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# Automated Realtime Mask Availability Detection Using Neural Network

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**Abstract:** The COVID-19 is highly known for its rapid spread. With over 65000 cases recorded on daily. The world started to face huge impacts and challenges. The World Health Organization strongly advice to wear a mask as measurement to fight back the huge spread of the virus. wearing a mask can reduce the infection for more than 80%. However, it's quite challenging for authorities and governments to ensure the mask availability for people in public places. As there exist people who are careless about wearing the mask. The mask availability system is automated solution to monitor the mask availability. The system contributes with neural networks, image processing and computer vision to take part of mask detecting. The system is trained with over 1000 image of people with mask and people with no mask. The images are used to create trained model using convolutional neural network. The trained model has achieved 97% of accuracy. The system has many strengths and weaknesses. One of the strengths observed is that the system was able to detect all the people faces who are facing the camera and showed the results in the screen. And on the other hand, one of the weaknesses that the system can be only maintained by certified people who are aware of the technologies used in the system. Future recommendations are to add live monitoring to temperature and increase the data set size to achieve higher accuracy of detection.

**Keywords:** neural network, artificial intelligence, image processing, computer vision, deep learning ,mask detection

## 1. INTRODUCTION

Now a days the rapid spread of COVID-19 has alerted the world and a lot of governments around the world started to take serious action to stop the rapid spreading of the virus. According to world meter, there are more than 650000 cases reported daily all over the world [1]. The World Health Organization states that "The use of masks is part of a comprehensive package of the prevention and control measures that can limit the spread of certain respiratory viral diseases, including COVID-19 [2]." Besides that, Alice McCarthy observed that wearing a face mask reduces the chance of infection to more than 80% [3]. However, the huge increasing scale of infection has put a lot of pressure on the governments around the world to control the spread of the COVID-19. Even so, the governments around the world are not the only major key to control the spread of this virus. Despite the strong efforts made by the governments to control the spread of COVID-19. There exist people who ignore the importance of wearing the mask as well as, the ignorance of following the regulation and instructions given by the authorities to fight back the infection. Due to this, the authorities are held back in the process of reducing the infection. Which also, affects the public interests and causes a loss of life. An effective solution is to use modern technologies such as artificial intelligence, neural network, and image processing in creating real-time mask availability detection to monitor the violators of the obligated ones in wearing masks. The solution combines the mentioned technologies to help reducing the infection between the people by detecting the faces and processing it into a neural network which provides us feedback whether the person is wearing or not wearing a mask.

### *A. Motivation*

Since we have shaded the light about how important is to wear mask to help in reducing the infection between people. This research is done to contribute with the authorities in order to reduce the infection by real time monitoring of people and detecting if they are wearing a mask or not. The real time live monitoring can be implemented in the streets, offices, and malls to ensure the mask availability in all times. The idea was inspired by the importance of spotting the offending people and help the authorities in taking actions towards them. From this point we try to maintain public health, decrease infection between people and reduce the loss of lives.

### *B. Constraints*

This work on this paper was done during the situation of COVID-19 so there are some limitations regarding the work of this article. Economical constraint is that we could not buy expensive monitoring cameras, so we used the laptop built-in camera for testing and developing the project. Also, in terms of health and safety constraint. It was not possible for us to test and implement the system in the public to identify its real performance. As we were not given the chance to test it publicly due to the lockdown of the pandemic of COVID-19.

## 2. LITERATURE REVIEW

Many mask detections schemes have been developed; we can observe that some have created voice recognition approaches to detect the mask. Others detect mask availability using image processing techniques with neural networks. A Recent research by Mohamed Loey et al. [4] showed that one of the important ways to protect against COVID-19 is wearing a mask. They proposed a hybrid model using image processing. The primary segment of the model consists of Resnet50 and the subsequent segment is Support Vector Machine known as (SVM). The training for the model was done with different data sets and showed 99.49% of accuracy [4]. Another research was made by G. Jignesh Chowdary et al. [5] states that, the entire world is facing huge impacts due to the high rate of spread of COVID-19. They observed that to reduce the spread of COVID-19 it is a must wear the mask according to World Health Organization instructions. As they admit that it is that monitoring people is very difficult while it is done manually. They introduced a model to make the process of monitoring to be done in an automated way. The proposed model is built by fine-tuning the pre-trained state-of-the-art deep learning model, InceptionV3. The trained model was tested upon the Simulated Masked Face Dataset (SMFD). Moreover, they have adopted image augmentation for better testing, the model testing phase showed an accuracy of 99.9% during training and 100% during testing [5].

A published study by Cornell University introduced breath monitoring and mask detection based on data augmentation, modeling, and feature representation. The study focuses on training the neural network with filter bank energies, speaker awareness, and gender-aware features. In addition, they increased the quantity of training data to improve the model by data augmentation schemes. They investigated different bottlenecks based on Bi-LSTM to monitor speech breath and did experimental testing. The testing showed the baselines and achieve 0.746 PCC and 78.8% UAR on the Breathing and Mask evaluation [6]. Another recent study by Nicolae-CatRistea et al. [7] proposed a different method for mask detection. The method proposed detects the mask availability by speech sound of the persons. The approach for this model was done by training Generative Adversarial Networks and generating new training utterances using the cycle consistently. Moreover, the study was depending on translating unpaired utterances between two categories. The first category is assigned for people who wear the mask, and the second category is for people with no mask. The decoded utterance is changed to spectrograms to be an input for ResNet neural network. Finally, the results are assembled into Support Vector Machine classifier to identify mask availability [7].

Many works have been presented, we can observe that [6] and [7] have created their approach to address voice recognition for detecting the mask. However, [4] and [5] are depending on image processing techniques and neural networks. We are interested in image processing and neural network to detect the mask availability in real-time. The voice monitoring approach is not convenient way for us to serve our goal, as it is hard to monitor everyone's voice in public places. Thus, we will focus on the image processing and neural network methods.

### *A. Image processing*

The playing field of image recognition and image processing has been involved in many aspects of the modern technology. In the last 5 years there was a significant increase in image data comparison and image recognition [8]. In Figure 1, explains how the image processing can be used for comparison.

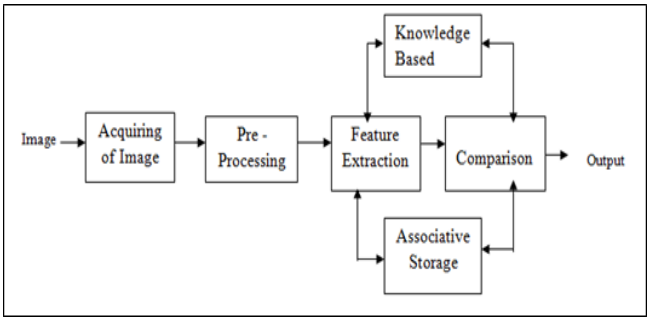


Figure 1. Example of Image Processing Application [9]

As in the human world, the images represent to us a huge amount of useful data. We were able to analyze and understand the surroundings of using our vision. The vision is considered as an input source of images to our brain which process the given image captured by our eyes to recognize things around us. In addition, we can extract some useful information to do comparisons between different things we see. But when it comes to electronics and machines it is impossible for inanimate to do what humans do. As the electronics and machines understand the binary language only and interact with electric signals. unlike humans, they use their vision to accomplish this. A computer vision is a technique used in the factor of duplicating the human vision by digitalizing the images and turn them into a form where

the computers, machines, and electronic devices can understand. This form can be accomplished by doing some operations on the images to extract some useful information as the human brain do. The set of information extracted can be used in different techniques to support the artificial intelligence in making decisions, observing, learning, and comparing between the different images which the computers get. With all these advantages combined under one roof, we can use computers and machines to duplicate the human brain and vision to build strong impact projects for the human being. Image processing can be defined as the process of extracting useful information from pictures after doing a set of mathematical operations on an image [10]. Image processing aims to translate useful information within images to be used in many applications. The image processing can be done with different techniques such as Linear filtering, Anisotropic diffusion, and neural network. A recent article by Daniel Faggella shows the importance of image processing. He states that **"**today, top technology companies such as Amazon, Google, Microsoft, and Facebook are investing billions of dollars in computer vision research and product development [11].**"** the huge amount of money is invested in a large variety of life applications and case studies.

### *B. Deep learning and neural network*

The neural network is a deep learning method stimulated by the real neural networks in humans' brains. In the computer and machines world, they are reflected as algorithms to analyze or recognize a given set of data. It is widely used for solving real-life problems in many industries where machines and computers are involved in the process. Unlike the biological neural network in the human brain, the neural network for the machines is a fully mathematical implanted model, where the neurons can store the information after doing a set of mathematical operations. Besides that, it features the ability of learning and recognizing from the images given as a data set [13]. Neural networks provide high accuracy in identifying and learning from images. The neural network architecture can be divided into 3 main layers. As Figure 2. shows, the description of the neural network architecture.

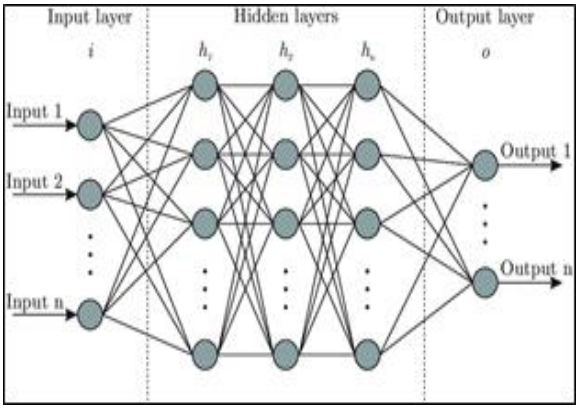


Figure 2. Neural Network Architecture [12]

The neural network is a deep learning method stimulated by the real neural networks in humans' brains. In the computer and machines, the input layer is the layer where you give a data set to be used for further processing in training the model. The input data set is also called the input of artificial neurons. Besides the input layer, there is a hidden layer. The hidden layer is the area located between the input layer and the output layer. The hidden layer can be more than one level depending on your model design and goal of the model. In the hidden layer, a set of mathematical nonlinear operations are done for the learning process. The result of the mathematical operations is stored in the neurons in the hidden layer. After each epoch, the hidden layer keeps updating the results for better learning and higher accuracy. The last layer is called the output layer. In the output layer, the result is given by computing values of the nodes [13]. There is a variety of options when it comes to learning algorithms such as backpropagation, random forest, and perceptron. Each algorithm has its advantages and disadvantages in terms of accuracy, performance, and time.

On the other hand, a convolutional neural network is one type of many types of neural networks. The convolutional neural network is used for deep learning and it is widely used for analyzing images by, processing and classifying them. As The convolutional neural network provides high accuracy in analyzing images, we decided to fit it in our system. the convolutional neural network can also train a big amount of data which is effectively considered as a great option for the project [14]. Figure. 3 shows a brief description of the convolutional neural network algorithm. It starts by taking an input image and starts to read it convolutional way by breaking the image into small matrixes. After that, the images are entered into the pooling phase which applies some filters on the image for learning and creation of highlight maps that summarize the existence of those features. In addition to that, the images processed in the network are gathered in a one-dimensional array. To be soft maxed and output the result [15].

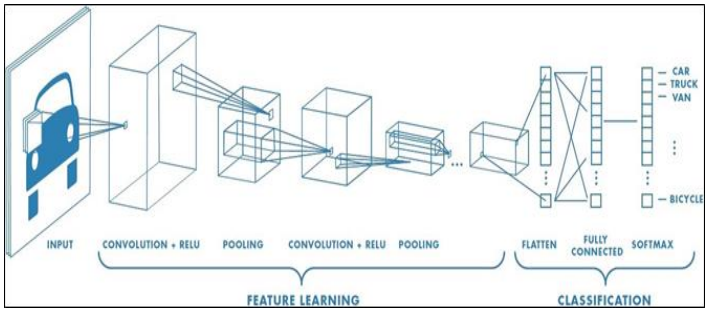


Figure 3. How Neural Network Algorithm Used for Image Processing [15]

## 3. SYSTEM DESIGN AND COMPNONETS

The system design showed in Figure 4. describes the proposed design. The design of the system is quite simple. As its real-time mask availability project, we need a camera to monitor people's faces. Besides that, we need a big data set of images. The images needed for our design are images of people with mask and on the other hand, people with no masks. The data set is used to create a trained model using a convolutional neural network with the help of Keras and TensorFlow of python. The monitoring camera which captures a live video is considered as an input for the system. The trained model should take the input from the live monitoring camera and process the image. After that, the live images should enter the neural network to predict the result and decides whether the person is wearing a mask or not.

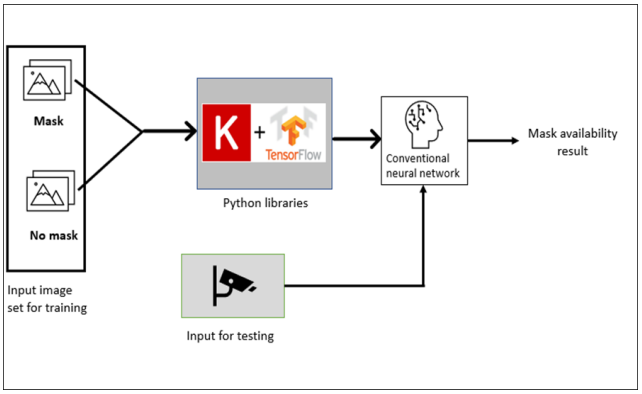


Figure 4. Model Design

The real-time mask availability project involves many parts combined to perform the task required for mask detection. The system involves the use of Python and its libraries of Computer vision, which is known as OpenCV, Keras, and TensorFlow for machine learning. The python programming language is used as the perfect environment to implement our project. As it is easy to learn and supports a lot of useful packages.

### *A. OpenCV for Computer vision*

The computer Vision knows as OpenCV is a package that can be installed in python to allow the features that are helpful in the investigation of the surroundings. Computer vision can be defined as an investigation of the surroundings to see how computers and machines can understand digital images and videos. The computer visions as we mentioned helps in understanding the images and videos to be processed in the artificial intelligence to create useful applications. The understanding of the images and videos for computers and machines was a bewildering mystery back in the ages. But, with the development of the technology, a set of algorithms has been discovered that helped in this field to make it possible for us to let the computers identify the images. As the machines and computers cannot understand the image as they were built to execute codes written by the programmers and manufacturers [16].

### *B. Tensorflow and keras for machine learning*

TensorFlow and Keras are famous library packages and widely used in python to support the implementation of machine learning techniques. It allows the implementation of the neural network methods and many more in the service of artificial intelligence. The packages provided by google provide a strong environment in the process of machine learning as they were built for this purpose. With the help of TensorFlow and Keras, we can train models to identify and recognize certain things just like human brains. The goal of training a model using TensorFlow and Keras is to outcome a model that can compare an input image with pre-trained model using images to identify the classification of the input image [17].

### *C. System implmentation*

Firstly, we gathered over 1000 images of people faces. The images are mixture of people who wear the mask and the people who do not. The image was sorted into two folders, to separate the images of people with mask from the people without mask.

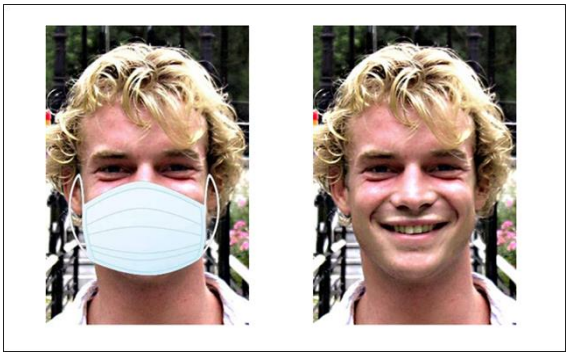

Figure 5. Sample of Data Set

Secondly, we started to read the images to process them. We changed the images color to the gray and resized the images to be unify in terms of the size. This operation is set for every picture in the two folders and stored in a form where it can be used for creating the neural network. Thirdly, we called the TensorFlow and Keras libraries to build our convolutional neural network. we used our processed data as the input layer of the convolutional neural network. The convolutional neural network has two hidden layers. The first layer consist of 200 kernel and the second layer is consist of 100 kernels to ensure the accuracy of training. for an epoch number of 20 the model is trained and saved to be used in the live monitoring. Lastly, using OpenCV and Keras We used the camera of our laptop as the live monitoring camera and we started to capture the frames in the live video and process each frame captured to be in gray color and unified to the same form of processed dataset to be entered inside the convolutional neural network. After the frame is passed to the convolutional neural network. We predict the result and return the label of the higher prediction to identify

if it is the group of masks or without the mask. After the frame is entered in the convolutional neural network it predicts the result by comparing the input images with the trained model and show it live on the screen of the laptop if the person is wearing a mask or not.

## 4. CONCLUSION AND FUTURE WORK

To conclude, the idea of this paper was inspired by involving the latest engineering technologies to fight back the spread of the virus. With an extremely high number of new cases. It is challenging for the governments and authorities to ensure that everyone is applying the laws of wearing the mask. The mask factor is important to maintain people's safety as it can reduce the infection by a high significant percentage. The research aimed to keep the public health and safety of people by creating a monitor system that detects the real-time mask availability. It has useful features of installation and flexibility to be installed everywhere. The system required no third party and can be hosted by authorities easily. The system uses artificial intelligence and computer vision to achieve its goal. The project uses image processing and besides that, a strong neural network model was designed for deep learning. The model was trained with over 1000 images. Thus, it gave us a high accuracy of mask availability detection. The project had a variety of advantages and disadvantages. One of the disadvantages that the training model can consume a lot of time to train depending on the power of the machine. On the other hand, one of the important advantages is the simplicity of the design.

### *A. Future work*

For future work, the system could have some improvements that would improve it significantly. The first recommendation is to increase the data set to 5000 images or more. The bigger the data set the more accuracy to achieve. The higher data set can lead to complexity and time to consume to train the model. But in return, we will achieve higher accuracy. The higher accuracy will reduce the fault tolerance which will enhance the mask detection more and more. Another suggestion is to have a backup machine to run the system. so, in case of any failures, another machine is ready to take the place and run the system. thus, will lead to an increase in availability. a high recommendation is to merge with the system a live temperature monitoring. This will also detect the people who are possible to have COVID-19 and still ignore staying at home and apply the rules of quarantine. This factor will also help in reducing the amount of infection between people by monitoring their temperature. Another piece of advice is to link the system with civil records and to identify the offender's identity quickly in a matter of a small fraction of time. The last suggestion is to host the system on a cloud, which will allow the interconnecting of the places that have been monitored under one roof. As well as cloud computing is raising technology known for its reliability and high performances for an affordable price.

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## REFERENCES


[1] Worldometers.info. 2020. Coronavirus Update From COVID-19 Virus Pandemic - Worldometer. [online] Available at: https://www.worldometers.info/coronavirus/? [Accessed 3 December 2020].

[2] "Advice on the use of masks in the community, during home care and in healthcare settings in the context of the novel coronavirus (COVID-19) outbreak", *Who.int*, 2020. [Online]. Available:https://www.who.int/publications/i/item/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak. [Accessed: 03- Dec- 2020].

[3] McCarthy, A., 2020. *How Masks Protect Against COVID-19: Understanding The Science - Boston Children's Discoveries*. [online] Boston Children's Discoveries. Available at: https://discoveries.childrenshospital.org/covid-19-mask-science[Accessed 3 December 2020].

[4] Loey, Mohamed, et al. "A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID-19 pandemic." *Measurement* 167 (2020): 108288.

[5] Chowdary, G. Jignesh, et al. "Face Mask Detection using Transfer Learning of InceptionV3." *arXiv preprint arXiv:2009.08369* (2020).

[6] Wu, Haiwei, et al. "Mask Detection and Breath Monitoring from Speech: on Data Augmentation, Feature Representation and Modeling." arXiv preprint arXiv:2008.05175 (2020).

[7] Ristea, Nicolae-Cătălin, and Radu Tudor Ionescu. "Are you wearing a mask? Improving mask detection from speech using augmentation by cycle-consistent GANs." *arXiv preprint arXiv:2006.10147* (2020).

[8] Leite, D., 2020. *The History Of Image Processing Information Technology Essay*. [online] Medium.com. Available at:https://medium.com/@danilloleite82/the-history-of-image-processing-information-technology-essay-a30690c352f4[Accessed 4 December 2020].

[9] Velasco, *researchgate*, 2020. [Online]. Available: https://www.researchgate.net/figure/Figure-2-Digital-image-processing-system-The-Digital-Image-Processing-System-consists_fig2_324827420

[10] Anbarjafari, G., 2020. *1. Introduction To Image Processing*. [online] Sisu.ut.ee. Available at: https://sisu.ut.ee/imageprocessing/book/1 [Accessed 8 December 2020].

[11] Faggella, D., 2020. *Computer Vision Applications - Shopping, Driving, And More*. [online] Emerj. Available at: https://emerj.com/ai-sector-overviews/computer-vision-applications-shopping-driving-and-more/[Accessed 10 December 2020].

[12] F. Bre, "Fig. 1. Artificial neural network architecture (ANN i-h 1-h 2-h n-o).", ResearchGate, 2017. [Online]. Available: https://www.researchgate.net/figure/Artificial-neural-network-architecture-ANN-i-h-1-h-2-h-n-o_fig1_321259051. [Accessed: 10- Dec- 2020].

[13] CHEN, J., 2020. *Neural Network Definition*. [online] Investopedia. Available at: https://www.investopedia.com/terms/n/neuralnetwork.asp[Accessed 10 December 2020].

[14] J. Brownlee, "How Do Convolutional Layers Work in Deep Learning Neural Networks?", Machine Learning Mastery, 2020. [Online]. Available: https://machinelearningmastery.com/convolutional-layers-for-deep-learning-neural-networks/.[Accessed: 11- Dec- 2020].

[15] S. Saha, "A Comprehensive Guide to Convolutional Neural Networks—the ELI5 way", *towardsdatascience*, 2018. [Online]. Available: https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53.[Accessed: 12- Dec- 2020].

[16] j. smith, "Computer vision and how it is related with machine learning", *ZEISS Digital*, 2020. [Online]. Available: https://blogs.zeiss.com/digital/the-relation-between-computer-vision-and-machine-learning/. [Accessed: 11- Dec- 2020].

[17] A. Choudhury, "TensorFlow vs Keras: Which One Should You Choose", *Analytics India Magazine*, 2020. [Online]. Available: https://analyticsindiamag.com/tensorflow-vs-keras-which-one-should-you-choose/. [Accessed: 11- Dec- 2020].

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