritm," in Journal of critical reviews 7 (1), 62-64, 2020.

Zhang, Y., Yasuno, T., D A Prasetya, "Adaptive walking for quadruep robot on irreguler terrain by using CPG network," in 52nd Annual Conference of the Society of Instrument and Control Engineering of Japan, Pages 1734-1737,2013.

D A Prasetya, T Yusano, "Cooperative control of multiple mobile robot using particle swarm optimization for tracking two passive target," in Proceeding of SICE Annual Conference (SICE), 1751-1754, 2012.