EE604: Assignment 1

Prof. Tushar Sandhan
sandhan@iitk.ac.in

Semester-I, 2023

Due date: 15^{th} Sept, 2023 Weight: 15%
Due time: 11:59PM Submission: MookIT

Introduction

You need to figure out which methods and algorithms are suitable for solving below real-world problems. Apart from this assignment, you are always welcome to practice basic image processing algorithms by your own. Obviously, no one is stopping you for that. So, go forth and pixelate, morph, and filter to your heart's content.

1 *Jai Hind*: `dronepositioner` [5%]

(a) Input (b) Output for 1a (c) Input (d) Output for 1c

Figure 1: Two sample examples showing inputs and corresponding outputs.

The national flag holds significant cultural and symbolic importance for a nation. It serves as a powerful emblem that embodies the history, values, unity of a country via evoking a sense of patriotism and pride. Flags are more than mere pieces of cloth; they are visual representations of a nation's identity.

During aerial maneuvers, UAV or drones have to position themselves by controlling tilt and height. Experimental robotics use ArUco markers (you can consider them as QR codes) which are placed on the grounds for adjusting their position. However, fixed size visual patterns can be used in remote terrain for drone positioning. Indian flag serves as a good localizer by military drones. At the current non-optimal position, drone sees the image as shown in 'input', then it adjusts its position (tilt and height) continuously with minimum movement till it sees the final 'reference' image. Note there is no need of rotation along Z-(height)-axis (yaw). Your task is to generate the 'reference' image for the input seen by drone. Few examples are shown in Fig. 1.

Your function should take input as an image array and it should return the output as an image array. Here each input image having a size 600x600 pixels, radius of circle = 100, center of circle is (300,300), circle width = 2 and spoke width = 1 pixel. You will be given the python program, where you have to complete the function while returning the proper reference image for each input image. There will be 10 to 20 test cases used for automatic evaluation of your program. Think about all corner cases.

2 *eent ka jawab image se* : `brickquality` [5%]

If you punch you hostel room's wall in distress or in over-excitement, you might create a window there. That would be a very high-quality punch; on the other side, there are poor-quality bricks lying. There are four qualities of bricks used in the construction, having different costs according to their quality. Sounds interesting? So they do, via making different sounds when struck together. We will consider only 2 quality bricks here - low and high. Properly cooked red soil bricks are of high quality. The furnace melts ferrites and imparts a metal-like quality to these bricks. Therefore, when high-quality bricks are struck together, they produce a sound resembling that of metal, while low-quality bricks sound like cardboard banged together.

You will be provided with audio (`.mp3` files) of these brick sounds. You can analyze it in the image domain via audio-to-spectrogram conversion using windowed Fourier transforms. You may use various python libraries for getting spectrogram, like the below pseudo-code:

```
:  import librosa
:  y, sr = librosa.load(audio_path, sr=None)  %sr=None preserves sampling rate
:  n_fft = 2048   %FFT points, adjust as you need
:  hop_length = 512  %Sliding amount for windowed FFT (adjust as needed)
:  spec = librosa.feature.melspectrogram(y, sr, n_fft, hop_length, fmax=22000)
:  # perform power to decibel (db) image transformation of 'spec'
:  # spec_db = perform power to decibel (db) image transformation of 'spec'
:  # inspect spec_db images via displaying them before designing your algorithm
```

Write the python program, which can process the brick sounds and outputs their quality in terms of metal (high) or cardboard (low) quality. Some representative sample inputs are given in Fig. 2. Note your program will be tested for 10 to 20 different sample inputs, where program should produce only one class output (either metal or cardboard) per sample testing.

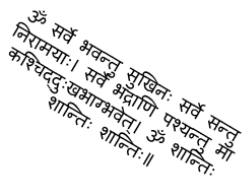
(a) Input (b) Output for 2a (c) Input (d) Output for 2c

Figure 2: Sample inputs and outputs for both the classes 'metal' and 'cardboard'. Your function should take the audio input and it should return the class name as either 'metal' or 'cardboard'.

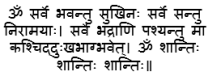
3 *Anuprasth Drishyam*: `horizontalviewer` [5%]

Indian ancient Sanskrit literature holds a wealth of knowledge, encrypted in the language that modern society is not fluent in. To digitize this knowledge, we need to scan the images and then use optical character recognition (OCR), an image processing algorithms to digitize it. However, many times, the scanned images are not horizontally aligned, which causes OCR to fail or produce erroneous digitization. These scanned images need to be re-rotated so that the final text appears perfectly aligned horizontally in a readable form.

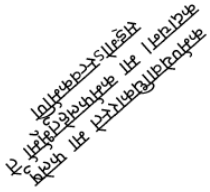
Design a python program to realign scanned text always in horizontal viewing manner. Fig. 3 shows some of inputs and corresponding output for these images. Your program will be tested on various different input images where in the output any text character should not be cut and image should be horizontally alinged. Output image size can be different than input image size.



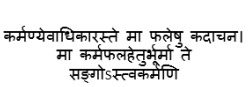
(a) Input



(b) Output for 3a



(c) Input



(d) Output for 3c

Figure 3: Sample inputs and outputs. Your function should take input as an image complete file path (string) and it should write the output in the same working directory as `.jpg` image.

Submission

For each question use the original images that are provided to you separately apart from this document. The only purpose of the figures here is to help with the proper explanations.

If your program does not produce output and throws errors, then you will receive a score of 0 for that question. You alone are accountable for the submitted program's proper operation. Kindly make sure it executes and outputs just the things which are being asked for.

Depending on the output quality, partial to full credit will be awarded if the program executes correctly. For plagiarized responses, even if your program does not execute or unexpectedly produces correct answer, in all cases you will be awarded full marks with an honorarium prefix as a negative sign.

Instruction for setting up the environment

You are expected to have a basic knowledge of python coding. It is recommended that you create a new environment and not install the dependencies in your base environment as there might be conflicts between versions of different dependencies. You are supposed to install **python3.10** for the environment setup initially.

Probably you might not be having the module **venv** installed which you can install using

```
sudo apt install python3.10-venv
```

Note the above command might not work if you don't have python version 3.10.

Now, you have to create a virtual environment using the command

```
python3 -m venv ee604
```

Now, you need to activate the above environment. For **Ubuntu/Mac** users you can do this by the command

```
source ee604/bin/activate
```

Windows users need to run the command

```
ee604\Scripts\activate
```

Now you need to install the modules in the **requirements.txt** file that has been provided in the zip file using

```
pip install -r requirements.txt
```

You are expected to use only the above modules and use of any other modules apart from the above listed module would result in failing of your code execution and you would be awarded 0 marks.

For all the questions, you have been provided with 2 files named **Q{x}_190720.py** and **tester{x}.py** where x denotes the question number. You need to just implement the **solution** function in **Q{x}_190720.py**. The solution function takes input as the path to the respective image/audio file so you must read the image/audio file before any processing. The tester function takes the output from your function and compares it with the ground truth and assigns a score except for Q3 where the checking will be done manually. This would give you a good idea of how well your code is performing and whether there are any bugs or not.

Additionally, before submitting ensure that you change the filename to **Qx_<your roll number>.py** Finally, you are required to create a folder named **your roll number** containing only the files **Qx_<your roll number>.py** for each of the questions and then upload this zip file. Any failure in naming connvention would be honored with 0 marks.

It is needless to say that the course has adopted a VERY STRICT policy about cheating. If we found that you have cheated from another student or you have copied from an external source, you and all those involved would be honored with an F grade and depending on the situation you might get reported to DOAA as well with the possibility of SSAC. If you think pragmatically, it is better to get less marks in this competition than failing the course. The idea is you learn by doing, it's OK even if you are unable to get the best result. We honor authentic efforts.

A link for setting up the environment and the problem statements in case you are facing some issues: Video for Environment setup

☺ **HAPPY CODING** ☺ ■