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#   ************** START OF PROGRAM *****************    #
#   ************** ACTUAL PROGRAM *****************    #
#   ***************** PROGRAM TO PREDICT HAND GESTURES AND UPLOAD THE
PREDICTIONS TO FIREBASE *****************    #
# *************** Imports from keras h5 model Prediction.py File
*************** #

import tensorflow.keras
from PIL import ImageTk, Image, ImageOps
import numpy as np

# *************** Imports for GUI *************** #

from tkinter import Tk, Frame, Label, Button
from tkinter import messagebox

# *************** Imports from FB DB upload.py File *************** #

from firebase import firebase

# *************** Imports from OpenCV DC.py File *************** #

import cv2

# *************** Imports for Process Schedulers *************** #

import sys
import os
import time
import threading

# *************** Imports for data analysis and data manipulation
*************** #

import pandas as pd
import seaborn as sns
import matplotlib.pylab as plt
import csv

# *************** Determine the way floating point numbers,
# arrays and other NumPy objects are displayed *************** #

np.set_printoptions(suppress=True)

# *************** Accessing firebase real-time database project
*************** #

firebase = firebase.FirebaseApplication("https://rtmc-hg-default-
rtdb.firebaseio.com/", None)

# *************** Assigning the saved keras.h5 model to a variable
*************** #

model = tensorflow.keras.models.load_model('Keras/keras_model.h5')

# *************** Assigning/Re-assigning the data in firebase with a
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Startup String ************** #

firebase.put("/Data", "Preds", "** PROGRAM START **")
time.sleep(3)

# ************** Creating global variables for later usage inside
functions ************** #

kernel = np.array([[-1, -1, -1], [-1, 9, -1], [-1, -1, -1]])
data = np.ndarray(shape=(1, 224, 224, 3), dtype=np.float32)
size = (224, 224)
t1, t2, t3, round_prediction, cap = None, None, None, None, None
off_data_upload_normal, off_data_upload_automate, off_video_capture,
start_process, automate_process, automateprev = \
    False, False, False, False, False, False
list_preds = []

fields = ["Hand_Closed", "Index", "Middle", "Ring", "Little", "Thumb",
"Index_Little", "Index_Middle",
          "Middle_Ring", "Ring_Little", "Thumb_Index", "Thumb_Little",
"Index_Middle_Ring", "Middle_Ring_Little",
          "Thumb_Index_Little", "Thumb_Index_Middle",
"Index_Middle_Ring_Little", "Thumb_Index_Middle_Ring",
          "Hand_Open", "Partial"]


# ************** START of Functions that are used as commands for
buttons ************** #


def start():
    # ************** A function that is bind to start_button to start
the program ************** #

    global cap, t1, t2, t3, start_process

    # ************** Determining when start can work **************
#

    if not automateprev and not start_process:

        # ************** Setting the start_process variable to True,
Hence multiple clicks doesnt work ************** #

        start_process = True

        # ************** Changing the camera_status label to LIVE
CAPTURE ON ************** #

        camera_status.config(text="⦿ LIVE CAPTURE ON", bg="black",
fg="#00D100")

        # ************** Removing any existing log.csv file from the
system ************** #

        try:
            os.remove("log.csv")
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        except FileNotFoundError:
            pass

        # *************** Creating a new log.csv file with initial
columns *************** #

        try:
            csvfile_test = open("log.csv", "r")
        except FileNotFoundError:
            csvfile_test = open("log.csv", "w", newline="")
            csv_writer = csv.writer(csvfile_test)
            csv_writer.writerow(fields)
        finally:
            csvfile_test.close()

        # *************** Using OpenCV VideoCapture for capturing live
video and setting window parameters *********** #

        cap = cv2.VideoCapture(0, cv2.CAP_DSHOW)
        cap.set(3, 1000)
        cap.set(4, 1000)

        # *************** threads for keeping active the function
video_stream and
        # constant_upload without both interfering *************** #

        t1 = threading.Thread(target=video_stream)
        t1.start()
        time.sleep(1)
        t2 = threading.Thread(target=constant_upload)
        t2.start()
        t3 = threading.Thread(target=timed_loop_prediction)
    else:
        pass


def automate():
    # *************** A function that is bind to automate_button to
automate the program *************** #

    global off_video_capture, off_data_upload_normal, list_preds, t3,
cap, automate_process

    # *************** Determining when automate can work
*************** #

    if start_process and not automate_process:

        # *************** Setting the automate_process variable to
True, Hence multiple clicks doesnt work *********** #
        # *************** Setting the off_video_capture,
off_data_upload_normal to True to stop the process ********** #
        # *************** Stopping the live video capture by
cap.release() ************* #

        automate_process = True
        off_video_capture = True
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        off_data_upload_normal = True
        cap.release()

        # ************** Changing the camera_status label to LIVE
CAPTURE OFF ************** #

        camera_status.config(text="⦿ LIVE CAPTURE OFF", bg="black",
fg="red")

        # ************** Giving the lmain label the initial image
************** #

        lmain.config(image=initial_image)

        # ************** Storing the predictions to a .csv file
************** #

        with open("log.csv", "a", newline="") as log:
            log_writer = csv.writer(log)
            log_writer.writerows(list_preds)

        # ************** Starting the thread t3 for automated data
upload ************** #

        t3.start()
    else:
        pass


def automate_prev():
    # ************** A function that is bind to automate_prev_button
to automate from the existing .csv file ******** #

    global automateprev

    # ************** Determining when automate_prev can work
************** #

    if not start_process and not automateprev:

        # ************** Reading from the existing .csv file
************** #
        # ************** Starting the thread t3 for automated data
upload ************** #

        try:

            with open("log.csv", "r") as log_read:
                log_reader = csv.reader(log_read)
                for row in log_reader:
                    if row == fields:
                        pass
                    else:
                        current_pred = [int(i) for i in row]
                        list_preds.append(current_pred)

                t3 = threading.Thread(target=timed_loop_prediction)
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                t3.start()

            # *************** Setting the automateprev variable to
True, Hence multiple clicks doesnt work *********** #

            automateprev = True

        except FileNotFoundError:
            messagebox.showwarning(title="WARNING", message="THERE IS
NO PREVIOUS log.csv FILE\n"
                                                            "CLICK THE
START BUTTON TO CREATE ONE")
            pass


def insight():
    # *************** A function that is bind to insight_button for
generating useful graphs ******** #

    try:
        log = pd.read_csv("log.csv")
        sns.heatmap(log, linewidth=0.5, center=0, cmap='Greens',
annot=True, fmt="d")
        plt.title("HEATMAP")
        plt.savefig('HEATMAP.png')

    except OSError or FileNotFoundError:
        messagebox.showwarning(title="WARNING", message="FILE IN
USE/NO log.csv EXISTS\nCLOSE THE FILE AND TRY AGAIN\n"
                                                        "OR PRESS
START TO CREATE A NEW log.csv")
        pass

    except ValueError:
        pass


def stop():
    # *************** A function that is bind to stop_button to stop
the program *************** #

    global off_data_upload_normal, off_video_capture,
off_data_upload_automate, list_preds

    # *************** Creating a .csv file when start is pressed and
automate is not pressed *************** #
    # *************** Setting required variable to true to stop the
process *************** #

    if start_process and not automate_process:
        with open("log.csv", "a", newline="") as log:
            log_writer = csv.writer(log)
            log_writer.writerows(list_preds)
            root.destroy()
            off_data_upload_normal = True
            off_data_upload_automate = True
            off_video_capture = True
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            sys.exit()
    else:
        root.destroy()
        off_data_upload_normal = True
        off_data_upload_automate = True
        off_video_capture = True
        sys.exit()


# *************** END of Functions that are used as commands for
buttons *************** #

# *************** Function that returns the README content in
messagebox *************** #


def general_message():
    text = "General Instructions :\n\n" \
           "1. Initially, the START, AUTOMATE(prev.), INSIGHT, STOP
buttons work.\n\n" \
           "2. The START button starts a new process by clearing the
previous\n" \
           "log.csv proceeding to start the live data capture and
prediction while\n" \
           "uploading the predicted data to the online database system
in the\n" \
           "interval of 1 second.\n\n" \
           "3. The AUTOMATE(prev.) button loops through the data that
is present\n" \
           "in the log.csv that is generated before, meanwhile
uploading the data\n" \
           "to the online database system in intervals of 1
second.\n\n" \
           "4. The INSIGHT button generates a HEATMAP with annotations
from the\n" \
           "log.csv.\n\n" \
           "5. The STOP button stops any process that is happening and
closes\n" \
           "the window.\n\n" \
           "Constraints and Specifics :\n\n" \
           "1. The AUTOMATE button works only after the START button
is pressed,\n" \
           "and the AUTOMATE button loops through the data that is
already predicted\n" \
           "meanwhile uploading it to the online database system in
intervals of 1\n" \
           "second, It also generates a new log.csv file that contains
the data that is\n" \
           "predicted.\n\n" \
           "2. Initially the INSIGHT button works, when the START
button is pressed\n" \
           "INSIGHT works only after AUTOMATE button is also
pressed.\n\n" \
           "3. The AUTOMATE(prev.) button works only when the START
button is\n" \
           "not pressed and vice versa.\n\n" \
           "4. The STOP button generates a log.csv file only when the
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START\n" \
           "button is pressed and AUTOMATE button is not pressed.\n\n"
\
           "5. The LIVE CAPTURE OFF text changes to LIVE CAPTURE ON
only when\n" \
           "the START button is pressed and the PROCESS NOT STARTED
text\n" \
           "changes to the predicted output(ie. Hand Closed, Hand
Open, etc.) when\n" \
           "the START/AUTOMATE(prev.) button is pressed, also it
denotes whether\n" \
           "the data being uploaded is LIVE or AUTOMATED.\n\n" \
           "6. If there is no log.csv and INSIGHT or AUTOMATE(prev.)
is pressed\n" \
           "initially, then the INSIGHT and AUTOMATE(prev.) shows a
descriptive warning. "

    return text


# *************** Creating a window called as root for GUI
*************** #

root = Tk()
root.title("RTMC-HG")
root.config(bg="black")
root.iconbitmap("Image/robotic-arm.ico")
root.focus()

# *************** Creating a frame *************** #

app = Frame(root)
app.grid(column=1, row=1, rowspan=5)

# *************** Creating a label in the frame amd assigning a
starting image for it *************** #

initial_image = ImageTk.PhotoImage(file="Image/Initial_Image.png")
lmain = Label(app)
lmain.config(image=initial_image)
lmain.grid()

# *************** Creating a label in the frame amd assigning the text
- ⦿ LIVE CAPTURE OFF *************** #

camera_status = Label()
camera_status.config(text="⦿ LIVE CAPTURE OFF", bg="black", fg="red")
camera_status.grid(column=0, row=0, columnspan=2)

# *************** Creating a label in the frame amd assigning the text
- PROCESS NOT STARTED *************** #

prediction_status = Label()
prediction_status.config(text="PROCESS NOT STARTED", bg="black",
fg="red")
prediction_status.grid(column=0, row=6, columnspan=2)
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# *************** Creating buttons inside the window to perform
different tasks *************** #

start_button = Button(text="START", command=start, bg="#59981A",
fg="white", width=9)
start_button.grid(column=0, row=1)
automate_button = Button(text="AUTOMATE", bg="#191970", fg="white",
width=9, command=automate)
automate_button.grid(column=0, row=2)
automate_prev_button = Button(text="AUTOMATE\n(prev.)", bg="#191970",
fg="white", width=9, command=automate_prev)
automate_prev_button.grid(column=0, row=3)
insight_button = Button(text="INSIGHT", width=9, bg="#191970",
fg="white", command=insight)
insight_button.grid(column=0, row=4)
stop_button = Button(text="STOP", command=stop, bg="red", fg="white",
width=9)
stop_button.grid(column=0, row=5)

# *************** Creating a popup that contains the general
instructions, constraints and specifics *************** #

messagebox.showinfo(title="README", message=general_message())


# *************** Function that are bind to the threads
*************** #


def video_stream():
    # *************** Function that Constantly predicts the output for
the input image and
    # updates the global variable round_prediction *************** #

    global round_prediction
    # *************** Code for opening the log.csv file in append mode
*************** #
    if not off_video_capture:
        # *************** Code for reading each frame, and
preprocessing the data *************** #

        success, img = cap.read()
        imgGrey = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
        imgblur = cv2.GaussianBlur(imgGrey, (3, 3), sigmaX=0,
sigmaY=0)
        imgOut = cv2.flip(imgblur, 1)
        imgOut = imgOut[300:850, 850:2700]
        imgOut = cv2.filter2D(imgOut, -1, kernel)
        imgOut = cv2.resize(imgOut, (224, 224))

        # *************** Code for converting the image to the
suitable format so that it can be used as
        # image for label inside the GUI window *************** #

        img = Image.fromarray(imgOut).convert("RGB")
        imgtk = ImageTk.PhotoImage(image=img)
        lmain.imgtk = imgtk
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        lmain.configure(image=imgtk)

        # *************** Code for prediction *************** #

        image = ImageOps.fit(img, size, Image.ANTIALIAS)
        image_array = np.asarray(image)
        normalized_image_array = (image_array.astype(np.float32) /
127.0) - 1
        data[0] = normalized_image_array
        prediction = model.predict(data)
        round_prediction = [round(i) for i in prediction[0]]

        # *************** Code for updating each frame to the label
inside the GUI window *************** #

        lmain.after(1, video_stream)


def prediction_viewer(round_prediction):
    # *************** Function that checks the prediction and returns
the appropriate text *************** #

    if round_prediction[0] == 1:
        return "Hand_Closed"
    elif round_prediction[1] == 1:
        return "Index"
    elif round_prediction[2] == 1:
        return "Middle"
    elif round_prediction[3] == 1:
        return "Ring"
    elif round_prediction[4] == 1:
        return "Little"
    elif round_prediction[5] == 1:
        return "Thumb"
    elif round_prediction[6] == 1:
        return "Index_Little"
    elif round_prediction[7] == 1:
        return "Index_Middle"
    elif round_prediction[8] == 1:
        return "Middle_Ring"
    elif round_prediction[9] == 1:
        return "Ring_Little"
    elif round_prediction[10] == 1:
        return "Thumb_Index"
    elif round_prediction[11] == 1:
        return "Thumb_Little"
    elif round_prediction[12] == 1:
        return "Index_Middle_Ring"
    elif round_prediction[13] == 1:
        return "Middle_Ring_Little"
    elif round_prediction[14] == 1:
        return "Thumb_Index_Little"
    elif round_prediction[15] == 1:
        return "Thumb_Index_Middle"
    elif round_prediction[16] == 1:
        return "Index_Middle_Ring_Little"
    elif round_prediction[17] == 1:
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        return "Thumb_Index_Middle_Ring"
    elif round_prediction[18] == 1:
        return "Hand_Open"
    elif round_prediction[19] == 1:
        return "Partial"


def constant_upload():
    # *************** Function that Constantly uploads the predictions
to the Firebase real time database  *********** #

    global round_prediction, list_preds
    # *************** Constant upload of the prediction to firebase on
interval of 1 sec *************** #
    while not off_data_upload_normal:
        time.sleep(1)
        # *************** Appending the predictions that are sent to
firebase to list_preds
        # so that it can be used for automation *************** #
        list_preds.append(round_prediction)

        # *************** Changes the label prediction_status with the
text received from prediction_viewer ********** #

        try:
            if not automate_process:
                prediction_status.config(text=f"LIVE PREDICTION :
{prediction_viewer(round_prediction)}"
                                                 f" [{len(list_preds)}]",
fg="#00D100")
        except RuntimeError:
            pass
        firebase.put("/Data", "Preds", str(round_prediction))


def timed_loop_prediction():
    # *************** Function that Constantly uploads when
automate/automate_prev in use
    # to the Firebase real time database  *********** #

    global list_preds
    while not off_data_upload_automate or off_data_upload_normal:
        for i in list_preds:
            if not off_data_upload_automate:
                time.sleep(1)

                # *************** Changes the label prediction_status
with the text received from prediction_viewer ** #

                try:
                    prediction_status.config(text=f"AUTOMATED UPLOAD :
{prediction_viewer(i)}", fg="#00D100")
                except RuntimeError:
                    pass
            else:
                exit()
            firebase.put("/Data", "Preds", str(i))
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#   ************** mainloop to maintain the window on screen
*****************    #

root.mainloop()

#   ************** END OF PROGRAM *****************    #
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