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Face Mask Detection using Haar Cascade Classifier Algorithm based on Internet of Things with Telegram Bot Notification

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***Abstract*—The lack of public awareness of wearing masks during the COVID-19 pandemic is one of the causes of the high number of Covid-19 cases in Indonesia. Since the beginning of June 2020, the government has set a New Normal phase. This is done to restore the economy and prevent the spread of the COVID-19 pandemic. During New Normal, activities can still run by implementing health protocols by requiring masks to be worn. Currently, the detection of masks is still done manually by security officers because of the fatigue factor, so that human errors often occur. To overcome this, an automatic system is needed to detect people wearing masks and not wearing masks. In this study, a mask detection system was made using the haar cascade classifier method by utilizing machine learning, image processing, and the internet to facilitate connectivity. The result of this research is an internet of things-based mask detection system using the haar cascade classifier method that runs on a raspberry pi to monitor and distinguish between people with masks and not masks in various light conditions with the help of an additional IR (Infrared) module on the camera. If a person is detected who is not wearing a mask, the program will automatically capture it, and an alarm will sound and send the captured results to the telegram bot. The resulting performance is when the video stream reaches 12-60 fps, the system can run well without stuttering even during the video stream. The connection speed to the telegram bot got excellent results without any delay with an average time of 0.001695977 seconds with a maximum detection distance of 1.2 meters.**

Keywords—Covid-19, Haar cascade, Internet of Things, Masker Detektor, Telegram.

I. INTRODUCTION

The lack of public awareness of wearing masks in the era of the COVID-19 pandemic is one of the causes of the widespread COVID-19 in Indonesia. Masks during this pandemic have become mandatory items for use in various agencies, organizations, and public spaces to prevent the spread of COVID-19 [1], [2]. The government as a policymaker enforces a new regulation, namely the IMR (Adaptation of New Habits) [3] or often called the new normal so that during a pandemic, people can still carry out activities on condition that they comply with health protocols. Based on the call from the governor of DKI Jakarta Number 9 of 2020 regarding the use of masks to prevent Coronavirus disease 2019 (COVID 19) [4], a circular from the Ministry of Health of the Republic of Indonesia [5] regarding the use of masks and the provision of handwashing facilities with soap (CTPS) and Presidential Instruction president [6] Number 6 of 2020 concerning increasing discipline and law enforcement of health protocols in the prevention and control of Corona Virus Disease 2019 (COVID-19), the use of masks in daily activities is significant as a way to prevent the spread of the COVID-19 virus. 19 through splashes when sneezing or coughing between humans [7]. The face detection system for mask users is an effort so that everyone always uses a mask.

Several face detection algorithms such as You Only Look Once with a smaller version (YOLOv3-Tiny) studied by [7], Faster R-CNN by [8], and Convolutional Neural Network (CNN) has been proposed by researchers [9] and [10] in face detection of mask users.

YOLO v3 Tiny has advantages in precision and light in some aspects, very good for object detection. To get maximum results, we need data that has been augmented before the training process so that the accuracy generated will be more accurate. However, the depth of convolutional layers is reduced so that YOLOv3-tiny cannot do multi-scale, the training process takes a long time, so it requires a higher computer architecture [7].

CNN has advantages in accuracy and slight training loss close to 0 but requires a long time in the training process, and the value of the learning rate should not exceed 10^{-4} because there will be overfitting besides CNN has problems in performance [9].

Faster R-CNN has advantages in speed but requires a long time to do training because selective search is needed to generate 2000 proposals per image. In Faster R-CNN, selective search is changed using RPN (Region Proposal Network) so that the main architecture of Faster R-CNN is Fast R-CNN and RPN [8].

In this study, the Haar Cascade Classifier algorithm [11] will be tried to be applied in the detection of the use of masks. The Haar Cascade Classifier algorithm was chosen because it has advantages in a speedy computational process. After all, it

has an effective way of working because it only depends on the number of pixels in a square (rectangular), not every pixel of an image [12]. Furthermore, the current use of Internet of Things (IoT) technology can answer the difficulties of system installation when using cables [13] so that the application of this algorithm will use IoT technology.

The mask detection system that will be made uses the python programming language with the OpenCV library, which detects faces. OpenCV there are various methods and algorithms for image processing [14]. The program created will then be run on the Raspberry Pi to detect whether people are wearing masks or not. If the person is not wearing a mask, a notification will be sent via telegram.

II. Related Work

In research [10], the algorithm for mask detection used is Convolutional Neural Network (CNN) which is implemented on raspberry pi. The system made can run well, but in terms of video streaming performance, it only reaches 20-30 fps, so that the resulting display is a little slow (lag) due to limited memory on the raspberry used, besides the accuracy of the detector mask decreases when in low light conditions.

In research [9], the algorithm used is the same as research conducted by [10] using the Convolutional Neural Network (CNN) algorithm with a sample size of 2000 where 95.2% was used at the training stage, and 4.8% was used at the testing stage to obtain an accuracy value. By 0.9933% and training loss 0.0213%. The weakness in this study is the detection distance which only reaches 2.3 meters.

In research [7], the algorithm used is You Only Look Once (YOLO), a small version, namely Yolo v3-Tiny. Even though it uses a reasonably minimal architecture, it gets good accuracy results and can still be maximized with data sets that have been segmented before the training process.

In previous studies for mask detection, no one has used the haar cascade classifier algorithm. This study uses the Haar Cascade Classifier algorithm integrated with an external camera and IR (Infra-Red) module on the Raspberry Pi device. The capture of the device that detects an unmasked face will be sent via the telegram bot automatically.

III. Methodology

Figure 1 shows the stages of the study consists of five steps: data collection, architectural design, system requirements, deployment, and testing.

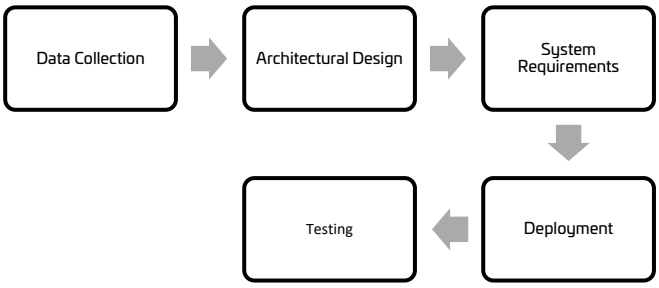

Fig. 1 Methodology

A. Data Collection

1. Problem Identification

The lack of public awareness of wearing masks during the COVID-19 pandemic is one of the causes of the high number of Covid-19 cases in Indonesia. However, security officers still detect masks manually because of fatigue, so human error often occurs [15]. To overcome this, an automatic system is needed to detect people wearing masks and not wearing masks. Several previous related studies related to face mask detectors have their respective advantages and disadvantages with the various algorithms used. The system can run well, but some still have shortcomings in performance, detection speed, accuracy, light conditions, and distance.

2. Literature Study

The research data was obtained through literature study and observation with direct observations obtained from national and international journals in survey papers and technical papers.

B. Architectural Design

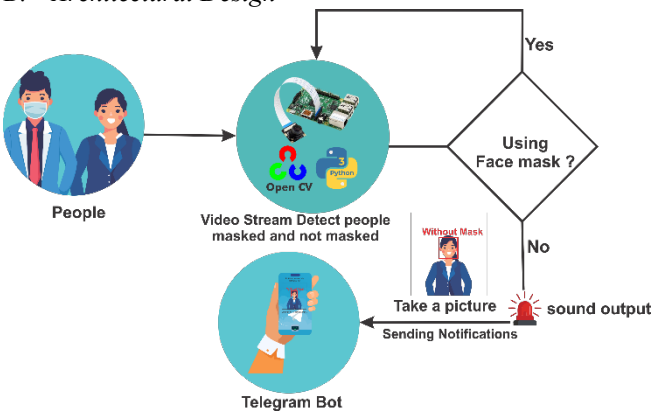

Fig. 2 Architectural Design

The architectural design can be seen in Figure 2. The human object is in front of the sensor and then detects whether the person is wearing a mask or not. If detected using a mask, the system is redirected back to the detection sensor. However, notifications and photos will be sent via Telegram Bot if not using a mask is detected.

Telegram Bot is a program that can respond to a chat, chat or command with additional functions equipped with artificial intelligence according to the desired configuration. The way to configure telegram bot is by getting API and token obtained from @botfather. Telegram bots can do anything like being an alert notification, search, link, reminder, and more [16].

C. System Requirements

The stage is to define the software and hardware requirements so that the system made runs well and the defined goals are achieved.

Figure 3 shows the camera module used on the raspberry pi, which is equipped with 2 IR (Infrared) sensors with the following specifications:

1. Sensor : OV5647
2. Pixels : 5 megapixels
3. CCD size : ¼ inch

4. Aperture (F) : 1.8
5. Focal Length : 3.6mm adjustable
6. Diagonal angle : 60 degree

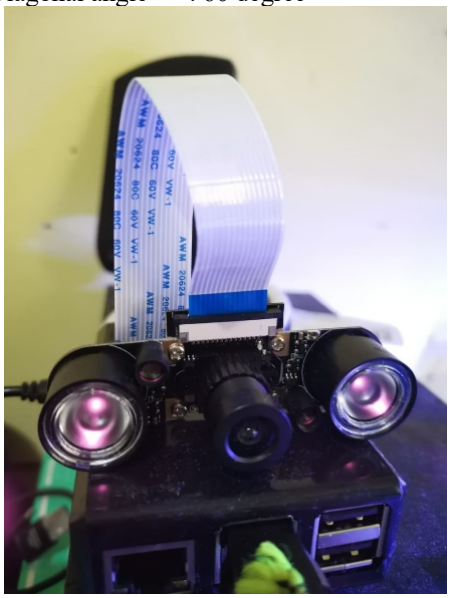

Fig. 3 Raspberrywith a camera module equipped with an IR sensor

The Raspberry Pi is a small computer the size of a debit/credit card that functionally has the same function as a computer in general developed and produced by the Raspberry Pi Foundation. Raspberry currently has many variants, starting from version A, B, and B+, version 2, version 3, and the latest version 4b+ [17].

D. Deployment

It is the stage where the algorithm used is implemented in a code and explains how it is built and executed. This study uses the python programming language, the Open CV-library, and other supporting libraries with the haar cascade classifier algorithm.

Python is an interpretive programming language that is considered easy to learn because it focuses on code's readability, clarity, and completeness, generally in object-oriented programming, imperative and functional programming. It runs on various platforms and is commonly used for software creation and development [14].

Open CV is an open-source library used for computer vision needs such as image processing that can be done dynamically and in real-time. In addition, OpenCV includes several feature bundles such as face recognition, object detection, and various artificial intelligence methods and algorithms. Developed by Intel and can run on various platforms such as Linux, Mac, Windows, iOS, and Android. OpenCV also supports several programming languages such as python, C language, and java [14].

Computer vision is a technology that can process, analyze, and detect an image and then turn it into information for the system to decide. In other words, computer vision technology duplicates the function of the human eye to recognize an object to be used as information processed on a computer board [18].

Haar-Cascade is a method that is often used for object detection. It is called haar because a mathematical function inspires it in the form of a square with the same principle as the Fourier function, namely Haar Wavelet [19]. A haar-like feature works to recognize an object first based on a simple value of a feature but not from a pixel value of the object's image. That is why haar-like features are often called a square function (Rectunglar-feature), which indicates an image. With this method, haar has a high-speed computational performance because it only depends on the number of pixels in a square, not every pixel of an image [12]. The haar-like feature is called the haar-cascade classifier because the filtration process is carried out in stages, so it is called the haar-cascade classifier method. The filter scheme can be seen in Figure 4.

Figure 4 shows the flow of object detection of the haar cascade classifier algorithm, which begins by first determining the detection area. If there is no object in the detection area, then it will not be processed further. However, if there are objects in that area, it will continue the following process: object detection using haar cascade classifier.

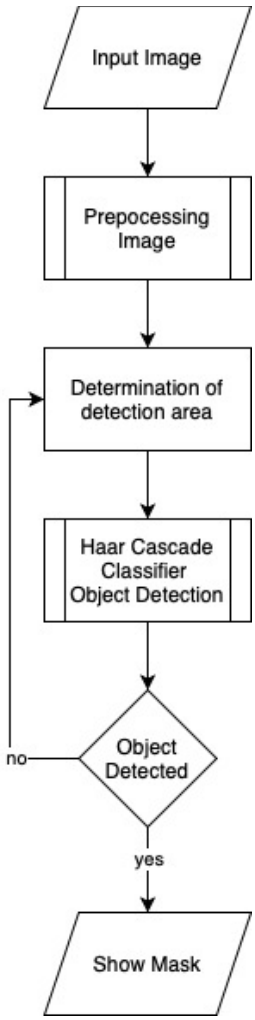

Fig. 4 Object Detection Flowchart with Haar

E. Testing

Conduct testing of the configuration results to ensure a system is running correctly or there are obstacles. Testing is

carried out using the black box method and then concludes the tests carried out.

IV. Result and Analysis

A. *Face Mask Detektor*

The face mask detector program can run at low specs; even if it can run the python program, the face mask detector program can be run in this study. The face mask detector program was run on a raspberry pi3 model b+ with 1Gb ram. The program is made using the python 3.7 programming language with several support libraries. The main library used is OpenCV, devoted to computer vision needs such as object detection, face detection, and image processing.

The created program succeeded in detecting and distinguishing in real-time people who were wearing masks and not wearing masks with good performance without any lag. The mask detector also added a feature to take pictures of people who were not wearing masks without disturbing the video stream process of the mask detection system and then sending the photo to the telegram bot in real-time can be called real-time because at the time of testing the mask detection speed and response time were below 1000ms [20], [21]. The mask detector system is also equipped with an fps (Frame Per Second) counter for the video stream mask detector frame and calculates the connection's response time with the telegram bot. In this study, 20 experiments were carried out to calculate the connection response time connection to the telegram bot.

The device has been built to successfully detect people's faces using and not using masks which can be seen in Figure 5 and Figure 6.

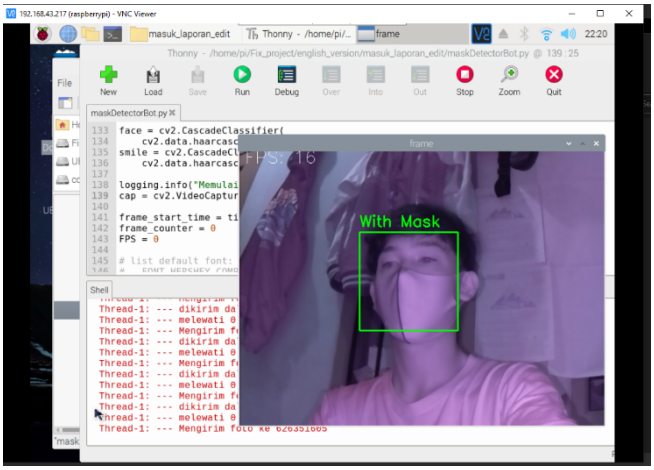

Fig. 5 Detected using a mask.

The telebot library is used to connect the API of the telegram bot with the python configuration by creating a message handle. The detection algorithm used in this face mask detector program is the haar cascade classifier included with open cv. The haar cascade classifier used in this program is haarcascade_frontalface_default.xml & haarcascade_smile.xml, which effectively detects faces and smiles. So there is no need to use data additional sets and have no restrictions on the type or pattern of masks can be detected accurately with lag-free performance. However, as in research [8], the decrease in accuracy occurs due to many mask pattern motifs used, so additional datasets are needed to increase accuracy due to the diversity of masks.

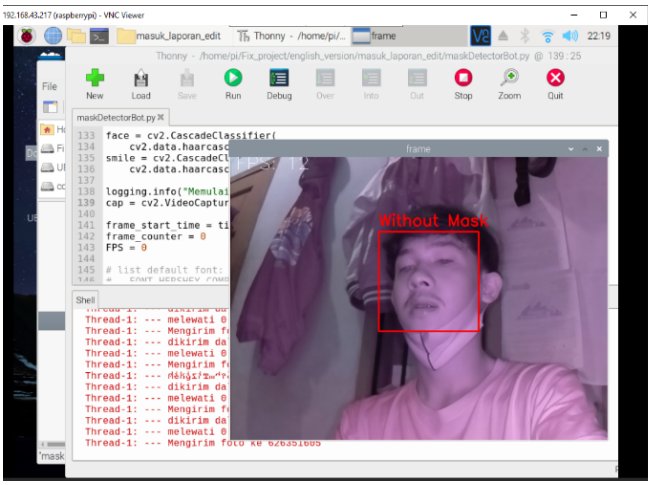

Fig. 6 Detected not wearing a mask.

In this study, using 'haarcascade_frontalface_default and smile.xml' was able to overcome this regardless of the mask's type, shape, and style. As long as the mouth was covered, it would be considered to be using a mask. If the mouth was visible, it was considered not to use a mask with a simple and effective way of working that could increase the performance of the video stream facemask detector. So that it runs without lag and the frame is stable without stuttering, it reaches 16-60 fps [22]. The resulting fps depends on the camera module used, but regardless of the number of fps that is produced, the performance when testing the black box does not have any lag or frames staggered so that this study can overcome the shortcomings of research [10] which uses the CNN algorithm with 20-32 fps which has frame constraints. However, this study experienced the same problem, namely decreased accuracy in low light conditions, in this study this can be overcome by using a better camera module by adding an IR (infrared) sensor to the camera; the results are even in low light conditions even though the accuracy is high. Not decreased as before.

B. *Telegram Bot Notification*

The research objectives that were previously determined were successfully achieved where the program created succeeded in detecting and distinguishing in real-time [21] people who use masks and those who do not wear masks. So that the performance is good and there is no lag to maintain accuracy, and Infra-Red module is added to the camera so that in conditions In low light, accuracy is maintained. In this configuration, a feature is also added to take pictures of people who are not wearing masks and then send the photos to the telegram bot.

In this study, the haar cascade classifier has shortcomings in low light conditions, but this can be overcome by maximizing the camera hardware using a better camera module and combining it with infrared so that even in low light conditions, the accuracy does not decrease, as shown in Figure 7.

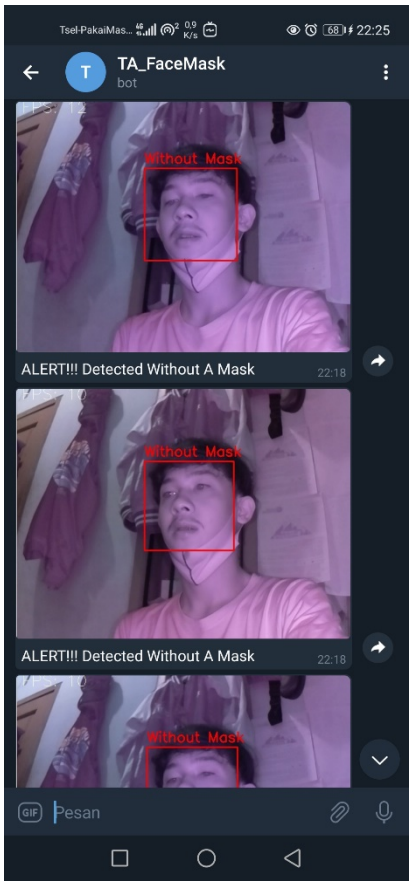

Fig. 7 Display on telegram bot

C. *Testing*

Figure 8 shows the distance test with a maximum detection result of 1.2 meters. Figure 8 also shows the test that the mask detector program is not limited to detecting only one face.

TABLE I. TESTING THE SPEED OF SENDING NOTIFICATIONS TO TELEGRAM

No	Second (s)
1	0.003032448
2	0.001443092
3	0.001429357
4	0.001368833
5	0.001358562
6	0.001227618
7	0.001334522
8	0.001332633
9	0.001675309
10	0.003206055
11	0.002177585
12	0.001659592
13	0.00148209
14	0.002379457
15	0.00182315
16	0.001409456
17	0.001454628
18	0.001309671
19	0.001407787
20	0.001407694
Avg	**0.001695977**
Fastest	**0.001227618**
Late	**0.003206055**

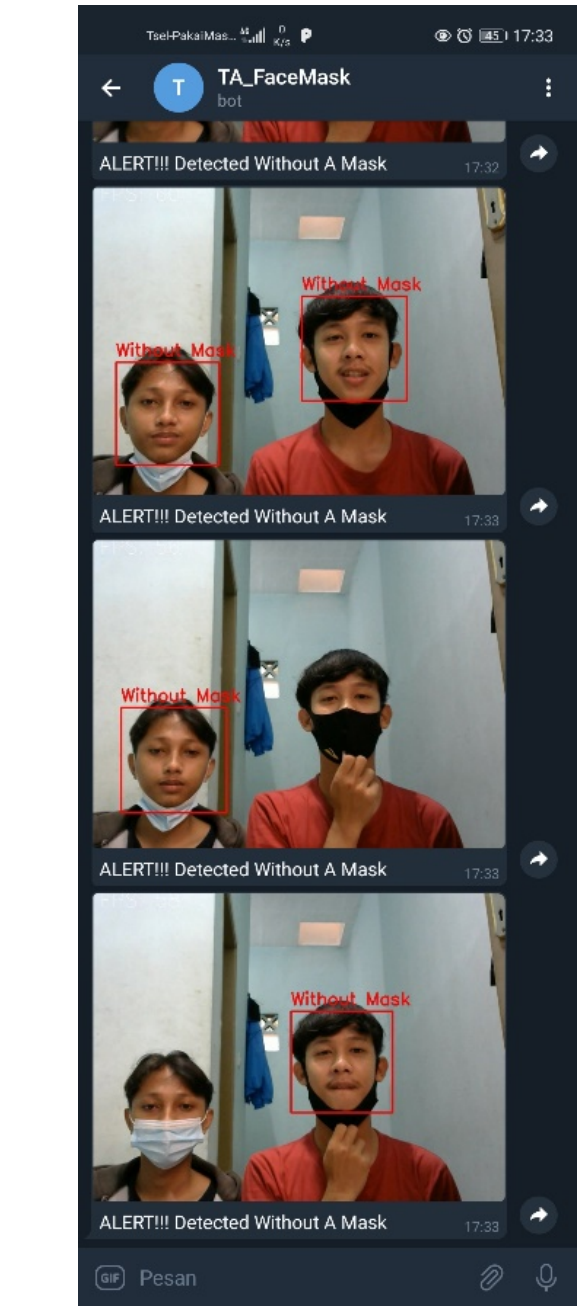

Fig. 8 Distance test and multiple face detection

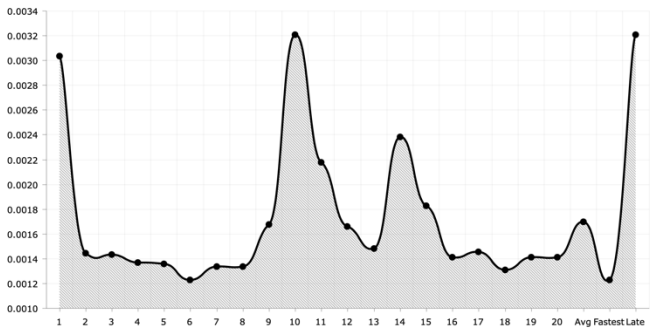

Fig. 9 Testing the Speed of Sending Notifications to Telegram

Table 1 and Figure 8 are the results of testing the sending of notifications in the form of picture messages from people who were detected not wearing masks. Based on the test

results, the average time is 0.001695977 seconds, the fastest time is 0.001227618 seconds, and the late time is 0.003206055 seconds.

V. Conclusions

The results of the black box test of the mask detection program show good results where the mask detector system with the haar cascade classifier algorithm reaches 16-60 fps when the video stream reaches 16-60 fps without stuttering even when the video stream captures people who are not wearing masks. In terms of accuracy, the haar cascade classifier has a weakness in lowlight conditions, but this can be overcome by adding an IR (Infrared) module to the camera. Finally, in terms of connection speed to the telegram bot got excellent results without any delay with an average time of 0.001695977 seconds with a maximum detection distance of 1.2 meters.

In terms of software for further optimization, it can be combined with TensorFlow and hard for machine learning computer vision. In terms of methods, it can also be combined with various algorithms such as CNN or YOLO to complement each other. In terms of hardware, it is recommended to use a camera module specification that is better than the one used in this research and add a PIR sensor for motion detection and a temperature sensor. For notifications, not only by telegram bots but by adding other instant messengers.

References

[1] D. P. Sari, "Hubungan Antara Pengetahuan Masyarakat Dengan Kepatuhan Penggunaan Masker Sebagai Upaya Pencegahan Penyakit Covid-19 Di Ngronggah," *Infokes: Jurnal Ilmiah Rekam Medis dan Informatika Kesehatan*, vol. 10, no. 1, pp. 52–55, 2020. DOI: 10.47701/infokes.v10i1.850

[2] F. Al Isfahani, F. Nugraha, R. Mubarok, and A. Rahmatulloh, "Implementasi Web Service untuk Aplikasi Pemantau Coronavirus Disease 2019 (COVID-19)," *Innovation in Research of Informatics (INNOVATICS)*, vol. 2, no. 1, May 2020 [Online]. DOI: 10.37058/innovatics.v2i1.1696

[3] Satgascovid19, "Pengantar Adaptasi Kebiasaan Baru - Pengantar | Satgas Penanganan COVID-19," 2021.

[4] S. Gubernur, "306_Seruan-Gubernur-Daerah-Khusus-Ibu-Kota-Jakarta-Nomor-9-Tahun-2020.Pdf." 2020.

[5] Kemenkes, "SE-PENGGUNAAN-MASKER-2020-(2)_1562.pdf." 2020.

[6] I. Presiden, "Peningkatan Disiplin dan Penegakan Hukum Protokol Kesehatan dalam Pencegahan dan Pengendalian Corona Virus Disease 2019," *Instruksi Presiden Republik Indonesia Nomor 6*, vol. 2019, no. 031242, 2020.

[7] D. Giancini, E. Y. Puspaningrum, and Y. V. Via, "Identifikasi Penggunaan Masker Menggunakan Algoritma CNN YOLOv3-Tiny," vol. 1, pp. 153–159, 2020.

[8] J. Adiwibowo, K. Gunadi, and E. Setyati, "Deteksi Alat Pelindung Diri Menggunakan Metode YOLO dan Faster R-CNN," *Jurnal Infra*, vol. 18, no. 2, pp. 106–112, 2020.

[9] T. Septiana, N. Puspita, M. Al Fikih, and N. Setyawan, "Face Mask Detection Covid-19 Using Convolutional Neural Network (Cnn)," pp. 27–32, 2020.

[10] M. M. Lambacing and F. Ferdiansyah, "Rancang Bangun New Normal Covid-19 Masker Detektor Dengan Notifikasi Telegram Berbasis Internet of Things," *Dinamik*, vol. 25, no. 2, pp. 77–84, 2020. DOI: 10.35315/dinamik.v25i2.8070

[11] F. Utami and Suhendri, "Implementasi Algoritma Haar Cascade pada Aplikasi Pengenalan Wajah," *Journal of Information Technology*, vol. 3, no. 1, pp. 33–38, 2021. DOI: 10.47292/joint.v3i1.45

[12] Jati, "Let share our knowledge: Deteksi Obyek Menggunakan Haar Cascade Classifier," 2015. .

[13] F. M. S. Nursuwars and A. Rahmatulloh, "RFID for nurse activity monitoring in the hospital's nurse call system with the Internet of Thing (IoT) concept," in *IOP Conference Series: Materials Science and Engineering*, 2019, vol. 550, p. 012025 [Online]. DOI: 10.1088/1757-899X/550/1/012025

[14] H. A. Sidharta, "Introduction to Open CV | BINUS UNIVERSITY MALANG | Pilihan Universitas Terbaik di Malang," 2017.

[15] Y. Sianipar, "Persepsi Masyarakat Tentang Covid-19 Yang Sering Membuat Melanggar Protokol Kesehatan," 2021.

[16] A. Saputri, "√ Pengertian, Fungsi Dan Cara Menggunakan Bot Telegram ⋆ Bukugue.com," 2019.

[17] pi foundation, "Teach, Learn, and Make with Raspberry Pi," 2021.

[18] R. Firdaus, "Rancang Bangun Sistem Navigasi Multirotor Berbasis Waypoint Dan Computer Vision," Universitas Komputer Indonesia, 2020.

[19] P. Purwanto, "IMPLEMENTASI FACE IDENTIFICATION DAN FACE RECOGNITION PADA KAMERA PENGAWAS SEBAGAI PENDETEKSI BAHAYA." Universitas Telkom, S1 Sistem Komputer, 2015.

[20] I. Darmawan, A. Rahmatulloh, and R. Gunawan, "Real-time Screen Sharing Using Web Socket for Presenting Without Projector," in *2019 7th International Conference on Information and Communication Technology (ICoICT)*, 2019, pp. 1–6 [Online]. DOI: 10.1109/ICoICT.2019.8835356

[21] MILLER RB, "Response Time in Man-Computer Conversational Transactions," vol. 33, no. pt 1, pp. 267–277, 1968. DOI: 10.1145/1476589.1476628

[22] M. K. A. Fauzi, B. Firman, and A. Novianta, "Pengukur Kecepatan Kendaraan Di Kawasan Pemukiman Menggunakan Algoritma Image Subtracting Berbasis Opencv," *Jurnal Elektrikal*, pp. 38–45, 2017.