ICIC Express Letters
Part B: Applications
Volume **13**, Number **2**, February **2022**

ICIC International ©2022 ISSN 2185-2766
pp. **219–224**

AUTOMATIC FACE MASK AND TEMPERATURE DETECTOR FOR PREVENTING SUSPECT OF COVID-19

Widodo Budiharto, Vincent Andreas and Derwin Suhartono

Computer Science Department
School of Computer Science
Bina Nusantara University
Jl. K. H. Syahdan No. 9, Kemanggisan, Palmerah, Jakarta 11480, Indonesia
{ wbudiharto; dsuhartono }@binus.edu; vincent.andreas89@gmail.com

Received April 2021; accepted July 2021

Abstract. *Due to COVID-19, wearing a mask is mandatory in public spaces and body temperature has also become an important consideration in determining whether an individual is healthy. This paper presents the development of an automatic face mask and temperature detector to prevent suspect of COVID-19 with the main symptom as the body temperature above 38° Celsius. We propose an algorithm and deep learning is used for face mask detector and wearing position. We implement multithreading in our system because without multithreading the real-time measurement cannot be achieved, and the system is always halted. Based on the experiment, we can detect masks accurately, and using digital temperature sensor MLX90614, the system is able to give accurate measurement with accuracy reaching 95%.*
Keywords: Face mask, Infrared temperature sensor, Deep learning, COVID-19

1. **Introduction.** The novel respiratory illness of Coronavirus disease 2019 (COVID-19) came to us suddenly with exponential speed. The impact of the coronavirus in Indonesia in terms of socio-economic aspects includes four things, i.e., the flow of people, the flow of goods, the flow of money, and the mental health conditions of the people. Total confirmed cases of COVID-19 until 18 April 2021 are 1,604,348 people with 43,424 death [1]. In Indonesia, a person can be called a suspected COVID-19 if they have one or more criteria, such as experiencing symptoms of a respiratory tract infection (such as fever, or ever had a fever with a body temperature above 38° Celsius) and any respiratory disease symptoms (such as cough, shortness of breath, sore throat, and runny nose).

The state of the art for this research has many approaches, for example, [2] proposed the correct detection for mask using computer vision. They conducted a comprehensive experimental evaluation of several recent face detectors for their performance with masked-face images. Other researchers use deep learning object detection methods to create mask position and head temperature detector using RetinaNet, a popular one-stage object detection. They build two modules for the RetinaNet model to detect three categories of mask-wearing positions and the head temperature. They implement an RGB camera and thermal camera to generate input images and capture a person's temperature respectively [3].

Yang et al. [4] proposed a face recognition algorithm using Shearlets Edges Fusion (Shearlet_EF). Shearlet_EF has advantages in transform, which can extract anisotropic and directional information effectively, and the fusion by the maximum modulus principle can hold significant edges and structural attributes of the face image. The result of the experiment shows that Shearset_EF has a better performance compared to relative algorithms.

DOI: 10.24507/icicelb.13.02.219

Loey et al. [5] used the YOLO-v2 with ResNet-50 deep transfer learning model to implement the device with real-time face detection and image processing. This device would help the government to handle and manage the people in the society to maintain social distance and to make sure everyone wears a face mask. The highest result reaches precision up to 81% using Adam Optimizer.

Another approach by Chowdary et al. [6] used transfer learning of InceptionV3 to identify people who are not wearing a mask in public places by integrating it with surveillance cameras. To enhance the performance of the model, the image augmentation technique is used to increase the diversity of the training data for enhancing the performance of the proposed model. The model gets an accuracy of 99.92%.

A Retina face mask has been proposed by Jiang et al. [7] which is a high-accuracy and efficient face mask detector. The models use ResNet and MobileNet to detect whether the person uses a mask or not. Transfer learning was used to extract robust characteristics trained on a large dataset of 7,959 images.

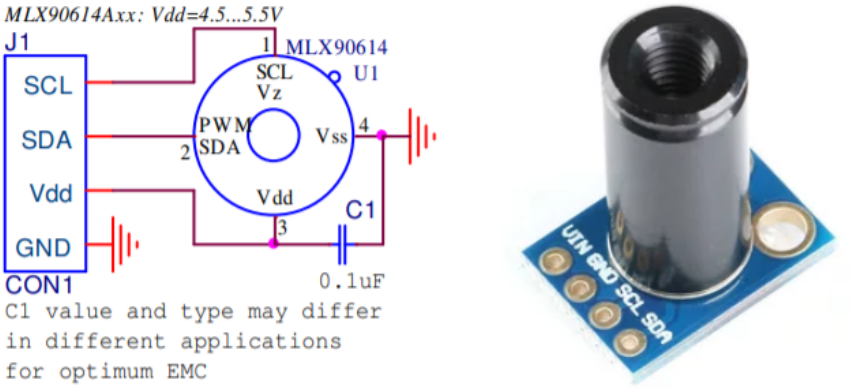
The advantage of this research compared to another approach is using multithreading to make face mask detection and temperature checking run simultaneously. The contribution of this paper is to propose another approach for face mask detection with temperature detection using multithreading in a public place. From our experiment, the program can run well, with the accuracy of our model reaching 95%.

In this research, we found that multithreading should be implemented to make the face detection and temperature detection can run simultaneously. Without multithreading, the sensor cannot measure temperature, and the face mask detector cannot detect the mask at the same time. Figure 1 shows our prototype of an automatic face mask and temperature detector named as BacaRupa V1.0. Part 1 of our paper is an introduction, Part 2 is the concept of temperature sensor and multithreading, Part 3 is the proposed method, Part 4 is the experimental result, and the conclusion is in Part 5.

FIGURE 1. Our prototype of face mask and temperature detector named as BacaRupa V1.0. We also provide hand sanitizer below the screen [11].

2. **Literature Review.**

2.1. **Temperature sensor for body of human.** The MLX90614 is a contactless Infrared (IR) digital temperature sensor that can be used to measure the temperature of a particular object ranging from $-70°C$ to $38.2°C$. The sensor uses IR rays to measure



(a) (b)

FIGURE 2. MLX90614 contactless Infrared (IR) digital temperature sensor circuit (a) and the sensor module (b) [8]

the temperature of the object without any physical contact and communicates to the microcontroller using the I2C protocol. Figure 2 shows the temperature sensor used in the research.

The specification:

- Working voltage: 3 ∼ 5V (internal low voltage regulator)
- Communication: standard IIC communication protocol
- Measuring distance: max 80cm
- Product size: 11.5mm × 16.5mm

2.2. **Multithreading.** A thread is an entity within a process that can be scheduled for execution. Also, it is the smallest unit of processing that can be performed in an OS (Operating System). A process in computing is an instance of a computer program that is being executed. The process has 3 basic components, i.e., an executable program, the associated data needed by the program (variables, workspace, buffers, etc.), and the execution context of the program (state of the process). The thread state can be running, ready, waiting, start, or do. Multiple threads or multithreading can exist within one process where each thread contains its own register set and local variables stored in the stack.

Running several threads is similar to running several different programs concurrently, but with the following benefits.

- Multiple threads within a process share the same data space with the main thread and can therefore share information or communicate with each other more easily than if they were separate processes.
- Threads are sometimes called lightweight processes and they do not require much memory overhead; they are cheaper than processes [9].

3. Proposed Method.

System architecture. The author has conducted prior research and experiment for face mask detection and controlling IR temperature sensors [10]. Deep learning is used because it has high accuracy for prediction/classification [13]. We use the laptop with GPU for deep learning, Arduino and temperature sensor. We use USB Port in the laptop for the controller's power. Figure 3 shows the architecture of our system.

First, the program will make a connection between the controller of Arduino and the laptop using the USB port. The development of a multithreading program is very difficult at first time. A thread has a beginning, an execution sequence, and a conclusion. It has

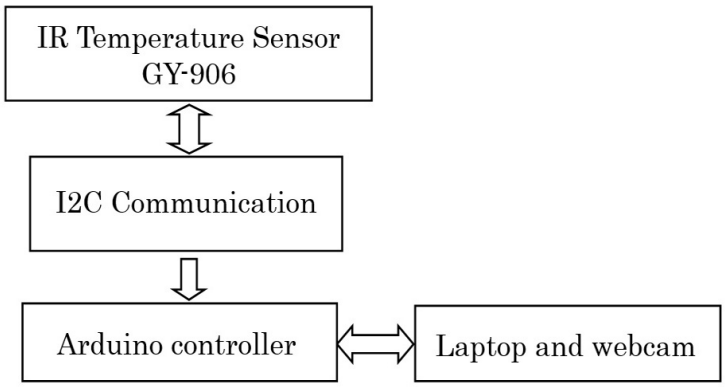


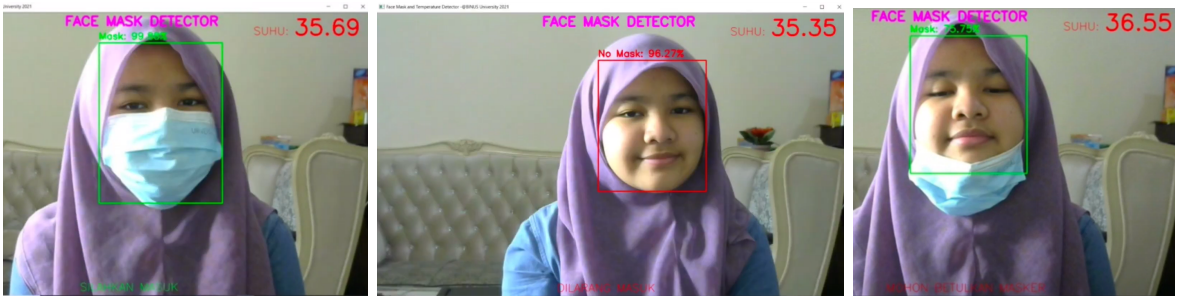
FIGURE 3. The architecture of automatic face mask and temperature detector

Algorithm 1. Real-time face mask and temperature detector using multithreading

```
begin
import keras #library for deep learning
import multiprocessing

declare variables

def detect_and_predict_mask():
  detect and predict confidence of mask #face mask detection

def check_temp(data, is_stop):
        ser = serial.Serial()
        ser.baudrate = 9600 #serial communication
         read temperature sensor

def main_program(data, is_stop):
        print "Loading face mask detector model..."
         prototxtPath = os.path.sep.join([args["face"], "deploy.prototxt"])
        weightsPath = os.path.sep.join([args["face"],
        "res10_300x300_ssd_iter_140000.caffemodel"]) #deep learning model
        vs = VideoStream(src=0).start() #video streaming
        while True:
                read temperature
                   frame = imutils.resize(frame, width=1280)
                (locs, preds) = detect_and_predict_mask(frame, faceNet, maskNet, vs)
                   display detection and temperature
#Alarm when "No Mask" and temperature above 38°C
if mask < withoutMask and (float(g3)) > 38:
   path = os.path.abspath("Alarm.wav") #alarm
   playsound(path)

if__name__ == '__main__':
        p = Process(target=main_program)
        q = Process(target=check_temp)
        p.start() #start processes for multithreading
        q.start()
end
```

an instruction pointer that keeps track of which within its context is currently running. It can be pre-empted (interrupted). After we understand the concept of multithreading, we can successfully make the program able to display temperature correctly. The output of these experiments is a live video that carries accurate information about whether a person is wearing a mask properly and what his or her head temperature is. The algorithm of face mask and temperature detector with multithreading is shown in Algorithm 1.

4. **Experimental Result.** We developed a program for controlling the sensor using Arduino [12]. We use Keras and Python programming language for face mask detectors. The result of our face detection program with temperature detection using multithreading is shown in Figure 4 below.



(a) (b) (c)

FIGURE 4. Result of the computer vision program using deep learning and Arduino for the face mask and temperature detector with mask (a), without a mask (b), and wearing a mask not properly with a warning message (c)

The program can differentiate when the user uses the mask properly or not. In the first image (a), the program detects that the person uses the mask correctly, with 99.98% probability. Because the temperature not above 38° Celsius, and the person uses the mask correctly, the person will be allowed to enter. In the second image, the person does not use the mask, with 96.27% probability. The person will not be allowed to enter. In the last image (c), the person uses a mask, but the position of the mask not correct, so the program alerts the person to correct the position of the mask (the warning message is shown below the screen).

Based on the experiment, the ability of the program for detecting mask and temperature is very good. We test the program with some combination, wearing and not wearing the mask, and temperature below 38° Celsius and above 38° Celsius. For the temperature above 38° Celsius, we use solder as the sample. For each combination, we test the program 10 times, using a different kind of mask (cloth mask, face mask, surgical mask, and N95 mask, with various mask colors). The result of our experiment is shown in Table 1 below.

TABLE 1. Experimental results for detecting mask and temperature detector

No	**Results from 10 times simulation**		
	Action	**Success**	**Not success**
1	Wearing mask and temperature $<$ 38° Celsius	10	0
2	Wearing mask and temperature $>$ 38° Celsius	9	1
3	Not wearing mask and temperature $<$ 38° Celsius	9	1
4	Not wearing mask properly and temperature $<$ 38° Celsius	8	2
	Accuracy		95%

Based on Table 1, the problem is for detecting not wearing mask properly because the training data for that is not enough. Compared to another state-of-the-art study, our performance is quite high, with accuracy reaching 95%, and not like other research, we also implement temperature detection using multithreading. We use a temperature sensor to make the cost implement the device cheaper, rather than using a thermal camera like implemented by Farady et al. [3].

5. **Conclusion.** In this paper, we propose a model of face detection and temperature detection for COVID-19. We propose an algorithm and deep learning is used for face mask detector and wearing position. With the trend of increasing positive cases in Indonesia as a second wave, the intelligent system used for handling COVID-19 is very important. We implement multithreading in our system because, without multithreading, the real-time measurement cannot be achieved, and the system always halted. Based on the experiment, we can detect masks accurately, and with using digital temperature sensor MLX90614, accuracy reaches 95%. For further research, we want to add an air quality sensor, and oximeter, to know more about personal health and the air quality around.

Acknowledgment. This work was supported by BINUS University.

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