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Multi-task Cascaded Convolutional Neural Network Face Recognition in Robot SAR (Socially Assistive Robot)

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ABSTRACT

This study intends to create a Face Recognition system for a Socially Assistive Robot (SAR) created especially for autistic youngsters. Autism is a developmental disease that has varied degrees of impact on social interaction, speech, and behavior. In order to address the developmental deficits in autistic children, early intervention is essential. Children with autism require the right kind of therapy to help them manage their anxiety, develop their social skills, and sharpen their concentration. In this study, Multi-task Cascaded Multi-task Cascaded Convolutional Neural Network (MTCNN) facial recognition technology is used to classify and identify the emotions of autistic children. The technology has the ability to record and recognize children's faces, gauge a child's level of autism, categorize their emotions, and offer the proper support. Previous studies have indicated that it is possible to identify children with autism through their facial expressions. It is anticipated that by using Face Recognition technology on a SAR, autistic youngsters will make progress in their treatment and will feel better emotionally and be more motivated. This research serves as a foundational step in the creation of technologies that can improve the quality of life for kids with autism.

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1. INTRODUCTION

Autism is a developmental disability that affects socialization abilities, communication, and attitudes. It can range in severity from mild to severe and is typically identified before a child turns three years old. Children with autism struggle with social interaction, verbal and nonverbal communication, emotional limitations, and sensory-perceptual issues. For children with autism to catch up on age-appropriate growth delays, early therapy is crucial. In order to expedite therapy and shorten recovery times, early detection and intervention are crucial [1].

Three primary categories—Autism Spectrum Disorder (ASD), Asperger Syndrome, and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS)—are used to classify children with autism. Each variety has unique traits, such as the tendency of children with ASD to act out and have trouble being quiet, whereas children with Asperger syndrome have trouble reacting to their surroundings but can engage effectively after lengthy conversations. Children with PDD-NOS can make eye contact, but they struggle to communicate. Additionally, there are three levels of symptom intensity that can be used to categorize autism [2].

The function of robots, especially SAR (Socially Assistive Robot) robots, is to replace human tasks, entertain or become a means for human health, especially for the emotional health of autistic children who have varying levels of anxiety and high fear so that they can create feelings who are uncomfortable and can make themselves more aggressive, like to hurt themselves and throw tantrums for no reason marked by a rapid heartbeat and body temperature that can fluctuate. Heart rate and body temperature rate are essential vital sign parameters for paramedics to determine a child's health [3].

Children with autism must receive therapy in order to improve their ability to communicate, interact with others, and pay attention. In order to provide these children with a secure and comfortable environment, therapy that is appropriate for their level of autism is required [3]. A SAR (Socially Assistive Robot) Robot with a Face Recognition system based on the Multi-task Cascaded Convolutional Neural Network (MTCNN) can help to categorize facial expressions, Autism levels, and provide the right support to kids with Autism. SAR robots offer close and effective engagement for the teaching, recovery, and rehabilitation of autistic children [4].

With great accuracy in identifying different emotions on autistic children's faces, research on the detection method for early signs of tantrums in children with autism using facial expressions has produced promising findings. This solution has a 100% success rate and a quick response time for sending notifications using Telegram bots. The SAR Robot's integration of face recognition technology offers a potential solution for making treatment for autistic children more enjoyable and comfortable while also giving them the emotional support they need to be enthusiastic about recovering from their illness [5].

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2. THE COMPREHENSIVE THEORETICAL BASIC

2.1. Raspberry PI 4

It is envisaged that using SAR, facial recognition, and MTCNN techniques, it will be possible to classify and identify children with autism and detect their emotional expressions on their faces. With the aid of this technology, it is anticipated that children with autism will get better care and support, enabling them to overcome obstacles and enhance their general quality of life [6].

Model A and Model B of the Raspberry Pi are the two available models. 512MB RAM Raspberry Pi model B, in general. Models A and B differ from one other in that model A uses 256 MB of RAM while model B uses 512 MB. Additionally, the model B has an ethernet port (network card) that the model A does not have. Because the operating system is contained on an SD Flash Card, it is relatively simple to exchange and replace. It has been used as a multimedia player with streaming capabilities, a gaming computer, an internet browser, and a mainboard for hardware development. However, its full potential has not yet been realized [18], [7].

2.2. Arduino UNO

The GY-906 sensor is an infrared sensor for non-contact temperature measurement. The signal conditioner integrated into the MLX90614 is a low noise amplifier, 17-bit ADC and a robust DSP unit that achieve the great accuracy and resolution of a thermometer. The MLX9061 sensor has 2 outputs: near temperature and object temperature. The MLX9061 sensor material integrates an infrared sensitive thermal sensor as well as an ASIC signal conditioning chip into the TO39 sensor housing. Signal conditioning takes the form of a low-noise amplifier, 17-bit ADC, and powerful DSP, providing high-resolution, high-precision thermometers. The sensor is calibrated with a SMBus digital output and measures the entire temperature range with a resolution of 0.02°C. The sensor can measure near temperatures from -40 to 125°C as well as object temperatures from -70 to 380°C [9], [10].

2.3. Arduino UNO

Using straightforward input/output (I/O) circuits and a development environment that supports the Processing programming language, Arduino is an open source physical computing platform [8]. You can use Arduino to create interactive independent objects or you can connect it to computer applications like Flash, Processing, VVVV, or Max/MSP. The sets are available for purchase or manual assembly. Open source software makes up the Arduino IDE (Integrated Development Environment) [19], [20].

2.4. MTCNN (Multi-task Cascaded Convolutional Neural Network)

Technique of recognizing (verifying) a known or unknown facial image using an algorithm, such as computing, and comparing it to existing facial data is known as face recognition or facial recognition [10]. The fundamental idea behind face recognition is to extract distinct facial information (facial contours), encode it, and then compare the findings to those of earlier decoding efforts. The Eigenface technique [11] is used. Multi-task Cascaded Convolutional Neural Networks (MTCNN) are among the most widely used techniques in image processing. In this study, data is trained using MTCNN to enable it to recognize data presented as SIBI numbers. It is hoped that utilizing MTCNN will enable higher accuracy values to be produced with minimal loss [4].

Face detection is one of the phases in face recognition that must be accomplished. In this study, the Multi-Task Cascaded Convolutional Neural Network (MTCNN) is the face detection technique used. The reason MTCNN is so popular is that it performs well on a variety of product datasets. The MTCNN approach may also identify face characteristics like the lips and eyes, which is referred to as landmark detection. A cascade structure is used by MTCNN. When numerous networks cooperate in a cascade, the output of the first network serves as the input for the next network, and so on. Figure 1 depicts the MTCNN's general structure. The provided image was scaled into a number of different scales based on Figure 1, which are then referred to as image pyramids. The image then follows the cascade structure in the subsequent three steps [16].

2.5. Face Recognition

Facial detection is a necessary step in the process of doing facial recognition. The Multi-Task Cascaded Convolutional Neural Network (MTCNN) is one of the deep learning techniques used to do facial recognition [17]. The representation of a face with intact body components serves as its physical embodiment. Iván de Paz Centeno's MTCNN project, which was employed in the testing phase, offered the library [17]. As illustrated in Figure 4, a selection of the captured images is made to be cropped in the face region using the MTCNN technique. The goal of this stage is to collect the most facial data possible for use in the face embedding procedure.

2.6. Image Processing

Image processing entails digitizing an image and applying various procedures to it in order to extract some valuable information from it. When using specific specified signal processing techniques, image processing systems typically interpret all images as 2D signals [12], [13].

Each pixel of the image must undergo a specific series of actions in order to process it. The initial series of actions are carried out pixel-by-pixel by the image processor on the

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image. When this processing is finished, it moves on to the next operation and so forth. At each pixel of the image, the output value of these processes may then be determined [14], [15], and [13].

3. RESEARCH METHOD

When developing electrical circuits, the author first designs the circuit before assembling all the components so they may be programmed. With Arduino Uno and Raspberry PI 4 integrated, Arduino manages servo control and Raspberry manages picture processing. Arduino then orders the servo to move after it has been read, for example by calling a name that reads and causes the servo to move.

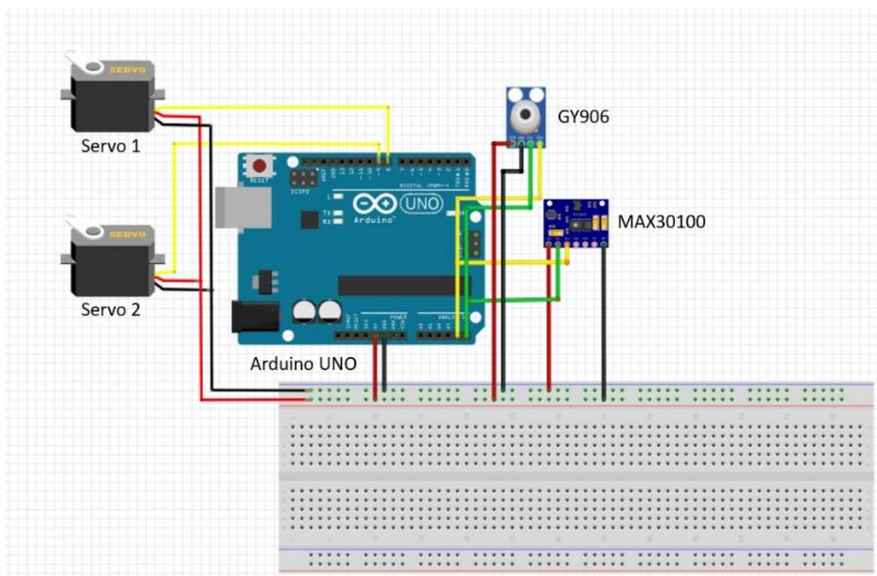

Figure 1. Schematic of the Raspberry PI 4, Arduino, Camera and Servo Motor circuits

One of the most crucial components in the design of a gadget is the block circuit diagram. The workings of the circuit as a whole can be deduced from the block diagram. In order for the entire block circuit diagram to create a system that can operate according to the guiding principles of a tool's design. A Socially Assistive Robot (SAR) for children with leukemia is depicted in block form in Figure 2.

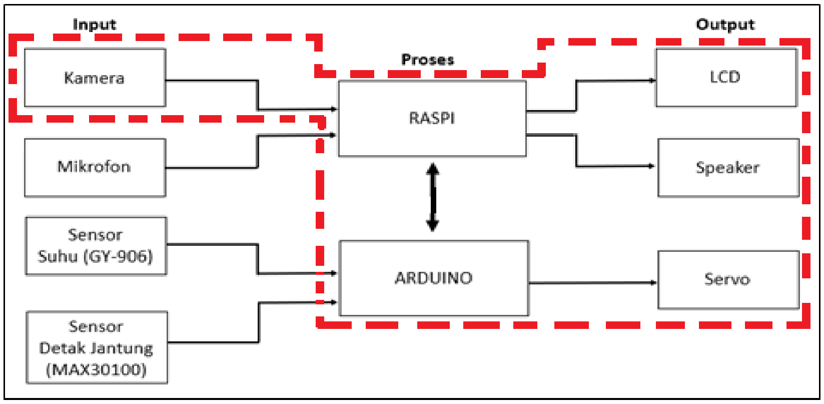

Figure 2. Block diagram Socially Assistive robot for children with Autism Spectrum Disorder

Then the flowchart or flowchart of the tool's process from its inception till it is deemed complete will show how a tool functions. Making a flowchart is something that needs to be done in the design to make reading easier.

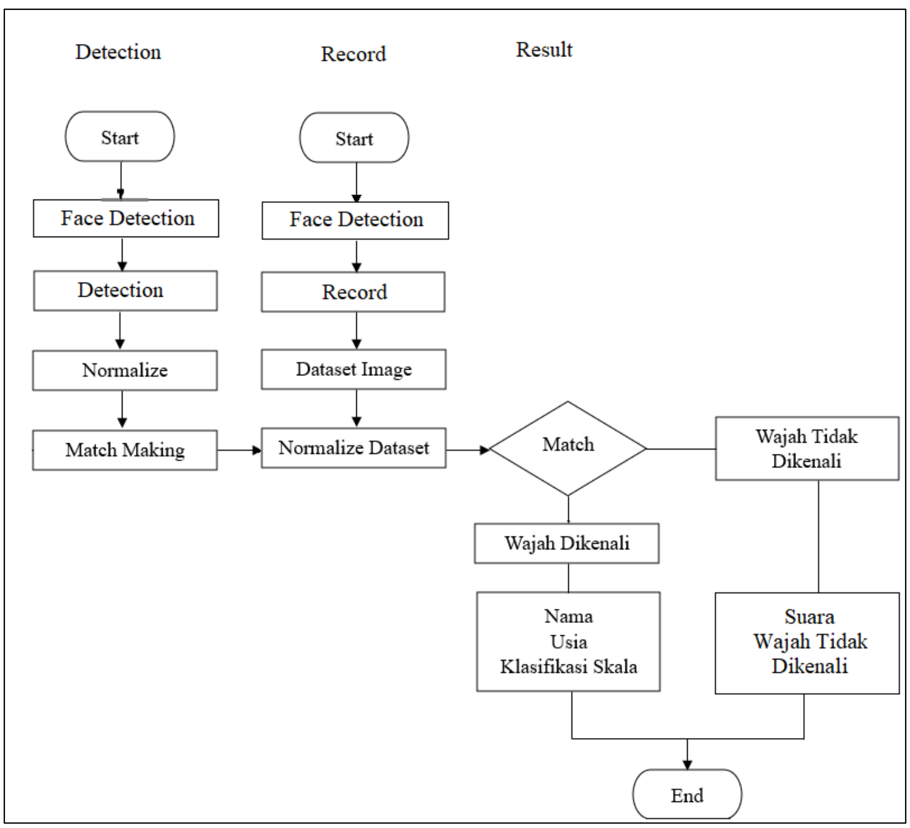

Figure 3. Flowchart of Face Recognition Socially Assistive Robot

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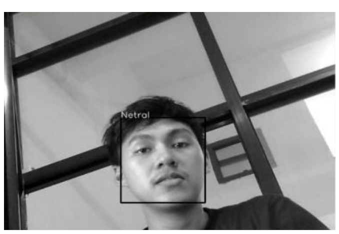
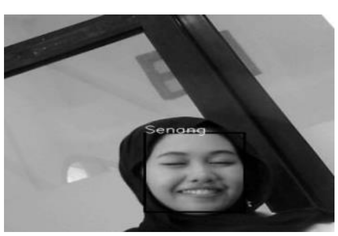
Face Recognition Flowchart: First, the Record detects the face, which is then entered into the Dataset Image, followed by Match Making. Both Face Detections find faces, normalize them, enter Match Making, and then compare the findings. If both are successful, Name, Age, Classification, and Scale will appear; if not, Unrecognized Faces will.

4. RESULT AND DISCUSSION

4.1. Face Recognition Data Test

Goal of this investigation is to put the SAR Robot's facial recognition technology to the test. In this experiment, a robot is tested to see if it can detect children's facial emotions. The test findings are presented as data testing data measurement on SAR robots for face recognition.

Table 1. Face Recognition Data to Determine Face Expressions

Child	Photo	Expression	Success Presentation
		Happy	
1.		Angry	60%
		Neutral	
2.		Happy	100%

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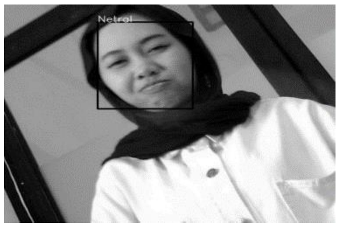
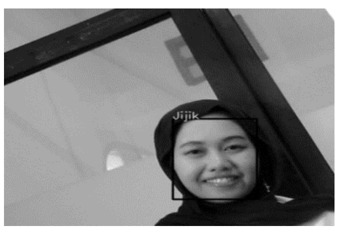
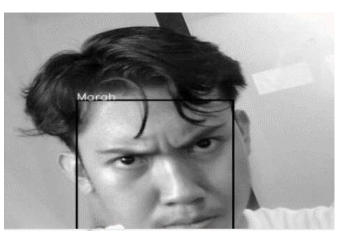
3.		Angry	80%
		Neutral	
		Afraid	
		Disgusted	
		Happy	
		Angry	

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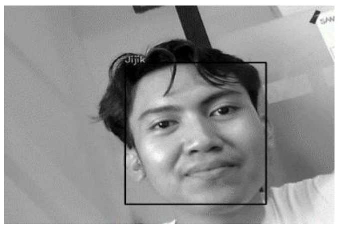
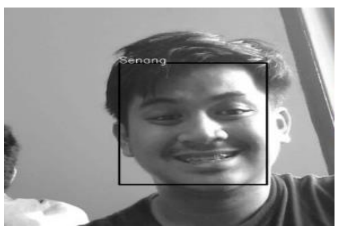
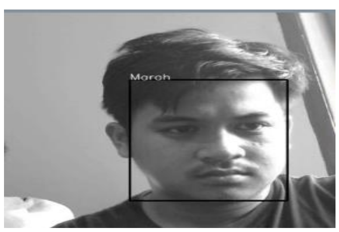
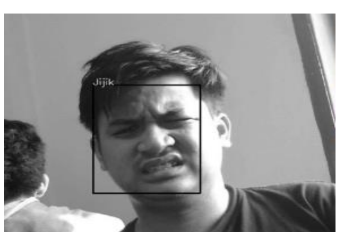
<table>
<tr><td rowspan="6">4.</td><td></td><td>Neutral</td><td rowspan="6">80%</td></tr>
<tr><td></td><td>Disgusted</td></tr>
<tr><td></td><td>Happy</td></tr>
<tr><td></td><td>Angry</td></tr>
<tr><td></td><td>Neutral</td></tr>
<tr><td></td><td>Disgusted</td></tr>
</table>

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		Happy	
5.		Afraid	60%
		Disgusted	

Capacity of the SAR robot to recognize facial expressions is made while using the robot as a medium to determine how the child is feeling through their facial expressions, as shown in Table 1. To prevent additional faces from being recognized on the robot during this study, it was conducted in a space that was not very crowded. As indicated in table 1, the researcher gathered test data on the robot by gathering information on a number of expressions.

Proportion of success in reading expressions is shown in table 1, and the researcher discovered that some facial expressions were marginally difficult to understand since the object of the reading was frequently changing and not always silent.

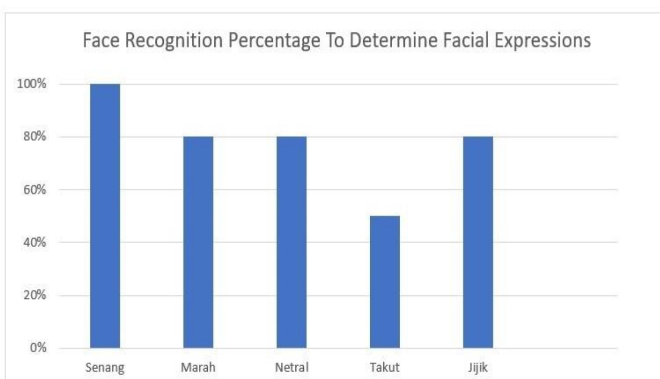

Figure 3 Percentage Face Reconition to Determine Face Expressions

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In order to make the data chart for the facial emotion detection testing easier to understand, brick diagrams are used in Figure 4. facial expressions are shown on the x-axis, while the robot recognition rate is shown on the y-axis. In order to make the data chart for the facial emotion detection testing easier to understand, brick diagrams are used in Figure 4. facial expressions are shown on the x-axis, while the robot recognition rate is shown on the y-axis.

Graph demonstrates that it is fairly simple to identify numerous happy facial expressions. while being slightly lessened when disgust, neutral, and angry expressions are detected. Fear, on the other hand, is a little more challenging to identify because, when tested, a little reads as repulsed.

5. CONCLUSION

From The study's finding is that while employing the robot, the SAR robot can distinguish and detect the facial expressions of kids with autism. The study's findings demonstrate how simple statements like "happy" are incredibly simple to read. In addition, some facial expressions, such as those of dread, are challenging to read.
Robot successfully recognizes a cheerful expression with a 100% success rate. With an 80% success rate, the robot was able to recognize it in expressions of disgust, neutrality, and fury. While the robot had a 50% success rate in identifying the expression of dread because it repeatedly picked up the appearance of happiness when the expression of fear was there.
Result, this study comes to the conclusion that the robot's ability to read face expressions is determined by facial expressions. This research offers crucial insights for the improvement of SAR robots' performance and efficacy in identifying and detecting facial expressions in autistic youngsters.

REFERENCES

[1] S. M. Rahayu, "Deteksi dan Intervensi Dini Pada Anak Autism," Jurnal Pendidikan Anak, vol. 3, no. 1. 2015. doi: 10.21831/jpa.v3i1.2900.
[2] B. A. B. Ii and T. Pustaka, "BAB II Tinjauan Pustaka BAB II Tinjauan Pustaka 2.1," no. 2020, pp. 1–64, 2002.
[3] J. Fisika, F. Sains, and U. I. N. A. Makassar, "A . Klasifikasi Umum Robot Berdasarkan fungsinya Gambar 1 Robot berdasarkan fungsinya Berdasarkan sifatnya," vol. 1, pp. 82–93, 2014.
[4] M. B. S. Bakti and Y. M. Pranoto, "Pengenalan Angka Sistem Isyarat Bahasa Indonesia Dengan Menggunakan Metode Convolutional Neural Networkk," Semin. Nas. Inov. Teknol., pp. 11–16, 2019.
[5] D. R. Salsabila, R. Aisuwarya, N. P. Novani, L. Arief, and N. Afriyeni, "JITCE (Journal of Information Technology and Computer Engineering) Sistem Pendeteksi Gejala Awal Tantrum pada Anak Autisme Melalui Ekspresi Wajah dengan Convolutional Neural Network," Jitce, vol. 02, pp. 93–106, 2021, [Online]. Available: http://jitce.fti.unand.ac.id.

[6] M. A. I. Hakim and Y. H. Putra, "Pemanfaatan Mini Pc Raspberry Pi Sebagai Pengontrol Jarak Jauh Berbasis Web Pada Rumah. Unikom," Jur. Tek. Komput. Unikom, no. September 2015, pp. 1–6, 2013, [Online]. Available: https://www.researchgate.net/profile/Yeffry_Handoko_Putra/publication/312040113.
[7] B. A. Pramono, A. Hendrawan, and A. F. Daru, "Raspberry Pi Dengan Modul Kamera Dan Motion Sensor Sebagai Solusi Cctv Lab Ftik Univ. Semarang," J. Pengemb. Rekayasa dan Teknol., vol. 14, no. 1, p. 5, 2019, doi: 10.26623/jprt.v14i1.1213. [8] S. K. Galkwad, B. W. Gawali, and P. Yannawar, "A review On Speech Recognition Technique," Int. J. Comput. Appl., vol. 10, no. November, p. 3, 2010.
[8] M. Ulfah, "Menggunakan Sensor Gy-906 Dan Esp32 Cam," Jurnal Pendidikan Teknologi Informasi (JUKANTI), no. 5, pp. 2621–1467, 2022.
[9] Alldatasheet.com, No Title. [Online]. Available: https://www.alldatasheet.com/view.jsp?Searchword=Mg995datasheet&gclid=Cj0KCQjwlPWgBhDHARIsAH2xdNcQNstXcDVpFr38yNYqcin0jhtzBWQHSpZIw1orw7dyNWMGI39TWmgaAhJ-EALw_wcB.
[10] Derisma, "Faktor-Faktor yang Mempengaruhi Sistem Pengenalan Wajah Menggunakan Metode Eigenface pada Perangkat Mobile Berbasis Android," J. Komput. Terap., vol. 2, no. 2, pp. 127–136, 2016, [Online]. Available: http://jurnal.pcr.ac.id.
[11] Y. Primatama, A. E. Rhamadani, F. D. Ramtomo, D. Cahya, and P. Buani, "Menggunakan Pemindai Wajah Berbasis Android," pp. 59–65, 2018.
[12] M. Egmont-Petersen, D. de Ridder, and H. Handels, "Image processing with neural networks - a review," Pattern Recognit., vol. 35, pp. 2279–2301, 2002.
[13] G. J. Awcock and R. Thomas, Applied image processing. Springer, 1995.
[14] J. D. Kothari, "A Case Study of Image Classification Based on Deep Learning Using Tensorflow," Papers.Ssrn.Com, no. April 2018, 2018.
[15] F. Ertam, "Data classification with deep learning using tensorflow," in 2nd International Conference on Computer Science and Engineering, UBMK 2017, 2017. doi: 10.1109/UBMK.2017.8093521.
[16] Basjaruddin, Noor Cholis, et al. "Attendance System with Face Recognition, Body Temperature, and Use of Mask using Multi-Task Cascaded Convolutional Neural Network (MTCNN) Method." Green Intelligent Systems and Applications 2.2 (2022): 71-83.
[17] Zhang, K.; Zhang, Z.; Li, Z.; Qiao, Y. (2016). Joint Face Detection and Alignment using Multitask Cascaded Convolutional Networks. IEEE Signal Processing Letters, 23 (10), 1499-1503, https://doi.org/10.1109/LSP.2016.2603342.
[18] Ilfan Sugianda and Thamrin, "Perancangan Sistem Deteksi Objek Pada Robot Kr Sbi Berbasis Mini Pc Raspberry Pi 3," Jurnal Teknologi Informasi dan Pendidikan , 2019.
[19] Thamrin, Delsina Faiza, and Ilmiyati Rahmy Jasril, "Rancang Bangun Alat Pengaduk Bubur Otomatis Menggunakan Sensor Suhu Berbasis Arduino Uno" Jurnal Teknologi Informasi & Pendidikan, vol. 10, 2017.
[20] R. Devita, R. Hartika Zain, and T. Syafriani, "Pengontrolan Pola Dancing Fountain Berirama Music Menggunakan Android Berbasis Mikrokontroler Arduino" Jurnal Teknologi Informasi dan Pendidikan, vol. 13, no. 1, 2020, doi: 10.24036/tip.v13i1.

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