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Designing a Framework to Detect Face Mask using Machine Learning

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Abstract: As we know the pandemic situation around us and many are doing various efforts to avoid it. Technological background and medical efforts are on the verge to prevent the situation. At least it's our duty as technocrats to provide the proper solution and the proposed system works on that principal. The main intension with the system is to make aware about for maintenance of hygienic conditions of an individual. The main objective is to make use of detection system and implementing based on its condition. The mask was being an important part at the same time washing hand by making use of sanitizer. The system includes camera embedded with sanitizer machine and detect the user about its mask. Also, this system installed at the gate which detects the image of the person entering premises and if the mask was wearing by the person, then only the gate will open and sanitizer will drop on the hand of person or else the system will not open the gate using Arduino.

Keywords: Techocrats, Sanitizer, Embedded, Gate, Arduino, etc.

I. INTRODUCTION

Due to the technical difficulties and their complexity in some fields, researchers worked hard to find efficient algorithms that help to find alternative solutions appropriate to reach speedy solution of the problems. Especially in using computer in the field of security and protection, the objects recognition by using computer becomes very necessary for making decisions. Nowadays, there is a big scientific development in the informatics and programming techniques, in which the images took a very important role in various zone such as medicine media, education, design, industry, security etc.

The main reason for this development is the wide using of computer in all these zones. The digital image permits to get images instantly without needing for chemical treatments. The image processing is used in many computer vision applications. It notices that the most researches nowadays, especially image processing researches, tend to use in security field, because the digital images become the main dependent component in most electronic devices used in this field. Where it can store a group of images in a computer database and then using images processing programs to recognize the captured pictures from monitoring camera can make the right decision depending on matching the recognized image with the stored database.

The system procedure begins with a picture captured by a digital camera and then the camera sends a captured picture to the computer. The computer recognition program runs to recognize the vehicle depending on the color and shape of the patch and matching it with sorted database. In case of the matching occurred, the system will permit the vehicle to enter.

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1.1 Objectives:

"Prevention is better than cure" is one of the effective measures to prevent the spreading of COVID-19 and to protect mankind. Many researchers and doctors are working on medication and vaccination for corona.

COVID-19 spreads mostly by droplet infection when people cough or if we touch someone who is ill and then to our face (i.e., rubbing eyes or nose). Ongoing pandemic shows that it is much more contagious and spreads fast. Depending on the infection spreading, we have two cases: Fast and Slow spread.

Fast pandemic will be terrible and will cost many lives. It occurs due to a rapid rate of infection because there are no countermeasures to slow it down. This is because, if the numbers of infected people get too large, healthcare systems become unable to handle it. We will lack resources such as medical staff or equipment like a ventilator.

- To avoid the above situation, we need to do what we can to turn this into a slow pandemic. A pandemic can be slowed down only by the right responses, mainly in the early phase. In this phase, everyone who is sick can get treatment and there is no emergency point with flooded hospitals.
- In this pandemic, we need to engineer our behavior as a vaccine. that is, "Not getting infected" and "Not infecting others". The best thing we can do is to wash our hands with soap or a hand sanitizer. The next best thing is social distancing.
- To avoid getting infected or spreading it, it is essential to wear a face mask while going out from home especially to public places such as markets or hospitals.

II. WORKING PRINCIPLES

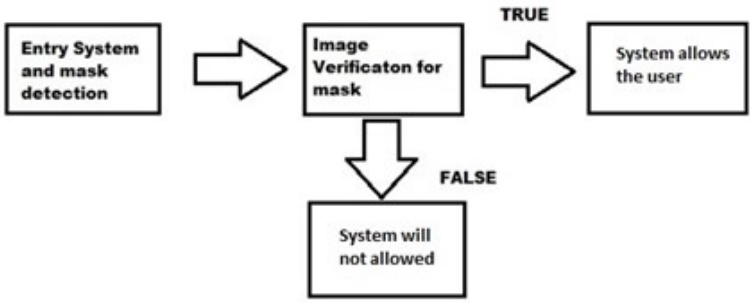

Figure 1: Block Diagram of Proposed Project

2.1 Proposed System:

The main intension with the system is to make aware about for maintenance of hygienic conditions of an individual. The main objective is to make use of detection system and implementing based on its condition. The mask was being an important part at the same time washing hand by making use of sanitizer. The system includes camera and detect the user about its mask. Also, this system uses the image of the person entering premises and if the mask was wearing by the person, then only the system allow user to enter. After an arise of Covid-19, the Face-Mask detection has widely considered problem in the image processing field.

This technology is currently more appropriate because it is applied to detect faces and to identify people wearing masks in images, videos and in real-time vision. By using deep learning and convolution neural network (CNN) techniques, it become possible to achieve high accuracy results in image classification and object detection applications.

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III. LITERATURE SURVEY

Face recognition is a method of identifying or verifying the identity of an individual using their face. There are various algorithms that can do face recognition but their accuracy might vary. Here I am going to describe how we do face recognition using deep learning. So now let us understand how we recognise faces using deep learning. We make use of face embedding in which each face is converted into a vector and this technique is called deep metric learning. Let me further divide this process into three simple steps for easy understanding:

Face Detection: The very first task we perform is detecting faces in the image or video stream. Now that we know the exact location/coordinates of face, we extract this face for further processing ahead.

Feature Extraction: Now that we have cropped the face out of the image, we extract features from it. Here we are going to use face embeddings to extract the features out of the face. A neural network takes an image of the person's face as input and outputs a vector which represents the most important features of a face. In machine learning, this vector is called embedding and thus we call this vector as face embedding. Now how does this help in recognizing faces of different persons?

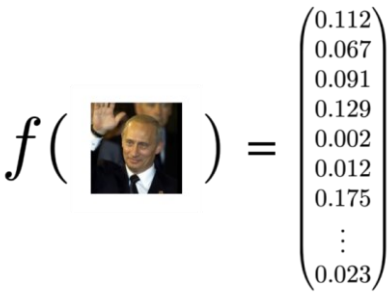

Figure 2: Feature Extraction

While training the neural network, the network learns to output similar vectors for faces that look similar. For example, if I have multiple images of faces within different timespan, of course, some of the features of my face might change but not up to much extent. So, in this case the vectors associated with the faces are similar or in short, they are very close in the vector space. Look at the below diagram for a rough idea:

Figure 3: Training the Images

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Now after training the network, the network learns to output vectors that are closer to each other(similar) for faces of the same person (looking similar). The above vectors now transform into:

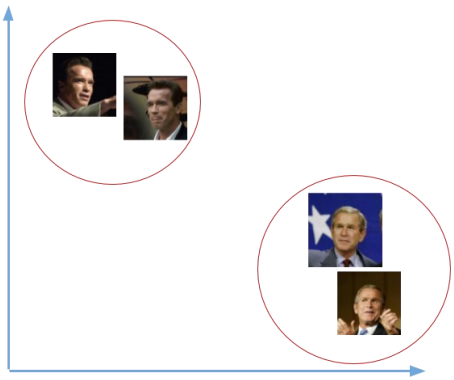

Figure 4: Vector Imaging

We are not going to train such a network here as it takes a significant amount of data and computation power to train such networks. We will use a pre-trained network trained by Davis King on a dataset of ~3 million images. The network outputs a vector of 128 numbers which represent the most important features of a face.
Now that we know how this network works, let us see how we use this network on our own data. We pass all the images in our data to this pre-trained network to get the respective embeddings and save these embeddings in a file for the next step.

Comparing faces: Now that we have face embeddings for every face in our data saved in a file, the next step is to recognise a new t image that is not in our data. So, the first step is to compute the face embedding for the image using the same network we used above and then compare this embedding with the rest of the embeddings we have. We recognise the face if the generated embedding is closer or like any other embedding as shown below:

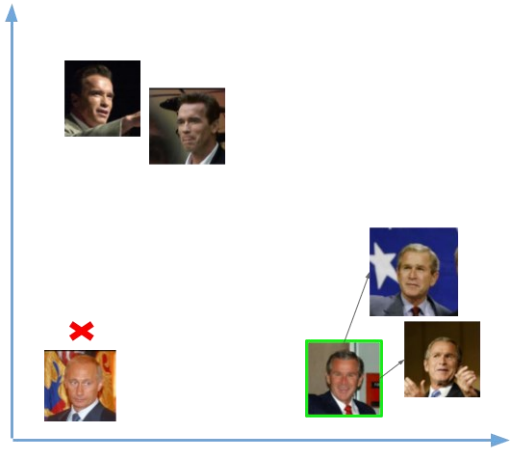

Figure 5: Comparing Faces

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So, we passed two images, one of the images is of Vladimir Putin and other of George W. Bush. In our example above, we did not save the embeddings for Putin but we saved the embeddings of Bush. Thus, when we compared the two new embeddings with the existing ones, the vector for Bush is closer to the other face embeddings of Bush whereas the face embeddings of Putin are not closer to any other embedding and thus the program cannot recognise him.

3.1 HAAR Cascade:

The HAAR feature continuously traverses from the top left of the image to the bottom right to search for the feature. This is just a representation of the whole concept of the HAAR feature traversal. In its actual work, the HAAR feature would traverse pixel by pixel in the image. Also, all possible sizes of the HAAR features will be applied. Depending on the feature each one is looking for, these are broadly classified into three categories. The first set of two rectangle features are responsible for finding out the edges in a horizontal or in a vertical direction (as shown above). The second set of three rectangle features are responsible for finding out if there is a lighter region surrounded by darker regions on either side or vice-versa.

The third set of four rectangle features are responsible for finding out change of pixel intensities across diagonals. Now, the HAAR features traversal on an image would involve a lot of mathematical calculations. As we can see for a single rectangle on either side, it involves 18-pixel value additions (for a rectangle enclosing 18 pixels). Imagine doing this for the whole image with all sizes of the HAAR features. This would be a hectic operation even for a high-performance machine. To tackle this, they introduced another concept known as The Integral Image to perform the same operation. An Integral Image is calculated from the Original Image in such a way that each pixel in this is the sum of all the pixels lying in its left and above in the Original Image. The calculation of a pixel in the Integral Image can be seen in the above GIF.

The last pixel at the bottom right corner of the Integral Image will be the sum of all the pixels in the Original Image. With the Integral Image, only 4 constant value additions are needed each time for any feature size (with respect to the 18 additions earlier). This reduces the time complexity of each addition gradually, as the number of additions does not depend on the number of pixels enclosed anymore. In the above image, there is no edge in the vertical direction as the HAAR value is -0.02, which is very far from 1.

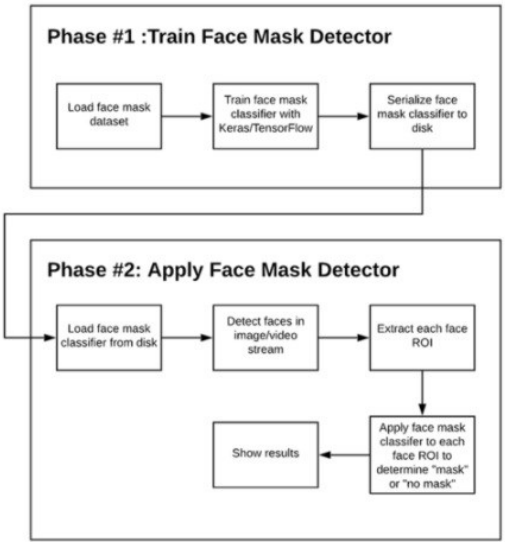

Figure 6: Phases of Face Mask

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Again, repeating the same calculation done above, but this time just to see what HAAR value is calculated when there is a sudden change of intensities moving from left to right in a vertical direction. The HAAR value here is 0.54, which is closer to 1 in comparison to the case earlier.

IV. EXPECTED OUTPUT

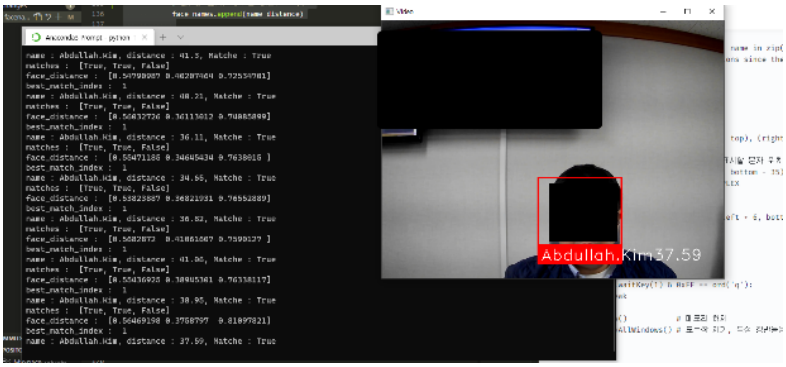

Figure 7: Detection of Frames, Temperature, and Distance

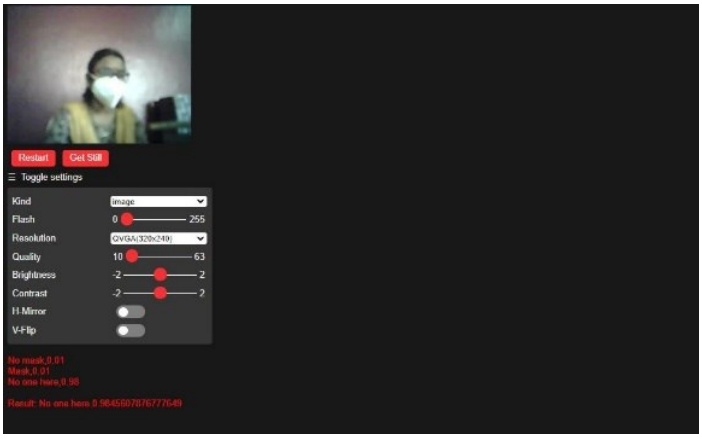

Figure 8: Identification of Mask

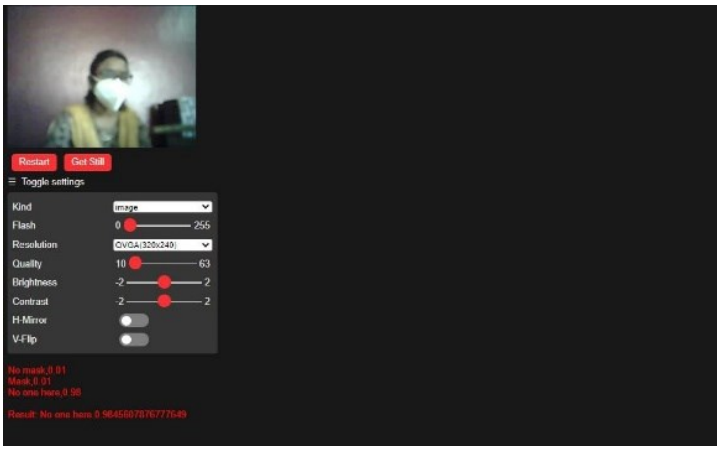

Figure 9: Multi Facemask Detection Also Possible

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V. CONCLUSION

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Modern artificial intelligence systems and machine learning algorithms have revolutionized approaches to scientific and technological challenges in a variety of fields. Nowadays Deep Learning (DL) and Machine Learning (ML) techniques has been a very useful tools in solving problems. In the proposed real-time-face mask detection model Deep Learning libraries has been used to detect face and determine whether the person wear a mask or not. from the experimental result table, is seems that the real time face-detection system has a high accuracy in detecting mask, this help to control the spreading of COVID-19 in public places by preventing the people to enter it without wearing a face mask.

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