A Gesture-Based Tool for Sterile Browsing of Radiology Images

Team ID: PNT2022TMID22259

Faculty Mentor – PAVITHRA

A Project Report

Submitted by

Rohith R	**(113019205045)**	**[TL]**
Meril Akash J	**(113019205031)**	**[TM1]**
Mohammed Musharaf Z	**(113019205033)**	**[TM2]**
Someshwaran U	**(113019205051)**	**[TM3]**

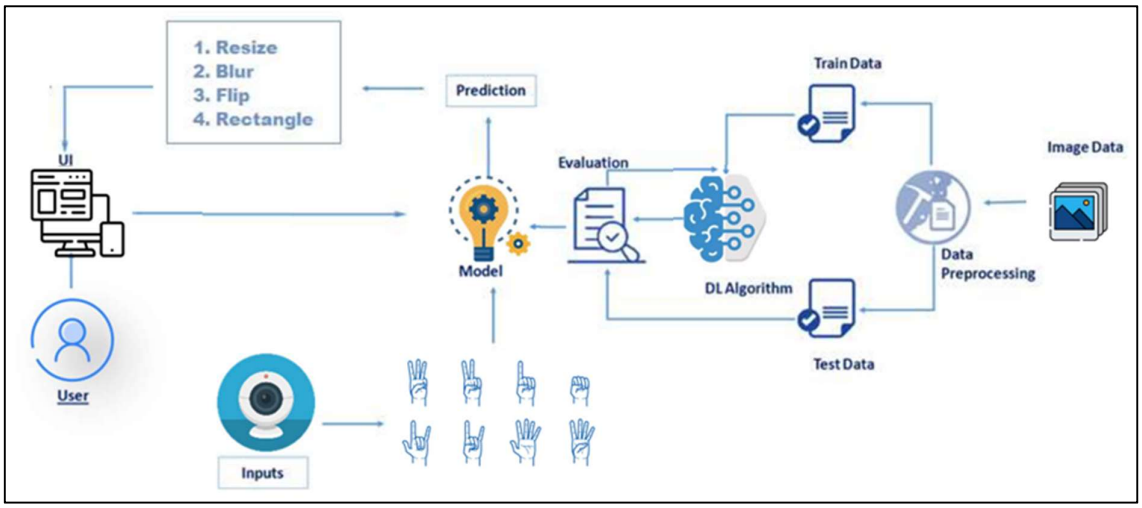
PROJECT CONTENT

1.INTRODUCTION

Humans can recognize body and sign language easily. This is possible due to the combination of vision and synaptic interactions that were formed along brain development. In order to replicate this skill in computers, some problems need to be solved: how to separate objects of interest in images and which image capture technology and classification technique are more appropriate, among others.

In this project Gesture based Desktop automation ,First the model is trained pre trained on the images of different hand gestures, such as a showing numbers with fingers as 1 ,2,3,4 . This model uses the integrated webcam to capture the video frame.The image of the gesture captured in the video frame is compared with the Pre- trained model and the gesture is identified. If the gesture predicts is 0 - then images is converted into rectangle, 1 - image is Resized into (200,200), 2 - image is rotated by -45°, 3 - image is blurred , 4 - image is Resized into (400,400) , 5 - image is converted into grayscale etc.,

Technical Architecture:



1.1 Project Overview

Our project which applies gesture recognition as a topic which comes under two computer science fields like augmented reality and human-computer interaction and we have created a virtual gesture system with the goal of elucidating human gestures through the mathematical algorithms. Users can use simple finger or hand gestures to control or interact with the radiology images without physically touching them

1.Defining our classification categories

2.Collect training images

3.Train the mode

4.Test our mode

1.2 PURPOSE

It is used to browse through the images obtained using radiology using hand gestures rather than using mouse, keyboard, etc. thereby maintaining distance. The algorithm is focused on deep learning for detecting the gestures. Hence, the proposed system will avoid disease spread by reducing the human interaction with the devices to control the system.

2. LITERATURE SURVEY

1: HAND GESTURES RECOGNITION USING RADAR SENSORS FOR HUMAN-COMPUTER-INTERACTION

Author Name: Shahzad Ahmed, Karam Dad Kallu – 2021

Content: A huge upsurge and rapid advancement of radar-based HGR was witnessed in the past decade. This paper reviewed some of the research related to HGR applications using radars. Currently, the researchers rely heavily on the commercially available radars made by tech companies such as Infection, Novelda and Texas Instrument. With these systems being on chips, much attention has been paid to develop the gesture detection and recognition algorithms. In recent years, interest is shifting from signal-processing-based HGR algorithms to deep-learning-based algorithms.

Particularly, variants of CNN have shown promising applicability. Although radar sensors offer several advantages over the other HGR sensors (i.e., wearable sensors and cameras), the adoption of radar-based HGR in our daily lives is still lagging behind these competing technologies. Attention must be paid to miniature hardware development and real-time recognition algorithms' development.

2: INFECTION CONTROL FOR RADIOLOGY

Author Name : FATMA AMER, MSc, PhD.

Content : The objectives of this chapter is to highlight the importance of IPC in activities related to the RD and to provide applicable recommendations. At the very beginning, good basic hygiene standards are crucial. All equipment, devices and instruments should be easily decontaminated and must be approved prior to use. All items coming in direct patient contact must be properly reprocessed in the way rendering it safe for the intended use. Currently, the importance of the RD has been emphasized with the emergence and spread of COVID-19. The close and frequent contact of radiographers with patients during radiological workflow have placed radiographers at a great infection risk. Key management and IPC procedure during the outbreak have been outlined.

2.1 Existing problem

Preventative measures should be taken at every level starting from general education and awareness to include proper disinfection of radiological equipment and more specific disinfection and sterilization protocols.

Hand Gesture tool to do Contactless navigation of radiology images. Use technology to assist doctors by taking hand gestures as input and perform necessary actions. These Gesture helps us to visualize the Words and help Gain the Listener's Attention. The Existing system maintain a good balance between complexity, accuracy and applicability not well.

A Hand-based Gesture Recognition System used for detecting any kind of Gestures which when the given input Gesture matches with the trained image. The Existing approach allows only to learn some certain Hand gestures. It is not that easy to control through these gestures .The Gesture must be Quiet simple and must easy to use by the user.

2.2 References

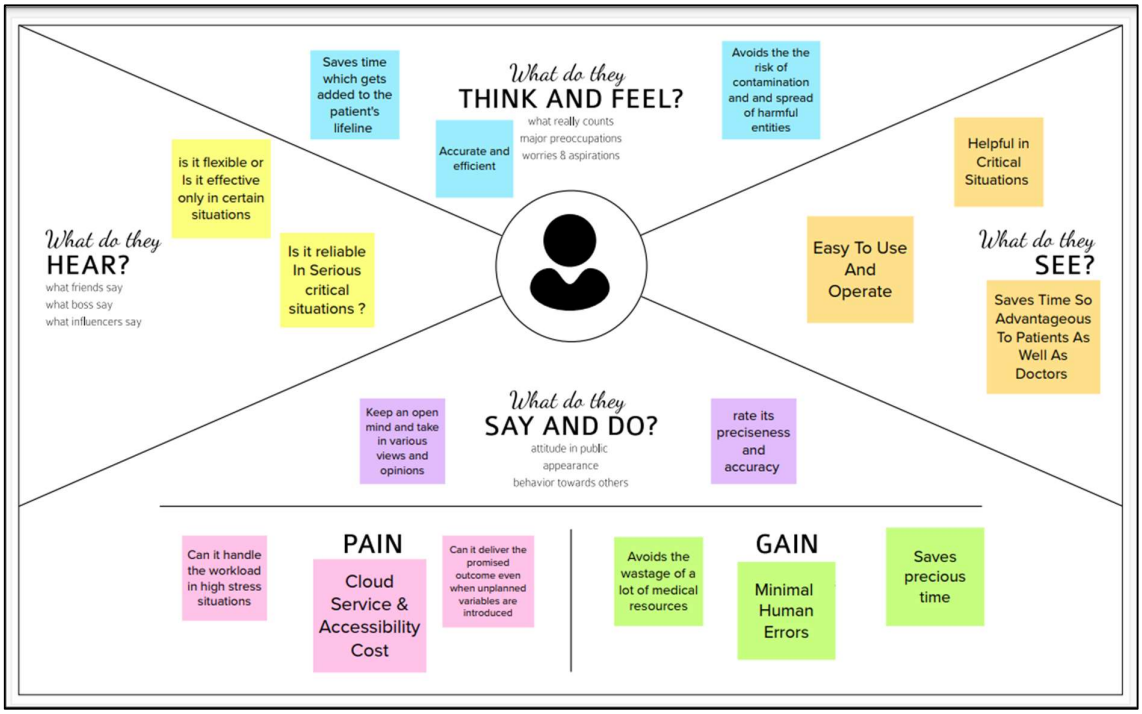
1. https://www.mdpi.com/2072-4292/13/3/527/html
2. https://isid.org/guide/hospital/infection-prevention-and-control-in-the-radiology-department-service/
3. https://www.paho.org/hq/dmdocuments/2011/HSS-diagnostic-imaging-2011.pdf

2.3 Problem Statement Definition

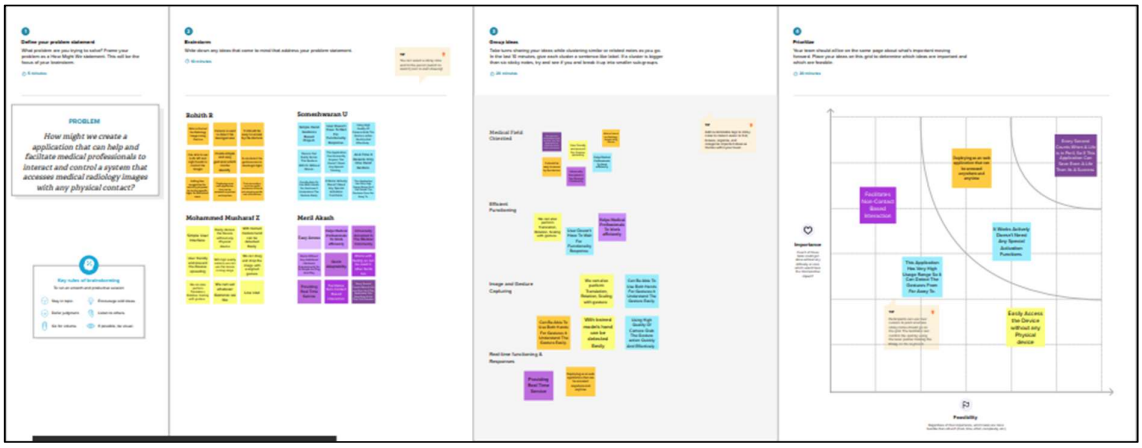
- A Hand-based Gesture Recognition System used for detecting any Gestures which when the given input Gesture matches with the trained image.
- The Combination of Vision and Synaptic interactions that were formed along brain development made the Humans to recognize body and sign language easily.
- When the System did not recognize the gesture correctly, which led to longer reaction time of the System.
- The hand gesture recognition can be accurate only if the camera is kept at an appropriate distance from the participants.
- In recent year there is lot of research on gesture recognition using Kine ct sensor on using HD camera, but camera and Kine ct sensors are more costly.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming



3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To design an ML model to identify and classify the hand gestures.
2.	Idea / Solution description	To develop a CNN based classifier model, which would be trained on our training data.
3.	Novelty / Uniqueness	We train a CNN based model to recognize the hand gesture. The training data include images that captures the hand gestures of 1,2,3,4,5 and 0. The image is resized without much loss of information and used for training a CNN based model. We use Python Flask to provide an interactive platform for out model.
4.	Social Impact / Customer Satisfaction	This project would help the doctors in operation theatres where physical contact between persons should be avoided in order to be sterilized and also prevent from any infections.
5.	Business Model (Revenue Model)	It can be sold as an open-source service to all the hospitals as a non-profitable work.
6.	Scalability of the Solution	The model could also be extended to other real world classifying problems like cancer detection from X-ray, COVID detection using X-ray images, mask detection, face detection etc..

3.4 Problem Solution fit

Project Title: A Gesture-based Tool for Sterile Browsing of Radiology Images **Project Design Phase-I** - Solution Fit Template **Team ID:** PNT2022TMID22259

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?
i.e. working parents of 0-5 y.o. kids

Used by doctors at hospitals and other medical clinics to avoid contact with infected tools. Used by workers in car manufacturing companies.

6. CUSTOMER CONSTRAINTS CC

What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.

Power consumptions needs to be reduced. Customer needs to remember various gestures to use it in appropriate situations. Proper camera to capture the gestures correctly. Stable connection is required to run the software.

5. AVAILABLE SOLUTIONS AS

Which solutions are available to the customers when they face the problem
or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking

Doctors can take the tool in their hand, which may cause infections to them. Doctors can use monitors, keyboard but this may lead to inaccurate observations as the doctor will be in movement and this may also cause infections to doctors.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one, explore different sides.

System helps the customers to show gestures based on which corresponding tools are taken by browsing with radiology images to avoid customers coming in contact.

9. PROBLEM ROOT CAUSE RC

What is the real reason that this problem exists?
What is the back story behind the need to do this job?
i.e. customers have to do it because of the change in regulations.

Unclear images detected by camera may lead to undesired results. As each gesture is mapped to tool, the customer needs to remember gestures to choose a tool. These technologies are expensive and may lead to delay in operation theatre.

7. BEHAVIOUR BE

What does your customer do to address the problem and get the job done?
i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

Proper training is provided to customers to use appropriate gestures for tools. Well-equipped manual is provided to customers to resolve their problems and doubts

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

What triggers customers to act? i.e. seeing their neighbor installing solar panels, reading about a more efficient solution in the news.

Technological development in AI and medical industry helps the customers to avoid physical contact

4. EMOTIONS: BEFORE / AFTER EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

Customers feel more safe and secure by using this technology as it prevents them from infections

10. YOUR SOLUTION SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behavior.

This solution helps the doctors to use gestures to select a tool and to perform operations at faster rate and in efficient way. This solution also avoids doctors coming in physical contact from the infected tools.

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE
What kind of actions do customers take online? Extract online channels from #7

Network connection is required to analyze and to choose the tool from captured radio images

8.2 OFFLINE
What kind of actions do customers take offline? Extract offline channels from #7and use them for customer development.

Doctors need to use proper gestures for choosing a tool. Power needs to be available.

Identify strong TR & EM

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Identifying User Gestures	The user gestures are identified using the images of gestures captured by the camera
FR-2	Deployment in Cloud	The trained Deep Learning Model is deployed in cloud, which could be accessed anywhere around the world
FR-3	User Interface	The user interface, which helps in the Human Computer Interaction is designed
FR-4	Gestures related to the Application Domain	The model should be trained with the gestures related to the application domain.

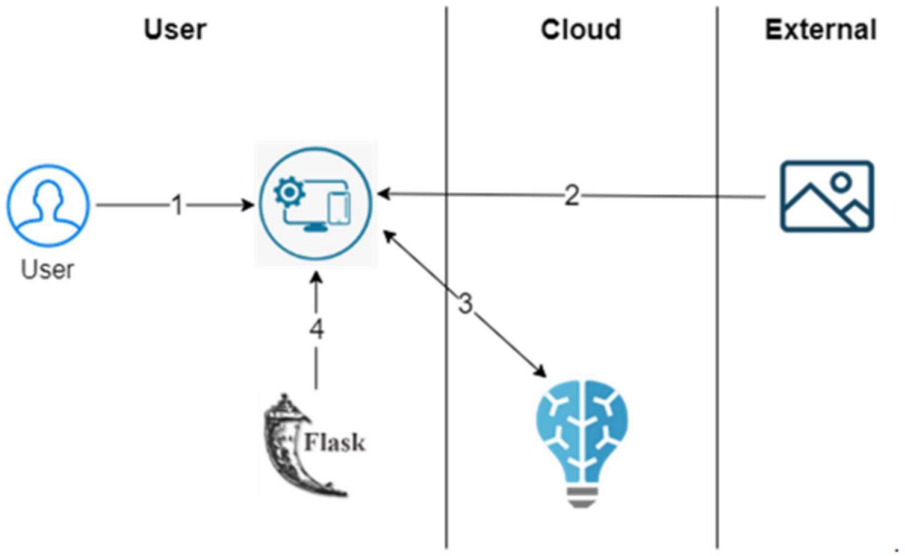
4.2 Non-Functional requirements

Following are the non-functional requirements of the proposed solution.

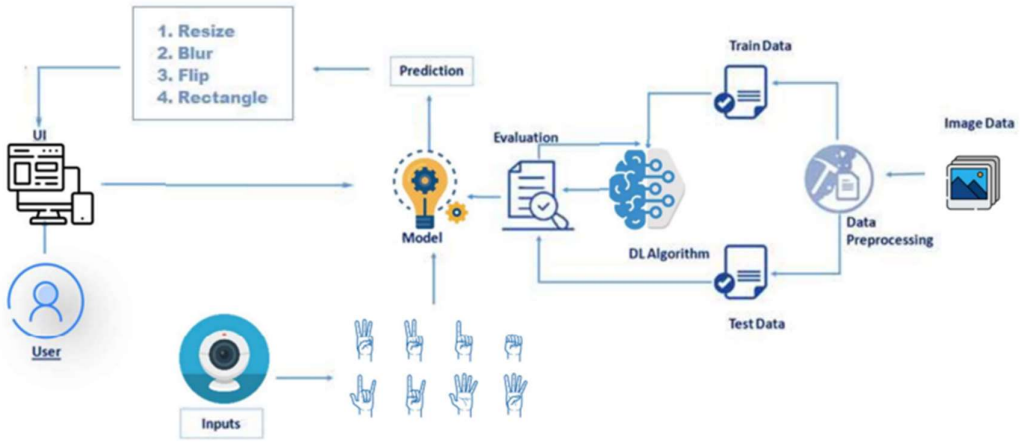
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The user interface which acts as an intermediate between the user and the DL Model which is deployed in the cloud
NFR-2	**Security**	The model deployed in the cloud should be accessible only by the approved users and it should be inaccessible by the attackers or the terrorists
NFR-3	**Reliability**	The tool or the system is 95% reliability for a year
NFR-4	**Performance**	The tool or the system should respond with the accurate response within 4-5 seconds
NFR-5	**Availability**	The model deployed in the cloud must be available to 99.8% of the people over a month during working hours
NFR-6	**Scalability**	The model deployed in the cloud must be accessible by over 10,00,000 people trying to access it using the user interface

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



5.3 User Stories

User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Web user)	Launch Web App deployed in cloud	USN-1	As a user, I can launch the webapp where I can upload the images for recognition	I can upload the images for classification	High	Sprint-4
	Prediction	USN-2	As a user, I can get the predicted results from the model deployed in the cloud	I can resize the radiology image, blur the image, flip based on the hand gesture	High	Sprint-4
	Deployment of webapp in the cloud	USN-3	As a user, I need the webapp to be accessible all over the world	I can access the webapp deployed in the IBM cloud	Medium	Sprint-3
	Deployment of AI model in the cloud	USN-4	As a user, I need the AI model to be accessible all over the world	I can access the model deployed in the IBM cloud	Medium	Sprint-3
	Model Building	USN-5	As a user, I need an AI model which could classify or recognize the hand gestures	I can get the prediction from the AI model	Medium	Sprint-1
	User Interface Building	USN-6	As a user, I need a web app for human computer interaction	I get User Interface for interaction with the model	Medium	Sprint-2

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

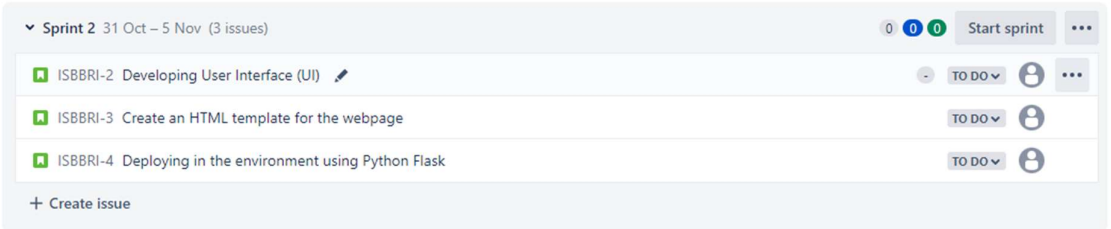
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Model Building	USN-5	As a user, I need an AI model which could classify or recognize the hand gestures	10	Medium	**Rohith R Meril Akash Someshwaran U Mohammad Musharaf Z**
Sprint-2	User Interface Building	USN-6	As a user, I need a web app for human computer interaction	10	Medium	**Rohith R Meril Akash Someshwaran U Mohammad Musharaf Z**
Sprint-3	Deployment of webapp in the cloud	USN-3	As a user, I need the webapp to be accessible all over the world	10	Medium	**Rohith R Meril Akash Someshwaran U Mohammad Musharaf Z**
Sprint-3	Deployment of AI model in the cloud	USN-4	As a user, I need the AI model to be accessible all over the world	10	Medium	**Rohith R Meril Akash Someshwaran U Mohammad Musharaf Z**

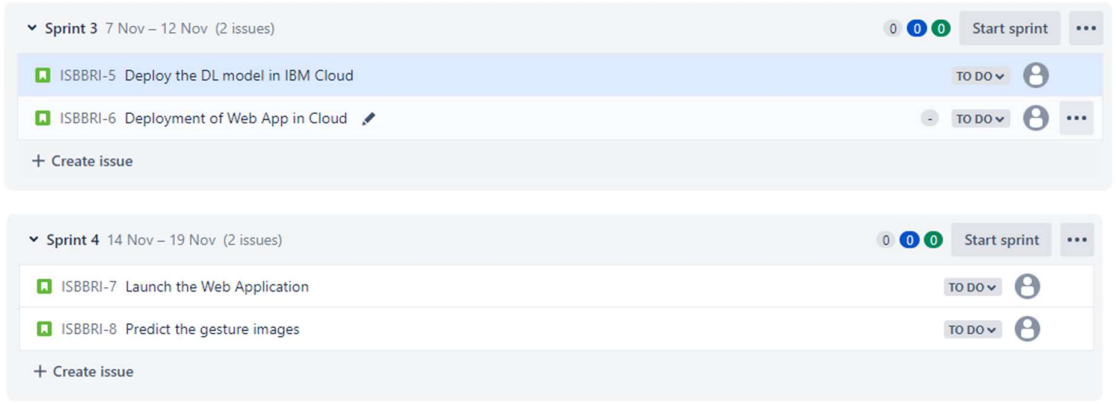
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-4	Prediction	USN-2	As a user, I can get the predicted results from the model deployed in the cloud	20	High	**Rohith R Meril Akash Someshwaran U Mohammad Musharaf Z**
Sprint-4	Launch Web App deployed in cloud	USN-1	As a user, I can launch the webapp where I can upload the images for recognition	20	High	**Rohith R Meril Akash Someshwaran U Mohammad Musharaf Z**

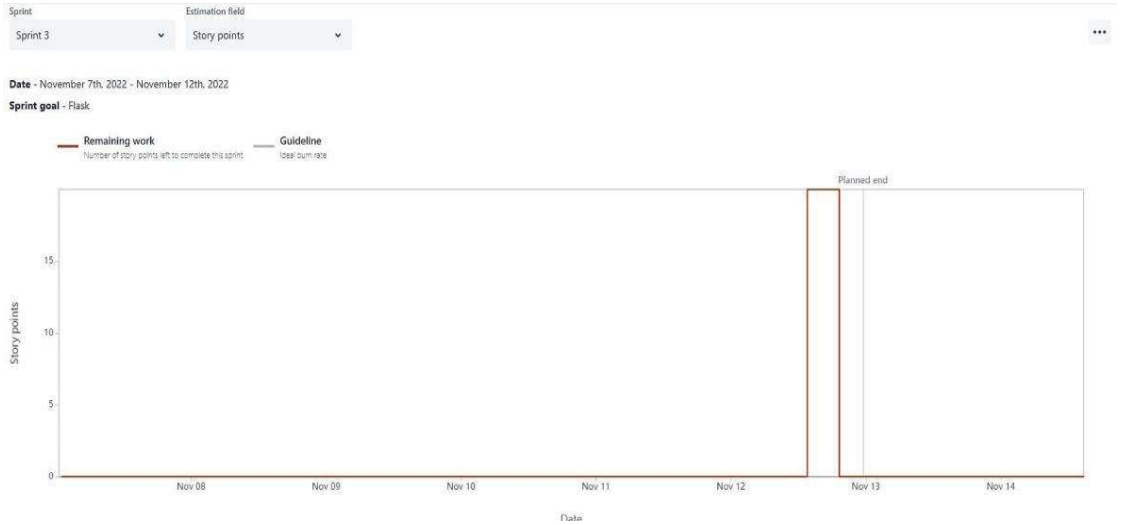
6.2 Sprint Delivery Schedule

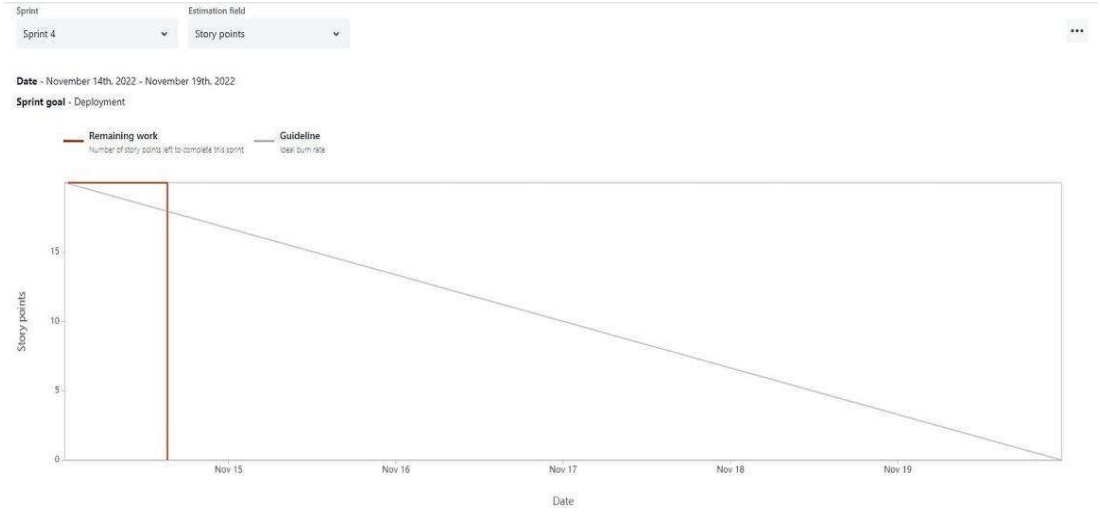
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	10	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	10	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	40	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA




Sprint 3 7 Nov – 12 Nov (2 issues)
0 0 0
Start sprint
ISBBRI-5 Deploy the DL model in IBM Cloud
TO DO
ISBBRI-6 Deployment of Web App in Cloud
TO DO
Create issue
Sprint 4 14 Nov – 19 Nov (2 issues)
0 0 0
Start sprint
ISBBRI-7 Launch the Web Application
TO DO
ISBBRI-8 Predict the gesture images
TO DO
Create issue


Sprint
Sprint 3
Estimation field
Story points
Date - November 7th, 2022 - November 12th, 2022
Sprint goal - Flask
Remaining work
Number of story points left to complete this sprint
Guideline
Ideal burn rate
Planned end
Story points
15
10
5
0
Nov 08
Nov 09
Nov 10
Nov 11
Nov 12
Nov 13
Nov 14
Date


Sprint
Sprint 4
Estimation field
Story points
Date - November 14th, 2022 - November 19th, 2022
Sprint goal - Deployment
Remaining work
Number of story points left to complete this sprint
Guideline
Ideal burn rate
Story points
15
10
5
0
Nov 15
Nov 16
Nov 17
Nov 18
Nov 19
Date

7. CODING & SOLUTIONING

7.1 Feature 1

- Here we are not use any kind of difficult Process like user login and other stuffs because these applications are used only in operation theatre and used by Doctors.
- First the user must know about the application, so we have giving some brief explanation in the application in Introduction page
- So Login is not necessary so we have just entering into application and start the process.

7.2 Feature 2

- Our Next feature is about the images which going to be show in different angles and stages.
- By uploading the radiology image, we easily change the Images in different angles and Different filters like blurring the image for better visible of the parts of human body.

8. TESTING

8.1 Test Cases

Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	TC for Automation(Y/N)	Executed By
Test Case - O1	Functional	web Page	Verify user is able to see the page popup when user they enter to web page		1.Enter URL and click go		webpage should display	Working as expected	Pass		Musharaf Z Meril Akash
Test Case - O2	UI	Home Page	Verify the UI elements in Hompage		1.Enter URL and click go 2.webpage displayed		Application should show below UI elements: a.Homepage b.Introduction c.Launch	Working as expected	Pass		Musharaf Z Meril Akash
Test Case - O3	Functional	Home page	Verify user is able to See the deatils about the webpage		1.Enter URL and click go 2.Webpage Displayed 3.Displays necessary details		User should navigate to homepage	Working as expected	Pass		Rohith R Someshwaran U
Test Case - O4	Functional	Introduction	Verify user is able to details about uses of the gesture based tool and its importance		1.Enter URL and click go 2.Webpage Displayed 3.Displays necessary details 4.click introduction to go Displays about the uses of the gesture based tool		user should navigate to introduction	Working as expected	Pass		Rohith R Someshwaran U
Test Case - O5	Functional	Launch	Verify user is able to navigate to launch		1.Enter URL and click go 2.Webpage Displayed 3.Displays necessary details 4.click introduction to go Displays about the uses of the gesture based tool 5.Click Launch to navigates to launch page		user should navigate to Launch	Working as expected	Pass		Musharaf Z Meril Akash
Test Case - O6	Functional	Launch	Verify user is able to upload image and predicts using the hand gesture		1.Enter URL and click go 2.Webpage Displayed 3.Displays necessary details 4.click introduction to go Displays about the uses of the gesture based tool 5.Click Launch to navigates to launch page 6.uploads the image and predicts using the hand gesture	Upload image : img1.jpg	Application should Display the images in different types of images like blurred , rotated image	Working as expected	Pass		Musharaf Z Rohith R

8.2 User Acceptance Testing

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	10	1	0	10
Security	0	0	0	0
Outsource Shipping	6	0	0	6
Exception Reporting	6	0	0	6
Final Report Output	5	0	0	5
Version Control	1	0	0	1

9. RESULTS

9.1 Performance Metrics

Final findings (Output) of the project along with screenshots. Through this project we found that we can maintain the sterility of an operation theatre, etc. by using hand based gesture tools to browse the images obtained.

10. ADVANTAGES & DISADVANTAGES

Advantages:

- Major advantage of this tool is that it helps to maintain the sterility of the environment.
- It is also easy to use and is quicker than the existing methods to browse images.
- It can also be performed even if the surgeon is a bit far away from the system, this helps to save time.
- The tool does not need the person using it to have an apparatus or any devices on them to use it.
- They can simply move their hands to browse through the images.

Disadvantages:

- The tool can be quite expensive as it requires cameras and other expensive devices to capture images and process it.

11. CONCLUSION

As the technology is booming with emerging trends therefore the virtual I/O interface which can possibly contribute to public healthcare. We used OpenCV and TensorFlow to detect movements and gestures. The models were trained with hand images. The accuracy of the model is achieved and the optimization of the model is a continuous process and we are building an accurate solution by tuning the hyper parameters. This specific model could be used as a use case for Virtual Human-Computer Interaction. By developing this system, we can allow the user to have a contact-less interactive experience, which would be of great help to society.

In this project we developed a tool which recognizes hand gestures and enables doctors to browse through radiology images using these gestures. This enables doctors and surgeons to maintain the sterility as they would not have to touch any mouse or keyboard to go through the images. This tool is also easy to use and is quicker than the regular method of using mouse/keyboard. It can be used regardless of the user's location since they don't have to be in contact with any device. It also does not require the user to have any device on them to use it. Further this technology can be extended to other industries like it can be used by presenters, by teachers for show images in the classroom, etc.

12. FUTURE SCOPE

The tool can be made quicker by increasing the recognition speed. More number gestures can be added thereby increasing this tool's functionality and usability for different purposes. Tracking of both hands can be added to increase the set of commands. Voice commands can also be added to further increase the functionality.

13. APPENDIX

Source Code: app.py

app.py > launch

```python
from flask import Flask,render_template,request
# Flask-It is our framework which we are going to use to run/serve our application.
#request-for accessing file which was uploaded by the user on our application.
import operator
import cv2 # opencv library
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np
from tensorflow.keras.models import load_model#to load our trained model
import os
from werkzeug.utils import secure_filename

app = Flask(__name__,template_folder="templates") # initializing a flask app
# Loading the model
model=load_model(r'gesture.h5')
print("Loaded model from disk")


@app.route('/')# route to display the home page
def home():
    return render_template('home.html')#rendering the home page


@app.route('/intro') # routes to the intro page
def intro():
    return render_template('intro.html')#rendering the intro page

@app.route('/image1',methods=['GET','POST'])# routes to the index html
def image1():
    return render_template("launch.html")

```

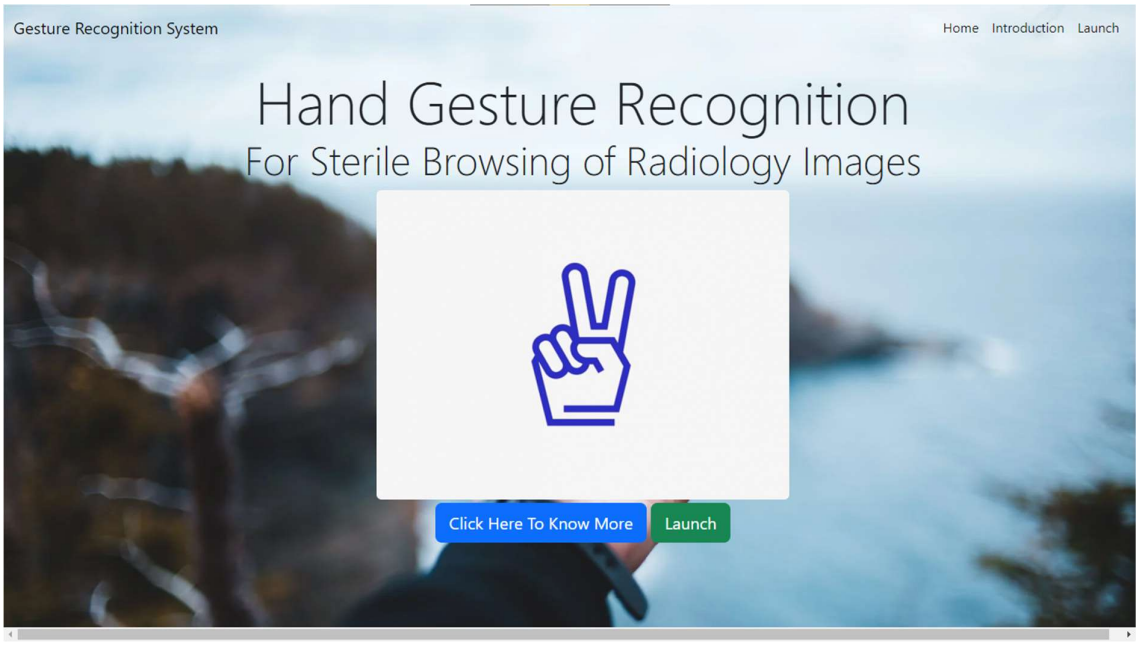
```python
@app.route('/predict',methods=['GET', 'POST'])# route to show the predictions in a web UI
def launch():
    if request.method == 'POST':
        print("inside image")
        f = request.files['image']
        basepath = os.path.dirname(__file__)
        file_path = os.path.join(basepath, 'uploads', secure_filename(f.filename))
        f.save(file_path)
        print(file_path)
        cap = cv2.VideoCapture(0)
        while True:
            _, frame = cap.read() #capturing the video frame values
            # Simulating mirror image
            frame = cv2.flip(frame, 1)
            # Got this from collect-data.py
            # Coordinates of the ROI
            x1 = int(0.5*frame.shape[1])
            y1 = 10
            x2 = frame.shape[1]-10
            y2 = int(0.5*frame.shape[1])
            # Drawing the ROI
            # The increment/decrement by 1 is to compensate for the bounding box
            cv2.rectangle(frame, (x1-1, y1-1), (x2+1, y2+1), (255,0,0) ,1)
            # Extracting the ROI
            roi = frame[y1:y2, x1:x2]
```

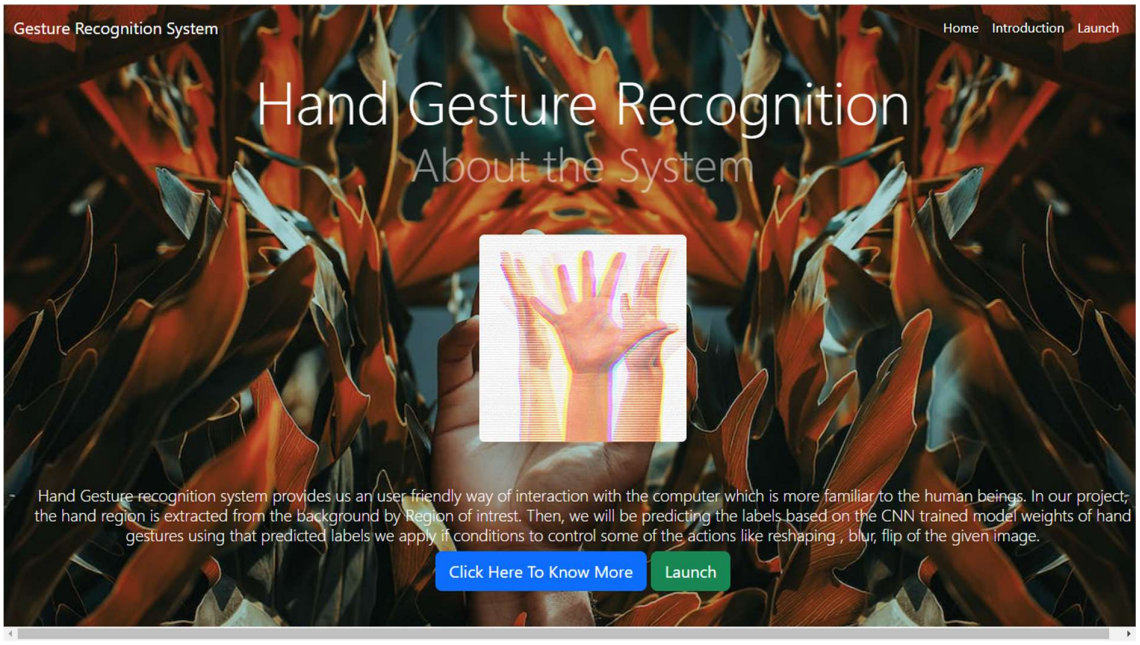
```python
            # Resizing the ROI so it can be fed to the model for prediction
            roi = cv2.resize(roi, (64, 64))
            roi = cv2.cvtColor(roi, cv2.COLOR_BGR2GRAY)
            _, test_image = cv2.threshold(roi, 120, 255, cv2.THRESH_BINARY)
            cv2.imshow("test", test_image)
            # Batch of 1
            result = model.predict(test_image.reshape(1, 64, 64, 1))
            prediction = {'ZERO': result[0][0],
                          'ONE': result[0][1],
                          'TWO': result[0][2],
                          'THREE': result[0][3],
                          'FOUR': result[0][4],
                          'FIVE': result[0][5]}
            # Sorting based on top prediction
            prediction = sorted(prediction.items(), key=operator.itemgetter(1), reverse=True)

            # Displaying the predictions
            cv2.putText(frame, prediction[0][0], (10, 120), cv2.FONT_HERSHEY_PLAIN, 1, (0,255,255), 1)
            cv2.imshow("Frame", frame)

            #Loading an image
            image1=cv2.imread(file_path)
            if prediction[0][0]=='ONE':
                resized = cv2.resize(image1, (200, 200))
                cv2.imshow("Fixed Resizing", resized)
                key=cv2.waitKey(3000)
                if (key & 0xFF) == ord("1"):
                    cv2.destroyWindow("Fixed Resizing")
```

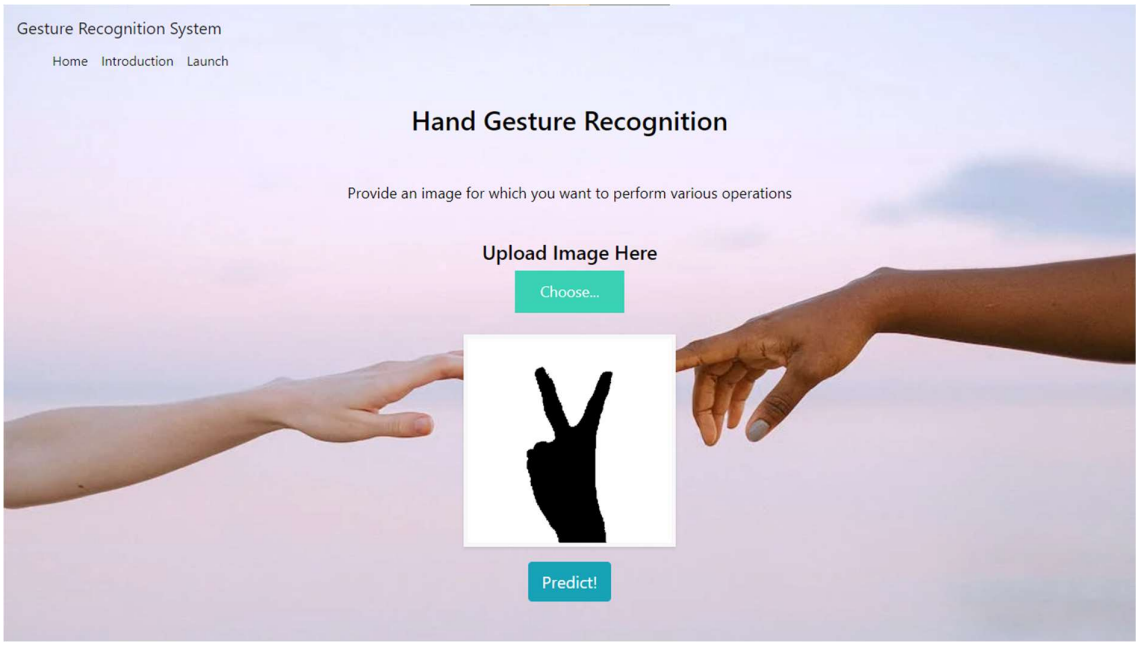
```
88              elif prediction[0][0]=='ZERO':
89                  cv2.rectangle(image1, (480, 170), (650, 420), (0, 0, 255), 2)
90                  cv2.imshow("Rectangle", image1)
91                  cv2.waitKey(0)
92                  key=cv2.waitKey(3000)
93                  if (key & 0xFF) == ord("0"):
94                      cv2.destroyWindow("Rectangle")
95
96              elif prediction[0][0]=='TWO':
97                  (h, w, d) = image1.shape
98                  center = (w // 2, h // 2)
99                  M = cv2.getRotationMatrix2D(center, -45, 1.0)
100                 rotated = cv2.warpAffine(image1, M, (w, h))
101                 cv2.imshow("OpenCV Rotation", rotated)
102                 key=cv2.waitKey(3000)
103                 if (key & 0xFF) == ord("2"):
104                     cv2.destroyWindow("OpenCV Rotation")
105
106             elif prediction[0][0]=='THREE':
107                 blurred = cv2.GaussianBlur(image1, (21, 21), 0)
108                 cv2.imshow("Blurred", blurred)
109                 key=cv2.waitKey(3000)
110                 if (key & 0xFF) == ord("3"):
111                     cv2.destroyWindow("Blurred")
112
113             elif prediction[0][0]=='FOUR':
114                 resized = cv2.resize(image1, (400, 400))
115                 cv2.imshow("Fixed Resizing", resized)
116                 key=cv2.waitKey(3000)
117                 if (key & 0xFF) == ord("4"):
118                     cv2.destroyWindow("Fixed Resizing")
```

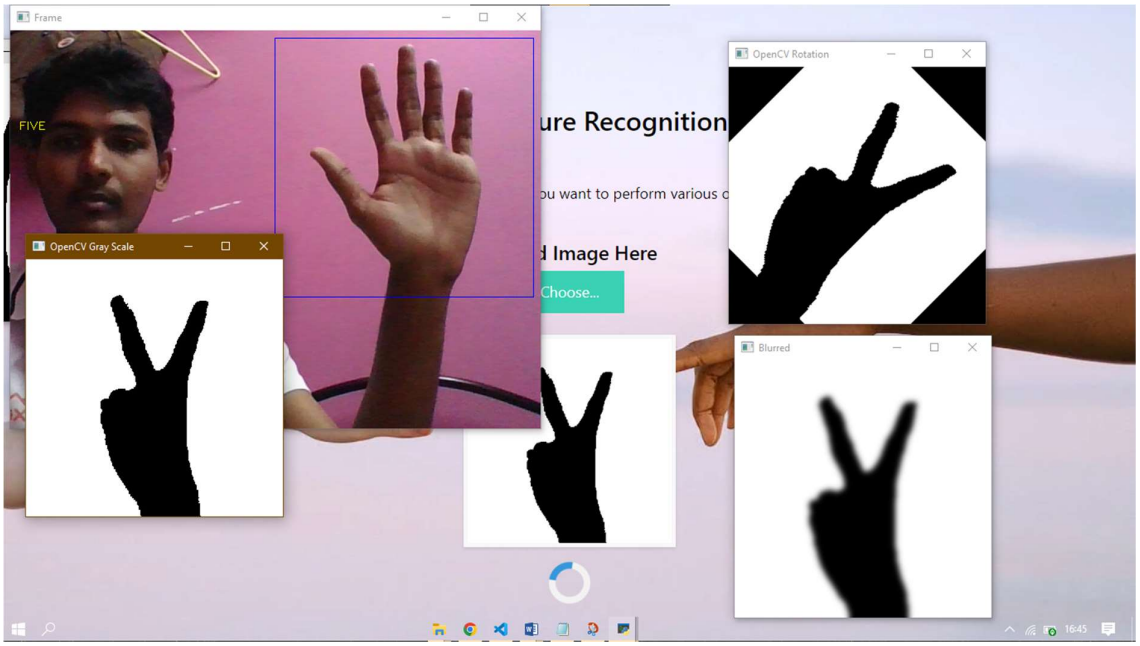
```
            elif prediction[0][0]=='FIVE':
                '''(h, w, d) = image1.shape
                center = (w // 2, h // 2)
                M = cv2.getRotationMatrix2D(center, 45, 1.0)
                rotated = cv2.warpAffine(image1, M, (w, h))'''
                gray = cv2.cvtColor(image1, cv2.COLOR_RGB2GRAY)
                cv2.imshow("OpenCV Gray Scale", gray)
                key=cv2.waitKey(3000)
                if (key & 0xFF) == ord("5"):
                    cv2.destroyWindow("OpenCV Gray Scale")

            else:
                continue


            interrupt = cv2.waitKey(10)
            if interrupt & 0xFF == 27: # esc key
                break


        cap.release()
        cv2.destroyAllWindows()
    return render_template("home.html")

if __name__ == "__main__":
    # running the app
    app.run(debug=True)
```

Screenshot of Web App:









GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-13848-1659533086