Deep Learning Applied to the Detection of Masks on Faces

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Abstract — Derived from the pandemic COVID19 that we are currently experiencing as a security measure it is very important that people wear face masks especially in public places, to try to minimize the spread of the SARS-Cov2 virus; this Project consisted in the detection of faces with and without face masks applying Deep learning neural networks, it was developed by using Python and the libraries TensorFlow and OpenCV which allowed to apply learning rules to artificial vision systems. The above would allow the installation of artificial vision systems in public places soon to warn and invite people to wear face masks when detected by the system.

Keywords — artificial vision, COVID-19, Deep Learning, TensorFlow.

I. INTRODUCTION

During the present year 2020 the most important event that has occurred worldwide there is the arising of the COVID19 pandemic, in the far East in the People's Republic of China in the Wuhan City, Hubei province. Such event shook the world, paralyzing the global economy, making humanity to reevaluate their priorities. The SARS-Cov2 virus has claimed more than 761 779 lives worldwide, with several 21.2 million 21 294 845 confirmed infected cases, unfortunately in our country the health crisis has reported 525 733 deaths with more than 57 023 infected people according to the World Health Organization.

Deep learning is a type of automatic learning in which a model learns to perform classification tasks directly from images, text, or sound. Deep learning is generally implemented using a neural network architecture. The term "Deep" refers to the number of layers of the network: The more layers, the deeper the network is. Traditional neural networks contain only 2 or 3 layers, while deep networks can have hundreds. Deep learning is especially suitable for identification applications such as facial recognition, text translation, voice recognition and advanced driver assistance systems, including lane classification and traffic sign recognition.

A Deep neural network combines multiple layers of nonlinear processing, using simple elements that operate in parallel and inspired by biological nervous systems. It consists of an input layer, several hidden layers, and an output layer. Layers are interconnected through nodes or neurons, and each layer uses the output of the previous layer as input.

The training of a Deep learning model can take hours, days or weeks depending on the size of the data and the amount of processing power you have available. The selection of a computing resource is a critical consideration when configuring your workflow.

The present Project proposes to apply the Deep learning paradigm in artificial neural networks derived from artificial intelligence using Python, TensorFlow and OpenCV libraries to perform the detection of people with and without masks, this would allow the development and installation of artificial vision systems in public places in a near future, to warn and invite people to wear the mask when detected by the system. This article is derivative of the SIP 20201970 Project

II. DEVELOPMENT

This stem was developed with the help of the open-source platform Anaconda 3, which was used to execute the performed codes that were based on Python, for which it was required to process large volumes of information, as well as to apply automatic learning.

The Anaconda package was used as the software that contributed to the data processing, a virtual environment was built, which had the function of storing all the libraries that were used in this Project, it was created through a command that allowed us to create a library which we called "MASK_DETECTOR" (Fig. 1), running on the "Anaconda prompt" program, that was based on 3.7.7 Python version through the Anaconda 3 platform.

```
Documents\UPIIH>conda create -n DETECTOR_CUBREBOCAS python=3.7.7 anaconda
```

Fig. 1. Executed command in "Anaconda prompt" program.

Then, it was necessary to install the libraries required for the execution of the project, these are the ones listed below:

1. TensorFlow.
2. Numpy.
3. Imutils.
4. Open CV.

A search and compilation were made in databases with around 700 images of people's faces with and without face masks, which served as basis for the training of the multilayer neural network deep learning. A sample of the set of images is observed in Fig. 2 and Fig. 2 b.

It was developed a program coded in python for the

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detection of faces with and without masks, for its execution process, it was first necessary to load the libraries for its operation (Fig. 3). In the same way, a code segment was drafted and written, where the detection cycle was made for the identification of faces and finally it was selected, where the prediction of the use of face masks was made, only if a face was detected. (Fig. 4).

Fig. 2 a. Sample of images of people without face masks.

Fig. 2 b. Sample of images of people with face masks.

```
# importar paquetes necesarios
from tensorflow.keras.applications.mobilenet_v2 import preprocess_input
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.models import load_model
from imutils.video import VideoStream
import numpy as np
import argparse
import imutils
import time
import cv2
import os
```

Fig. 3. Libraries Load.

```
# loop en las detecciones
for i in range(0, detections.shape[2]):
    confidence = detections[0, 0, i, 2]

    # Filtra detecciones nulas
    if confidence > args["confidence"]:
        # Coordenadas para caja de detección
        box = detections[0, 0, i, 3:7] * np.array([w, h, w, h])
        (startX, startY, endX, endY) = box.astype("int")
        (startX, startY) = (max(0, startX), max(0, startY))
        (endX, endY) = (min(w - 1, endX), min(h - 1, endY))

        face = frame[startY:endY, startX:endX]
        face = cv2.cvtColor(face, cv2.COLOR_BGR2RGB)
        face = cv2.resize(face, (224, 224))
        face = img_to_array(face)
        face = preprocess_input(face)
        face = np.expand_dims(face, axis=0)
        faces.append(face)
        locs.append((startX, startY, endX, endY))

# Solo hacer predicciones si por lo menos un rostro fue detectado
if len(faces) > 0:
    preds = maskNet.predict(faces)
```

Fig. 4. Code for face detection.

A subroutine was written to print the legend "Loading model ...", which aims to indicate if the mask detection model

is being loaded and later it was started the video through the connected webcam defined as "src", the value of this variable was used to indicate which web camera would be used (Fig. 5), the number 0 is the default camera.

```
# Cargar modelo
print("Cargando modelo detector de cubrebocas...")
maskNet = load_model(args["model"])

# Iniciar video
print("Iniciando video...")
vs = VideoStream(src=0).start()
time.sleep(2.0)
```

Fig. 5. Model loading and Starting video.

Subsequently it was determined through the models created with the images that served as a training set, if there was a face with or without a mask, once this was done a label was programmed on the frame created for the face, which would indicate if a face with or without mask was detected, in the case of having a face mask the frame and the legend would be indicated with a green label, otherwise since there were no face masks, the frame and the legend would be indicated with a red label, finally, a window was created where the video was shown and in the case of wanting to leave from this window you must press the letter "q" (Fig. 6). The execution of the program is carried out with the Anaconda command prompt (Fig. 7).

```
# Determinar si hay cubrebocas o no
(locs, preds) = detect_and_predict_mask(frame, faceNet, maskNet)

for (box, pred) in zip(locs, preds):
    (startX, startY, endX, endY) = box
    (mask, withoutMask) = pred

    label = "Cubrebocas" if mask > withoutMask else "SIN cubrebocas"
    color = (0, 255, 0) if label == "Cubrebocas" else (0, 0, 255)

    # Porcentaje de igualdad
    label = "{}: {:.2f}%".format(label, max(mask, withoutMask) * 100)

    cv2.putText(frame, label, (startX, startY - 10),
                cv2.FONT_HERSHEY_SIMPLEX, 0.45, color, 2)
    cv2.rectangle(frame, (startX, startY), (endX, endY), color, 2)

# Muestra la ventana
cv2.imshow("Detector de cubrebocas", frame)
key = cv2.waitKey(1) & 0xFF

# Presionar "q" para salir
if key == ord("q"):
    break
```

Fig. 6. Show indication of the use of face masks.

python Detector_de_cubrebocas.py

Fig. 7. Command to run the developed program.

III. RESULTS

To validate the efficiency of the prototype of the developed system many tests were carried out, executing the code through Anaconda prompt, putting this in operation (fig.8), in the same way that it was tested with different people and different types of face masks, having a very efficient and satisfactory system behavior. (Fig. 9 a and Fig. 9 b).

Cargando modelo...
Cargando modelo detector de cubrebocas...

Fig. 8. Legend when running the program.

Fig. 9 a. Person detected without mask.

Fig. 9 b. Person detected with mask.

Finally, the system was trained with a database of approximately 700 faces, in 6 seconds time, after performing multiple tests, the performance of the system was very satisfactory, with a high degree of efficiency in detecting a face of a person wearing a mask, preferably light color, the detection of the face with or without mask was carried out in 6 seconds. However, some problems were found when wearing dark-colored masks, especially when detecting in places with poor lighting, the recognition came to fail on some occasions.

IV. CONCLUSIONS

A prototype of a system was developed for detecting the faces of people with and without masks using deep learning, based on open-source tools, the Anaconda platform 3, code developed in Python and the TensorFlow libraries, Numpy, Imutils, and OpenCV. The prototype showed a high degree of efficiency in detection when the person wore light colored masks.

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