Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF FACE MASK DETECTION SYSTEM USING MACHINE VISION

CHAN YOKE LIN

Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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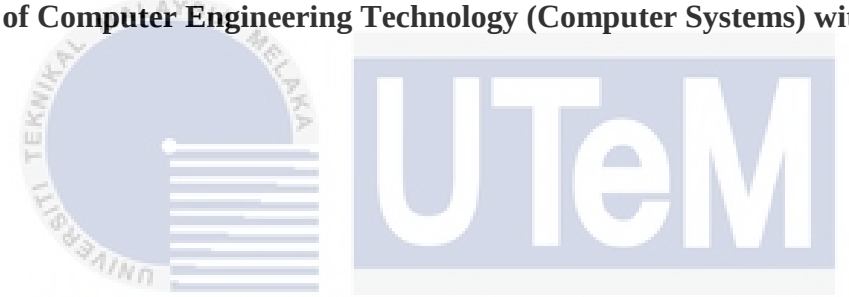
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Computer Engineering Technology (Computer Systems) with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Alamat Tetap: 562, Kanthan Baru, 31200, Chemor, Perak.

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

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DEDICATION

To my PSM supervisor

To my beloved mother and father

To dearest friends and coursemate

ABSTRACT

Coronavirus disease (COVID-19) spreads in tiny liquid particles from mouth or nose. To prevent people from being infected by Covid-19, the Malaysia government has made it compulsory for people to wear masks in public since 1st Aug 2020. This is difficult to make sure everyone follows the rule especially when people came in a crowd. Hence, face mask detection system is proposed to identify whether a person is wearing mask or not. The scope of this project is limited to white surgical mask and front view of the face. This system is created using MATLAB with computer vision toolbox. The method used is training Cascade Object detector. This is a feature based detector and need to be trained. Cross-validation is used to train the detector due to small dataset. After testing, accuracy of the system is calculated from the output included positive and negative images. In this project, the accuracy for first training with the original size images is 76.67%, second training with the cropped ratio 9:11 is 67.50% and accuracy for third training process with 9:4:7 cropped images is 89.17%. In future work, system can be improved to detect other colours and types of face masks.

ABSTRAK

Penyakit Coronavirus (COVID-19) merebak dalam zarah cecair kecil dari mulut atau hidung. Untuk mengelakkan orang ramai daripada dijangkiti Covid-19, kerajaan Malaysia telah mewajibkan orang ramai memakai topeng di khalayak ramai sejak 1 Ogos 2020. Ini adalah sukar untuk memastikan semua orang mematuhi peraturan terutamanya apabila orang ramai datang beramai-ramai. Justeru, sistem pengesan topeng muka dicadangkan untuk mengenal pasti sama ada seseorang itu memakai topeng atau tidak. Skop projek ini terhad kepada topeng pembedahan putih dan pandangan hadapan muka. Sistem ini dicipta menggunakan MATLAB dengan kotak alat penglihatan komputer. Kaedah yang digunakan ialah melatih pengesan Objek Cascade. Ini adalah pengesan berasaskan ciri dan perlu dilatih. Pengesahan silang digunakan untuk melatih pengesan kerana set data yang kecil. Selepas ujian, ketepatan sistem dikira dari output termasuk imej positif dan negatif. Dalam projek ini, ketepatan untuk latihan pertama dengan imej saiz asal ialah 76.67%, latihan kedua dengan nisbah potong 9:11 ialah 67.50% dan ketepatan untuk proses latihan ketiga dengan imej terpotong 9:4:7 ialah 89.17%. Dalam kerja akan datang, sistem boleh dipertingkatkan untuk mengesan warna dan jenis topeng muka yang lain.

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CHAPTER 1

INTRODUCTION

1.1 Background

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus [1]. The majority of those infected with the virus will have mild to moderate respiratory symptoms and will recover without the need for medical attention. COVID-19 can make anyone sick and cause them to get very ill or die at any age. When an infected person coughs, sneezes, speaks, sings, or breathes, the virus spreads in tiny liquid particles from their mouth or nose. Based on World Health Organization, being thoroughly informed on the disease and how it spreads is the best strategy to avoid and slow down transmission. Stay at least 1 metre away from people, wear a well fitted mask, and wash your hands or use an alcohol-based rub periodically to protect yourself and others from infection.

To prevent people from being infected by Covid-19, the government has made it compulsory for people in Malaysia to wear masks when in public since 1st Aug 2020. By machine vision, we can identify whether a person is wearing mask or not. This system can be applied in shop, restaurant or shopping mall to make sure everyone is wearing mask.

1.2 Problem Statement

Although the Malaysia government announced that it is not compulsory to wear a face mask in outdoor areas. However, students and lecturers are still required to wear masks when they enter the laboratory in UTeM. To make sure that everyone is

following standard operating procedure (SOP), this face mask detection system can be applied at the entrance of laboratory to check whether everyone is wearing a face mask or not.

Before entering the laboratory, everyone should check temperature by using the thermometer provided. This is necessary to install a camera on the thermometer and capture an image to check whether a person is wearing mask or not. Therefore, the scope of project is set as below.

1.3 Project Objective

a) To develop a face mask detection system by using machine vision.

b) To analyse the accuracy of the system.

1.4 Scope of Project

The scope of this project are as follows:

a) Only for people wearing white colour surgical mask as shown in Figure 1.1.

Figure 1.1 White Surgical Mask

b) The front view of people's face should face toward the camera as shown in figure 1.2.

Figure 1.2 Facing toward camera

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will present the ideas of development of face mask detection system by summarizing some past related work. Moreover, some methods for object detection also showed. Related theory also will be explained in this chapter.

2.2 Past Related Work

This topic will show the summary of some past related work.

2.2.1 Past Related Work of Face Mask Detection

The related work is more to this proposed project which is face mask detection by using different methods.

2.2.1.1 Automatic Face Mask Detection Using Deep Learning

Based on the article by Stephanie Anderson, Suma Veeravenkatappa, Priyanka Pola, Seyedamin Pouriyeh and Meng Han [2], an automatic face mask detection is developed by using Deep Learning. In this study, they aim to build a model that automatically detects whether a person is wearing a face mask, wearing face mask incorrectly or no mask. The dataset is comprised of 3,515 photos divided into three classes, Mask, No Mask, and Incorrect Mask. The photos were collected by combining several different Kaggle datasets

that consisted of photos in JPEG format. In addition to the Kaggle datasets, images from Google were added. They also personally took photos of themselves, their family, and friends to increase the size of the dataset. The model uses 80% of dataset for training neural networks and 20% of dataset for testing. Convolutional Neural Networks(ConvNet/CNN) has the ability to automatically learn a large number of filters in parallel specific to a training dataset under the constraints of a specific predictive modelling problem. It is a deep learning algorithm that can take in an input image, assign weights and biases to various aspects/objects in the image, and distinguish between them. CNNs are used for image detection and recognition because of their high precision. Consequently, their face mask detection model has achieved a 96% accuracy. However, if someone covers his or her face with hand will be classified as either wearing a face mask or wearing a face mask incorrectly.

2.2.1.2 Face mask detection using MobileNet and Global Pooling Block

Moreover, based on an article by Isunuri B Venkateswarlu, Jagadeesh Kakarla and Shree Prakash [3], a face mask detection system is developed by using MobileNet and Global Pooling Block. They have selected two publicly available datasets for the evaluation of the proposed model. Dataset 1 is real time image that contains 1918 images are without a mask and the remaining 1915 images are with a mask. Dataset 2 contains 824 images are without a mask and the remaining 826 images are with a mask. Rotation-based data augmentation has been performed to generate the dataset. The proposed MobileNet and Global Pooling is shown as Figure 2.1. Firstly, pre-trained MobileNet without output layer accept the input images and generates a feature of map. Next, global pooling block (GP Block) transforms a multi-dimensional feature map into a one-dimensional vector having 64 features. Lastly, a

softmax layer with two neurons takes 64 features and perform binary classification. In sum, the proposed model has achieved 99% and 100% accuracy on DS1 and DS2 respectively.

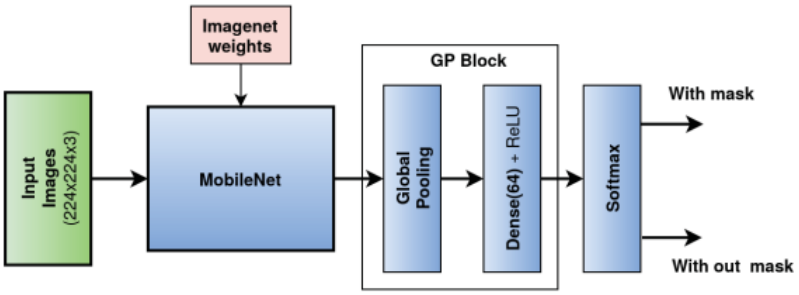

Figure 2.1 MobileNet and Global Pooling article by Isunuri B Venkateswarlu, Jagadeesh Kakarla and Shree Prakash **[3]**

2.2.1.3 Non-Contact Temperature Detection, Face Mask Detection, and Attendance System using Facial Recognition Technique

Another article by Prajwal C Hegade, Glenson Toney, Nilesh B Markal and Amit P Sangolli [4] presented a non-contact temperature detection, face mask detection and attendance update system using facial recognition technique. Figure 2.2 showed the proposed model. Raspberry pi is the controller and ultrasonic sensor is connected to measure the distance of the person from the device. MLX90614 Infrared temperature ensor is used to check the body temperature without direct contact. Update of attendance and mask detection are done with the HOG facial recognition technique. Creating a database containing all of the candidate's images. Put all the images in one folder and include the location path directory in the source code implemented using Python. All the images are renamed with the candidate's name. The model is then trained by using HOG algorithm method with these images for identifying the employee when a scan is performed. In conclusion, the face detection provides 96.67% efficiency.

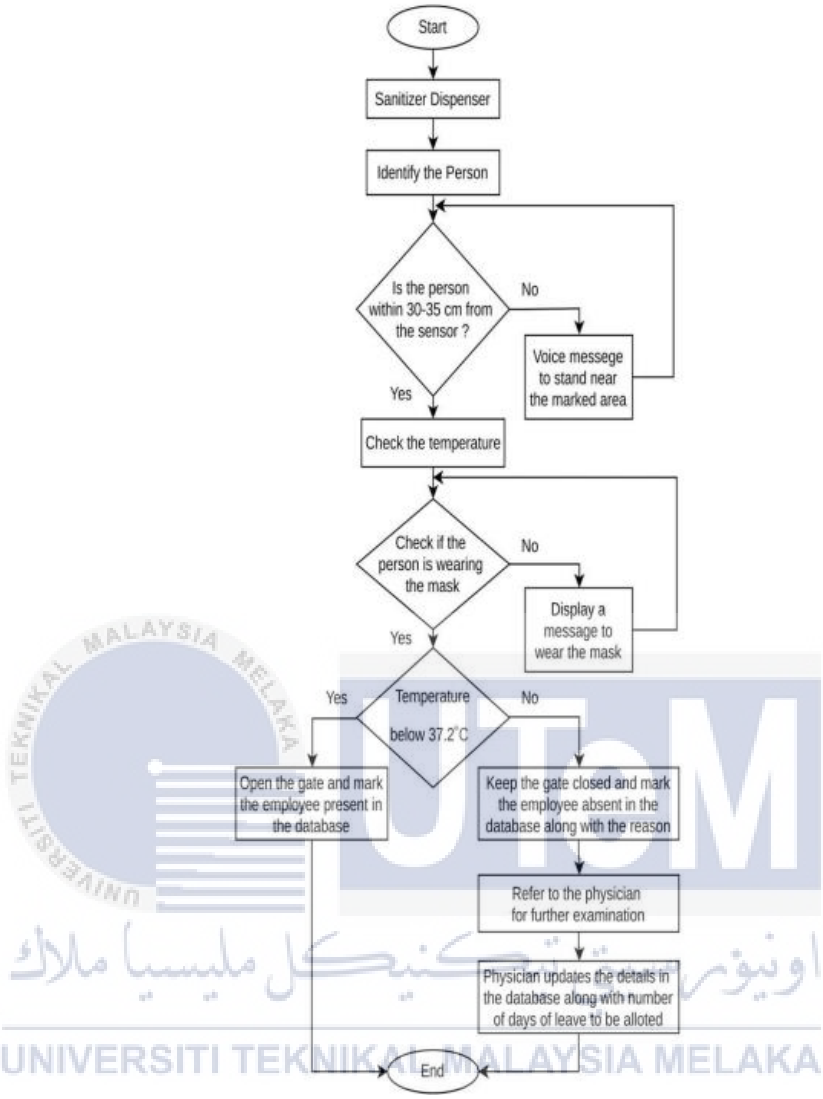

Figure 2.2 Flowchart of proposed model by Prajwal C Hegade, Glenson Toney, Nilesh B Markal and Amit P Sangolli **[4]**

2.2.2 Past Related Work of Methods used in object detection

There are numerous approaches for object detection in vision machines. Most of the algorithms of object detection are included in computer vision toolbox of MATLAB.

2.2.2.1 Detects object using point features

There are many algorithms in point features detection such as SIFT(Scale Invariant Feature Transform), SURF(Speeded Up Robust Feature), Harris Corner and FAST(Features from Accelerated Segment Test).

Based on article by Divya CChhabra and Dr.Amandeep Verma [5], SURF is grounded on Hessian matrix determinant and detect blob like structure where the determinant is maximum. In the proposed methodology, 300 strongest feature points are detected in the reference image and 100 strongest feature points are detected in scene image. At these interest points, there feature descriptors are extracted. These feature descriptors are then matched and are called putatively matched points. Putatively matched points have two types of point outliers and inliers. For locating the objects in the scene, a geometric transform is applied which calculates the conversion involving the matched points whilst eliminating the outliers. This transformation allows localizing the object in the scene. Transform points obtained indicates the position of the object in the scene. These are then converted into the coordinate system so as to create a bounding box around the object. The process of SURF point features detection as shown in Figure 2.3. In conclusion, major advantage of the proposed approach is that it can detect objects despite a scale change or in-plane rotation. It is also robust to out-of-plane rotation and occlusions up to a small extent.

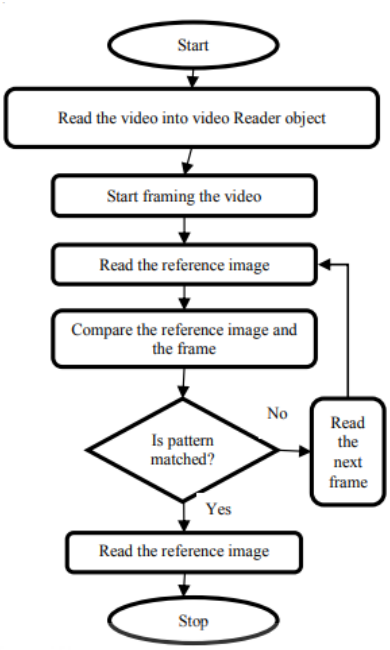

Figure 2.3 Process of SURF point features detection **[5]**

2.2.2.2 Detect object using feature-based detector

There are many feature-based with different algorithms. For example, Cascade Object detector, Foreground detector, Barcode detector and April Tag detector.

Based on the article by Erteza Tawsif Efaz, Ahmed Masud Chowdhury, Jafrina Jabin, Md Ehtesham Adnan and Ashfia Binte Habib [6], object detection and classification is done by cascade object training. For this purpose, a set of 50 positive images were taken to train the model, collected from Google Images. Their objective of this research is to build a model that can detect and label objects utilizing cascade training and detection. The training is to complete using Cascade Trainer Graphical User Interface (GUI), and the testing by MATLAB. The object identifying algorithms typically employ CV techniques to find and classify objects from photographs. By utilizing MATLAB (R2018b), the most suitable object identification procedures with minimal lines of code can be explored. Besides, it will be able to stimulate the method of training by the usage of GPUs. Once the Cascade Trainer

generates the .xml file after completing the training, MATLAB reads the file to detect cups with saucers. The vision.CascadeObjectDetector() API is used to create the detector object, which is further fed into the step() method to run the detector object to detect the object of interest. After the detection, the detected region is outlined with a rectangle and captioned as 'cup' to be displayed. In conclusion, this developed algorithm in terms of CV successfully detected and labeled the test images with varying degrees of accuracy, neutralizing the deficiencies of the primordial Viola-Jones' cascade classifier while maintaining almost zero incorrect refusal. However, accuracy can be improved by increasing the number of positive and negative images.

2.2.3 Summary of Past Related Work

This subchapter presented face mask detection using deep learning, MobileNet, Global Pooling Block and facial recognition technique. Face mask also can be detected using object detection. Thus, point feature detection and feature based detection are listed in this subchapter. Consequently, feature based detection is used in this project to detect face mask.

2.3 Theory

This topic will present some explanations about a few important topics related to this project.

2.3.1 Region of interest

Based on help center of MATLAB [7], a region of interest (ROI) is a portion of an image that you want to filter or operate on in some way. ROI can be represented as a binary