A GESTURE BASED TOOL FOR STERILE BROWSING OF RADIOLOGY IMAGES

PROJECT REPORT

SUBMITTED BY

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CONTENTS

1. INTRODUCTION

A gesture based automation tool for sterile browsing of radiology images helps in processing the radiology images by means of gestures and without having any physical contact with the computing devices such as keyboards, mouse etc.

1.1 Project Overview

Humans are able to 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 CNN 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 1 then images is resized. If 2 is predicted, image is blurred, 3 for image rotation and 4 for rectangle.

1.2 Purpose

The purpose of this project is to do the following.

- To assists surgeons while performing operations at a fast rate without any physical contact.
- Make use of hand gestures as an alternative to existing interface techniques, thus offering the major advantage of sterility.
- To highly benefit customers by performing surgeries without touching any pointing devices and also to save time.

2. LITERATURE SURVEY

A gesture-based tool for sterile browsing of radiology images (2008) by JUAN P. WACHS, PHD, HELMAN I. STERN, PHD, YAEL EDAN, PHD,

MICHAEL GILLAM, MD, JON HANDLER, MD, CRAIG FEIED, MD, PHD, MARK SMITH, MD - "Gestix," a vision-based hand gesture capture and recognition system that interprets in real-time the user's gestures for navigation and Manipulation of images in an electronic medical record (EMR) database is used. Navigation and other gestures are translated to commands based on their temporal trajectories, through video capture.

Hand-gesture-based sterile interface for the operating room using contextual cues for the navigation of radiological images (2012) by Mithun George Jacob, Juan Pablo Wachs, Rebecca A Packer. Computer vision algorithms were developed to extract intention and attention cues from the surgeon's behavior and combine them with sensory data from a commodity depth camera.

REALISM: Real-Time Hand Gesture Interface for Surgeons and Medical Experts (2010) by David Louis M. Achacon Jr., Denise M. Carlos, Maryann Kaye Puyaoan Christine T. Clarin, Prospero C. Naval, Jr. The project was developed using OpenCV, a computer vision library originally developed by Intel and Cascade Classifiers, PCA and Nearest Distance Matching.

S. No	**Title**	**Merits**	**Demerits**
1	A gesture-based tool for sterile browsing of radiology images	Ease of use, Rapid reaction, An unencum bered interface, Distance control—the hand gestures can be performed up to 5 meters from the camera	The setup time for the whole "Gestix" system was approximately 20 minutes.
2	Hand-gesture-based sterile interface for the operating room using contextual cues for the	It uses environmental cues to determine intent allowing the user to perform gestures anywhere in the field of view of the	The tracking algorithm occasionally failed in the presence of several people in the camera field of view.

	navigation of radiological images	sensor and also the framework can be extended to a large gesture vocabulary.	
3	REALISM: Real-Time Hand Gesture Interface for Surgeons and Medical Experts	The hand detection module was able to achieve higher precision and recall in well lighted environment.	Although the system detects most of the hands present in the camera's vision, it still misclassifies some objects as hands. The performance was not that good in poorly illuminated environment

2.1 Existing problem

One of the problems in existing system is that the "Gestix" system takes approximately 20 minutes for setup. The tracking algorithm occasionally failed in the presence of several people in the camera field of view. Although the system detects most of the hands present in the camera's vision, it still misclassifies some objects as hands. The performance was not that good in poorly illuminated environment

2.2 References

- A gesture-based tool for sterile browsing of radiology images by JUAN P. WACHS, PHD, HELMAN I. STERN, PHD, YAEL EDAN, PHD, MICHAEL GILLAM, MD, JON HANDLER, MD, CRAIG FEIED, MD, PHD, MARK SMITH, MD
- Hand-gesture-based sterile interface for the operating room using contextual cues for the navigation of radiological images by Mithun George Jacob, Juan Pablo Wachs, Rebecca A Packer.

- REALISM: Real-Time Hand Gesture Interface for Surgeons and Medical Experts by David Louis M. Achacon Jr., Denise M. Carlos, Maryann Kaye Puyaoan Christine T. Clarin, Prospero C. Naval, Jr.

2.3 Problem Statement Definition

Computer information technology is increasingly penetrating into the hospital domain. A major challenge involved in this process is to provide doctors with efficient, intuitive, accurate and safe means of interaction without affecting the quality of their work. Keyboards and pointing devices, such as a mouse, are today's principal method of human—computer interaction. However, the use of computer keyboards and mice by doctors and nurses in intensive care units (ICUs) is a common method for spreading infections. Even though voice control also provides sterility, the noise level in the operating room (OR) deems it problematic. Our solution for this problem is the use of hand gestures as an alternative to existing interface techniques, offering the major advantage of sterility. In our work we refer to gestures as a basic form of non-verbal communication made with the hands.

Problem Statement (PS)	**I am (Customer)**	**I'm trying to**	**But**	**Because**	**Which makes me feel**
PS - 1	Doctors	Perform surgery by sterile browsing of radiology images	The gestures may be misinterpreted	Camera may detect multiple persons in the OR	Frustrated
PS - 2	Nurses	Perform surgery by sterile	It may predict wrong	Camera hardly detects	Anxious

		browsing of radiology images	under bad lightings	images in darkness	

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

3.2 Ideation & Brainstorming

1

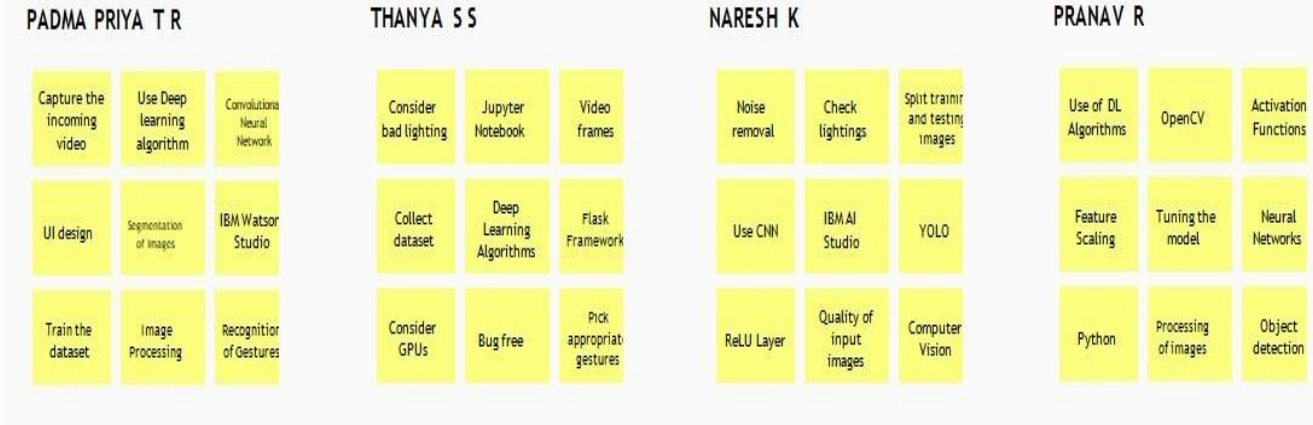
Define your problem statement

PROBLEM

Keyboards, mouse etc are today's principal method of human—computer interaction. However, the use of computer keyboards and mice by doctors and nurses in intensive care units is a common method for spreading infections. Even though voice control also provides sterility, the noise level in the operating room deems it problematic. To overcome this, our system makes use of hand gestures as an alternative to existing interface techniques, offering the major advantage of sterility.

2

Brainstorm



3

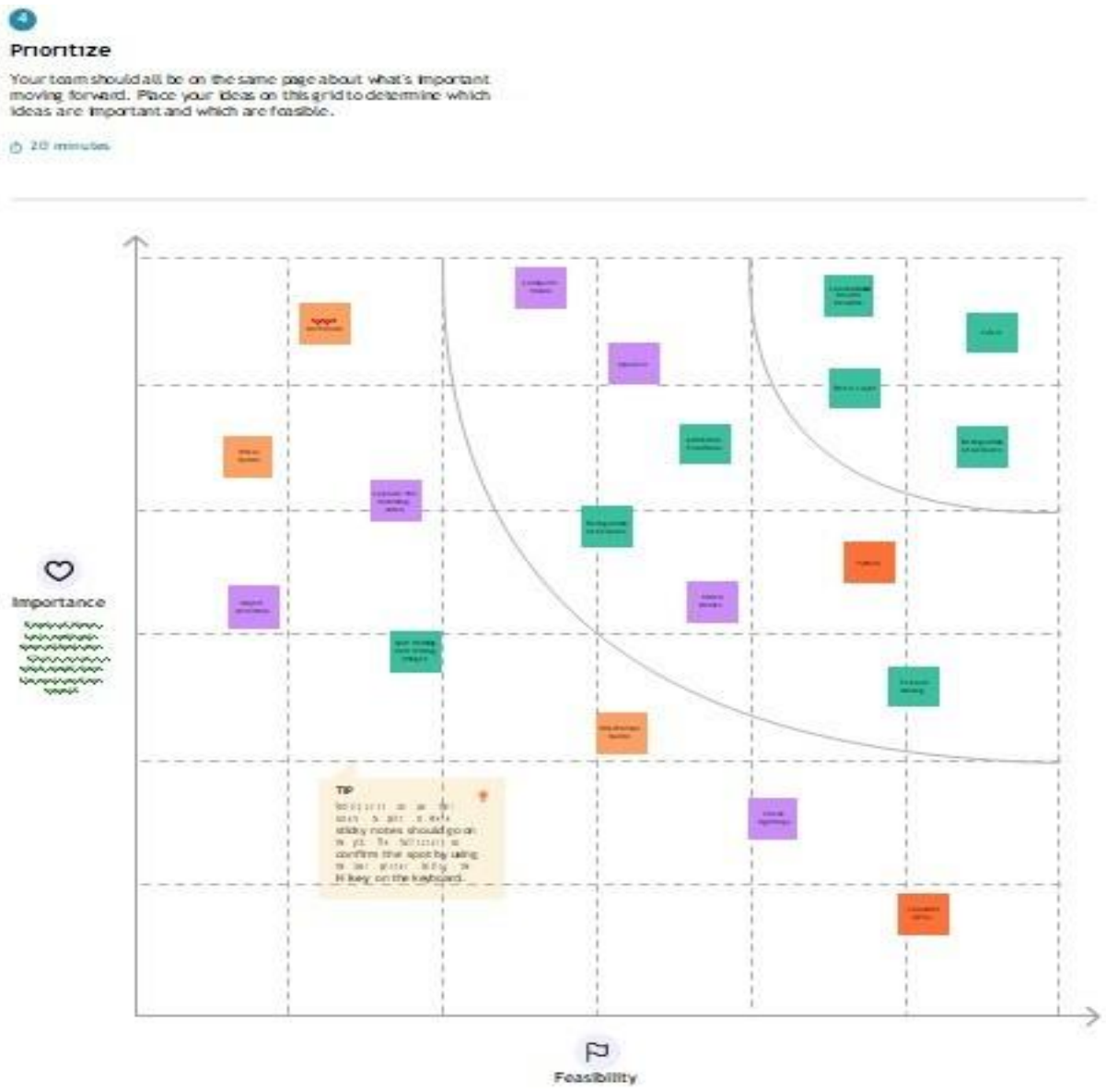
Group ideas

Image Processing

Deep learning model

User Interface

Platforms



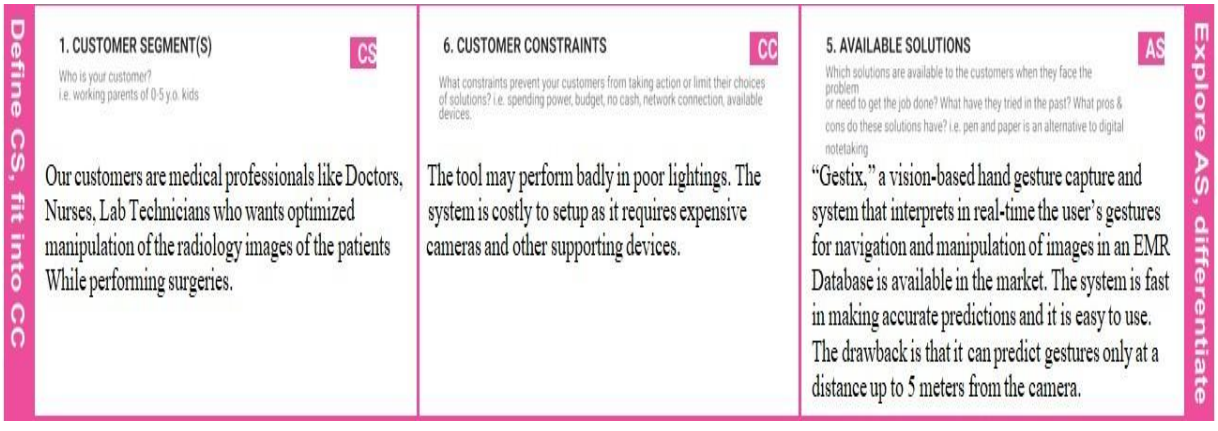
3.3 Proposed Solution

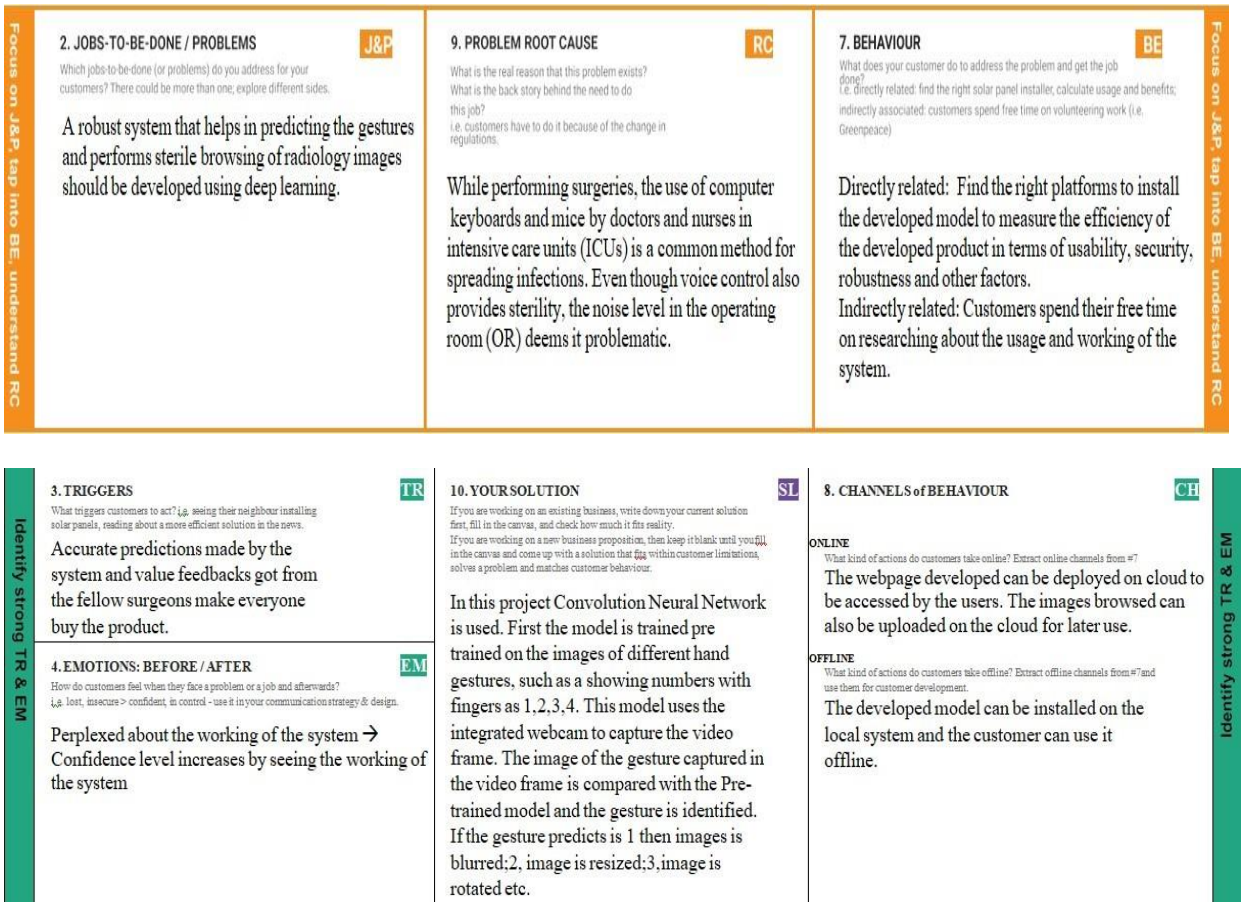
In our solution, Convolution Neural Network is used. First the model is trained pre trained on the images of different hand gestures, such as a showing numbers with fingers as 1,2,3,4. This model uses the integrated webcam to capture the video frame. The image of the gesture captured in the video frame is compared with the Pre-trained model and the gesture is identified. If the gesture predicts is 1 then images is blurred; 2, image is resized; 3, image is rotated; 4, rectangle.

SI. No	Parameter	Description
1	Problem Statement (Problem to be solved)	Computer information technology is increasingly penetrating into the hospital domain. A major challenge involved in this process is to provide doctors with efficient, intuitive, accurate and safe means of interaction without affecting the quality of their work. Keyboards and pointing devices, such as a mouse, are today's principal method of human—computer interaction. However, the use of computer keyboards and mice by doctors and nurses in intensive care units (ICUs) is a common method for spreading infections. Even though voice control also provides sterility, the noise level in the operating room (OR) deems it problematic. Our solution for this problem is the use of hand gestures as an alternative to existing interface techniques, offering the major advantage of sterility. In our work we refer to gestures as a basic form of non-verbal communication made with the hands.
2	Idea / Solution description	In this project Convolution Neural Network is used. 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 1 then images is blurred;2, image is resized;3,image is rotated; 4, rectangle.
3	Novelty / Uniqueness	The proposed system prevents surgeon's focus shift and change of location while achieving, rapid intuitive interaction with

		image databases. The system allows the surgeon to use his/her hands, their natural work tool. Non-verbal instructions by hand gesture commands used in this project are intuitive and fast.
4	Social Impact / Customer Satisfaction	This system assists surgeons while performing operations at a fast rate without any physical contact. Customers are highly benefited as the surgeries can be performed without touching any pointing devices. It also saves time. It can also be placed in other industries like banking. It can also help blind people.
5	Business Model (Revenue Model)	This system can be used in hospitals and diagnosis centers. It can also be placed in private and government medical camps.
6	Scalability of the Solution	More number of gestures can be added so that they can be improved. In addition to this, more number of images can be added so that the system makes correct prediction.

3.4 Problem Solution fit





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	Launching the model	Launch from the cloud where it is deployed Launch offline by installation
FR-2	Image Capturing	Capture Image via Camera Upload images from local system
FR-3	Perform gestures	Gestures should be captured correctly in the camera and proper gestures should be

		performed
FR-4	Model rendering	When the user captures/uploads the gestures followed by a click on the submit button, the deep learning algorithm should starts its processing task.
FR-5	Sterile browsing	After recognizing the gestures, sterile browsing of images should be done properly
FR-6	Displaying the images	The browsed images should be visible to the user.

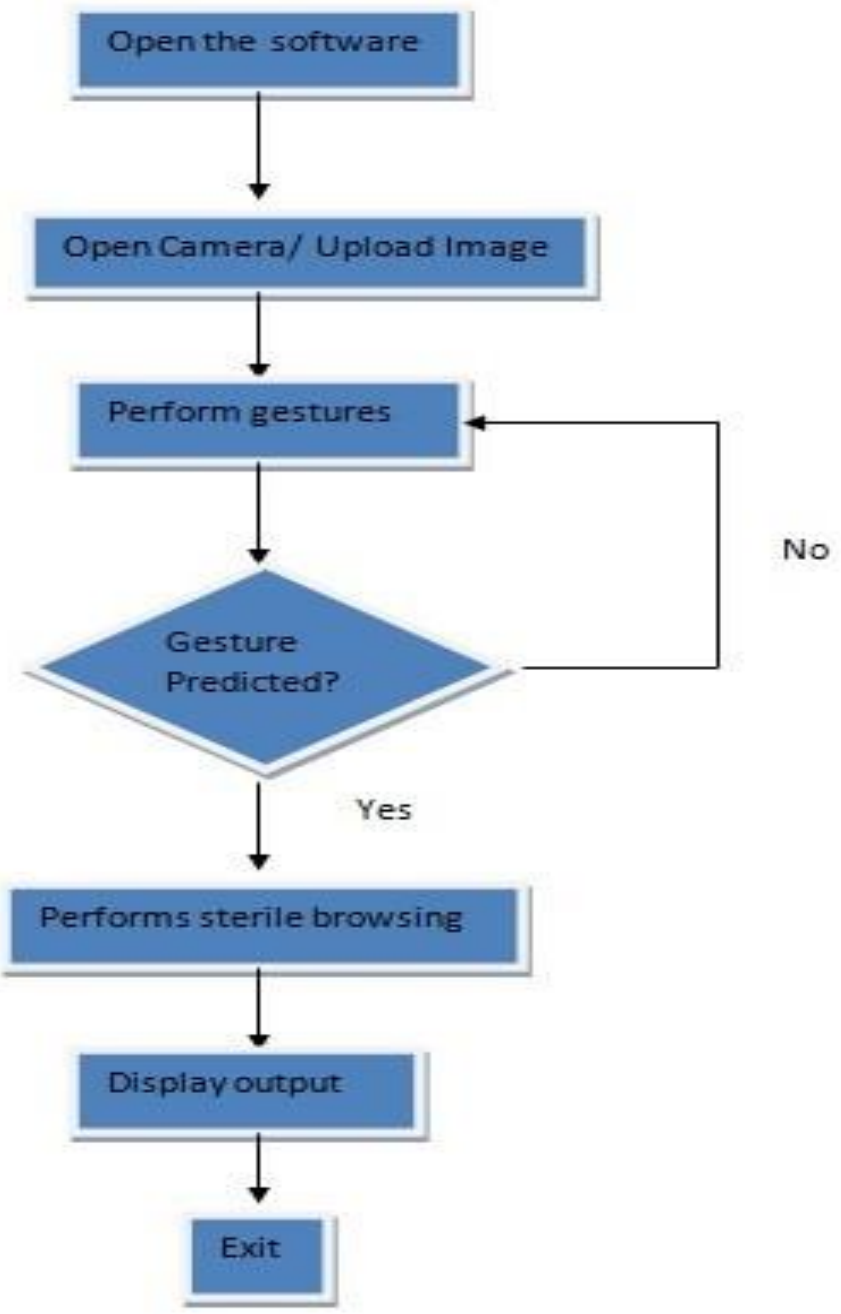
4.2 Non- Functional requirement

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The system designed is user-friendly
NFR-2	**Security**	The system is enforced with security mechanisms to avoid data theft.
NFR-3	**Reliability**	The system predicts the gestures and perform sterile browsing accurately and it produces improper results
NFR-4	**Performance**	It handles the visitors with a handsome response time, it is scalable and the underlying hardware and software is perfect.
NFR-5	**Availability**	The system is available or accessible by an authorized user whenever it is needed. It is not influenced by Denial of Service and Loss of Data Processing Capabilities
NFR-6	**Scalability**	The developed software model never downs the website due to an increase in website visitors.

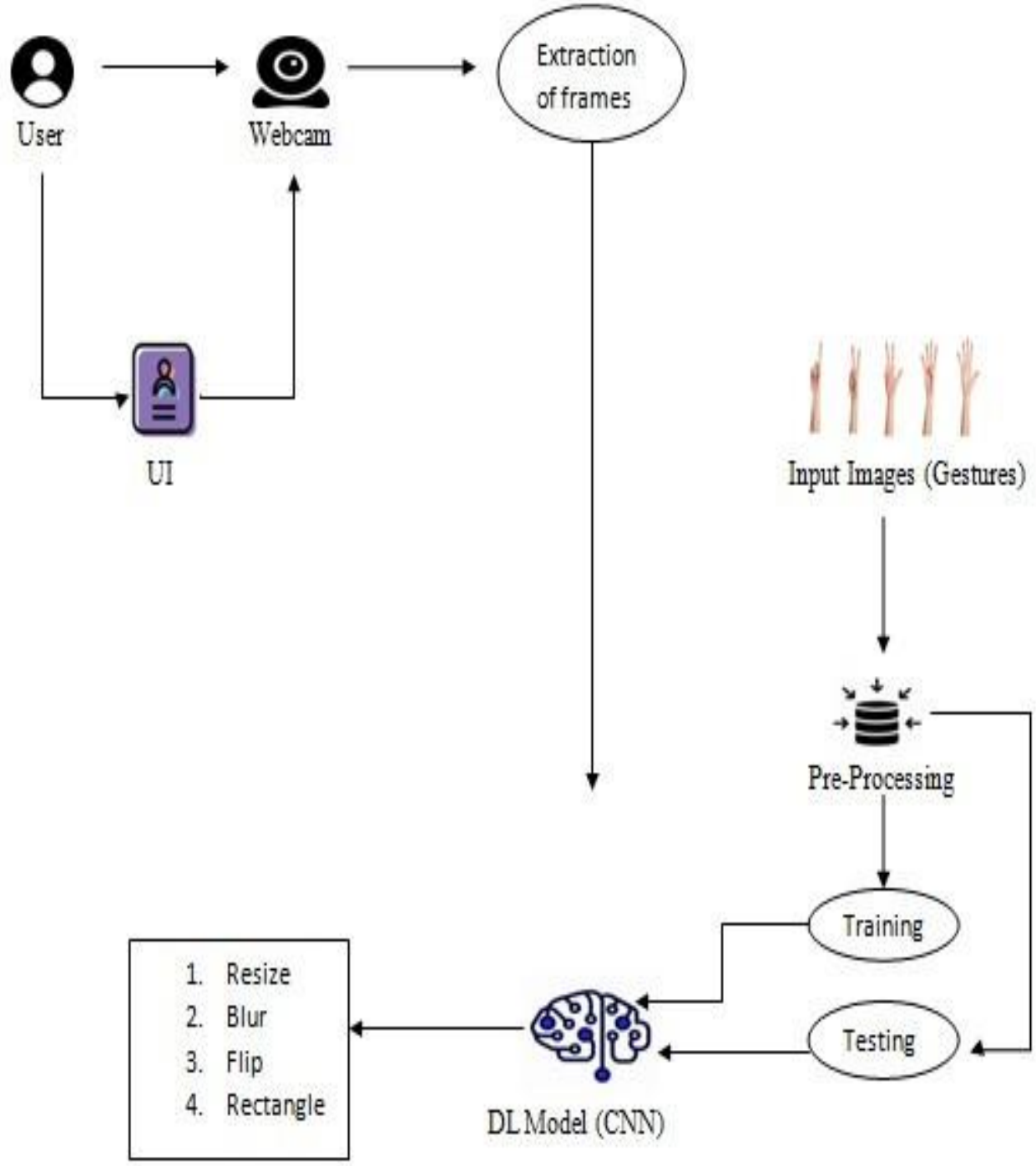
5. PROJECT DESIGN

5.1 Data Flow Diagram

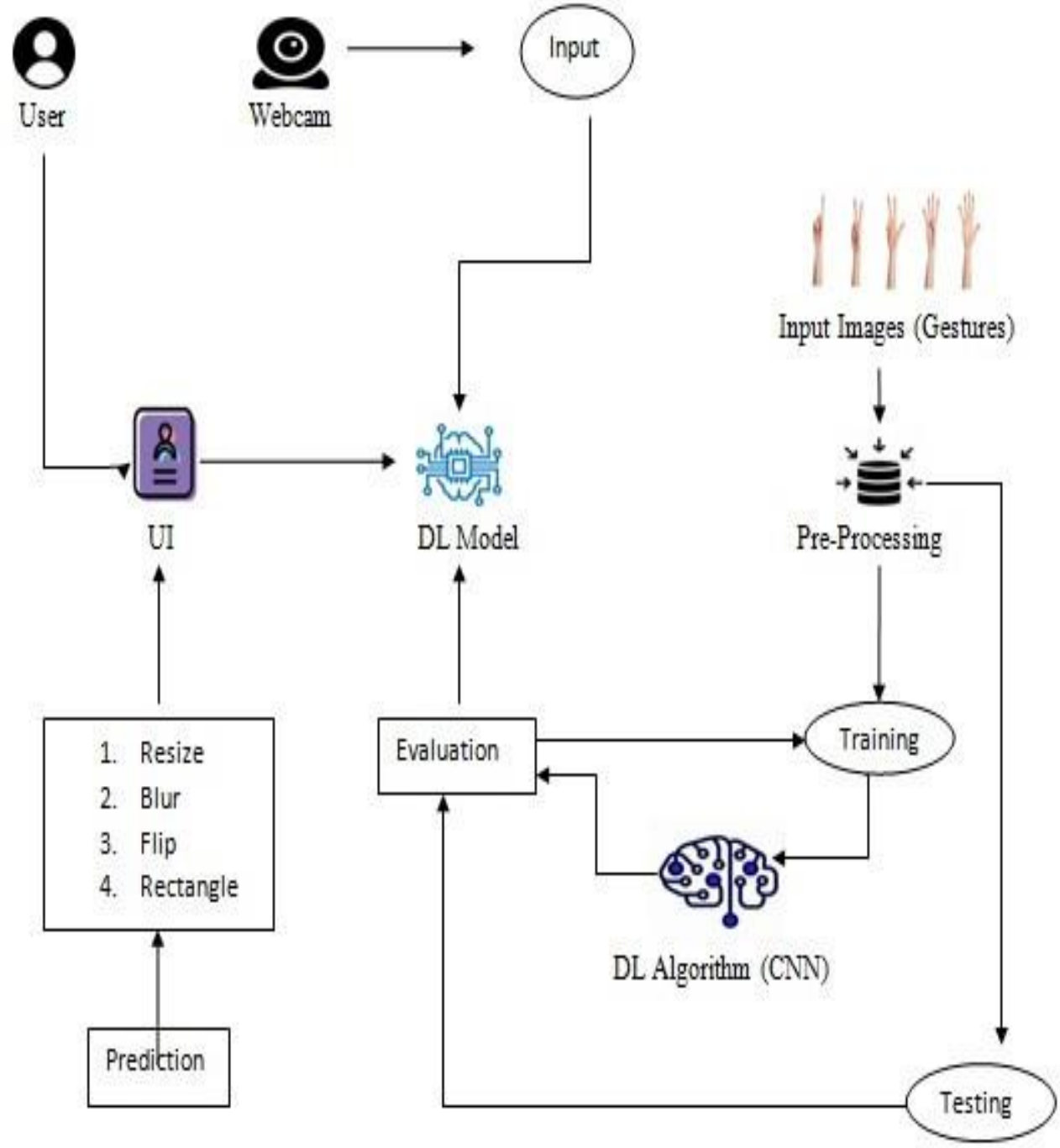


5.2 Solution & Technical Architecture

5.2.1 Solution Architecture



5.2.2 Technical Architecture



5.3 User Stories

The following depicts the user stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Surgeons	Launching Software	USN-1	As a user, I can launch the developed software.	I can launch the software	Low	Sprint-1
	Access UI	USN-2	As a user, I can use the software and operate on the UI	I can access the UI	Medium	Sprint-1
Surgeons (Performs live browsing using camera)	Launching camera	USN-3	As a user, I can open the camera from the software to perform gestures	I can open the camera to capture the images	Low	Sprint-2
Surgeons (Performs browsing by uploading existing images)	Upload images from local system	USN-4	As a user, I can upload images to the software from the local system	I can upload images to the software	Low	Sprint-2
Surgeons (Performs live browsing using camera)	Perform Gestures	USN-5	As a user, I can perform various gestures with respect to system specification for processing.	I can perform various gestures	Medium	Sprint-3
	Display	USN-6	As a user, I	I can see	High	Sprint-

	output		can see the sterile browsed image with respect to the gestures performed, displayed on the screen	the sterile browsed image on the screen		4

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	Launching Software	USN-1	As a user, I can launch the developed software.	1	Low	Padma Priya T R Thanya S S Naresh K Pranav R
Sprint-1	Access UI	USN-2	As a user, I can use the software and operate on the UI	1	Medium	Padma Priya T R Thanya S S Naresh K Pranav R
Sprint-2	Launching camera	USN-3	As a user, I can open the camera from the software to perform gestures	1	Low	Padma Priya T R Thanya S S Naresh K Pranav R
Sprint-2	Upload images from local system	USN-4	As a user, I can upload images to the	2	Low	Padma Priya T R Thanya S

			software from the local system			S Naresh K Pranav R
Sprint-3	Perform Gestures	USN-5	As a user, I can perform various gestures with respect to system specification for processing.	2	Medium	Padma Priya T R Thanya S S Naresh K Pranav R
Sprint-4	Display output	USN-6	As a user, I can see the sterile browsed image with respect to the gestures performed, displayed on the screen	2	High	Padma Priya T R Thanya S S Naresh K Pranav R

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	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	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	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

Imagine we have a10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

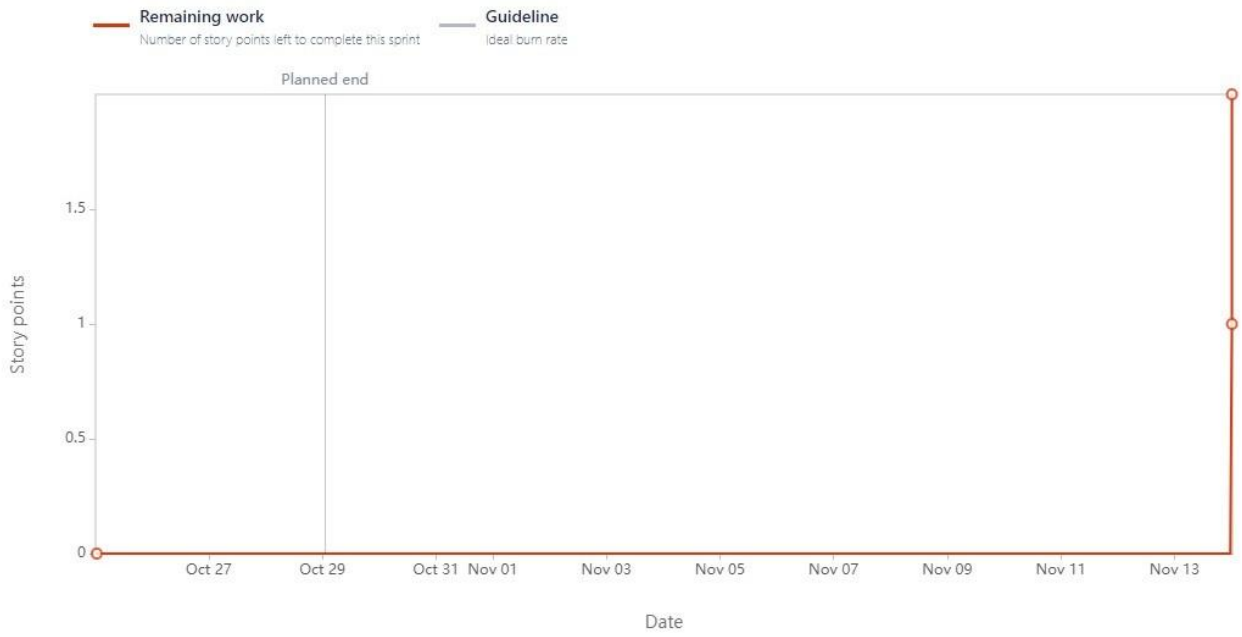
$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

6.3 Reports from JIRA

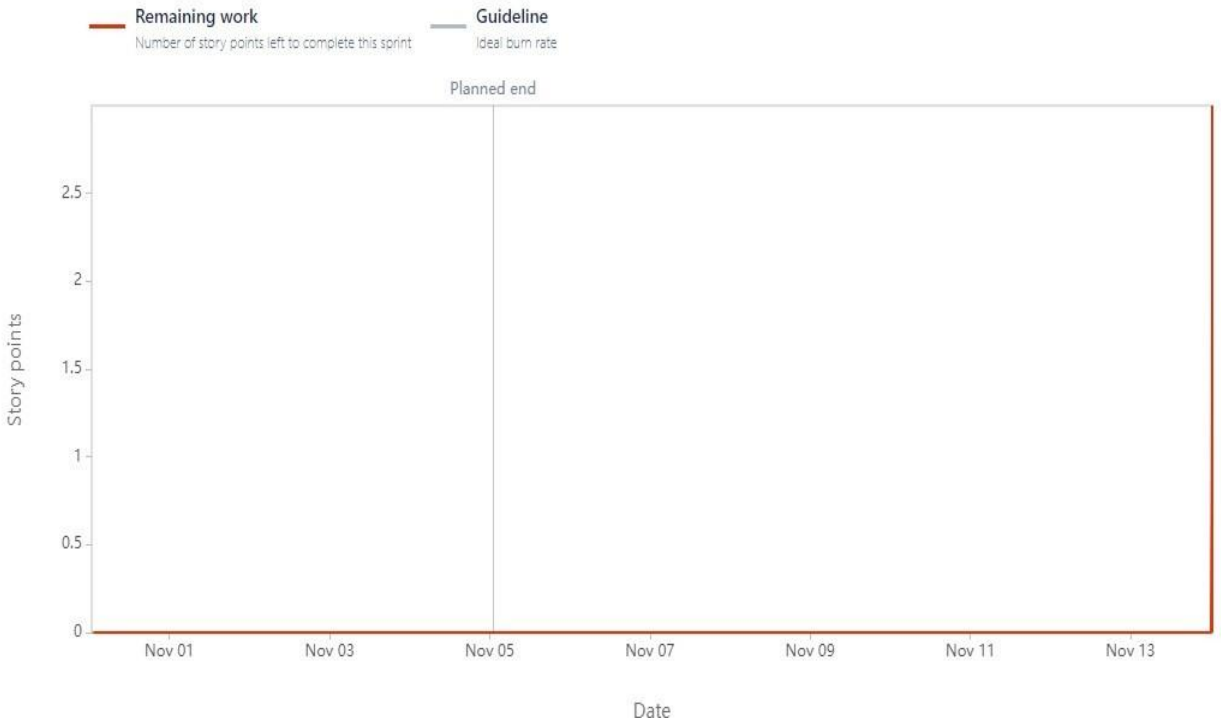
6.3.1 Velocity Report

6.3.2 Sprint Burndown Chart

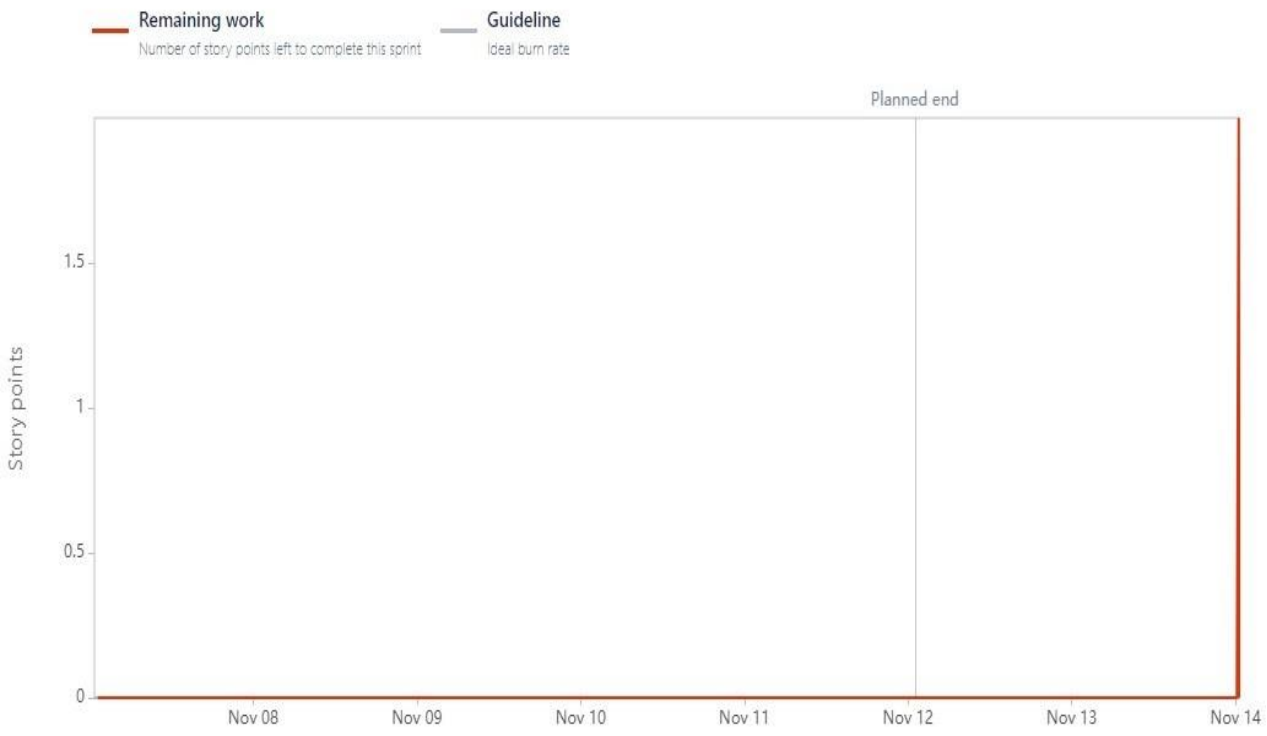
Date - October 24th, 2022 - October 29th, 2022



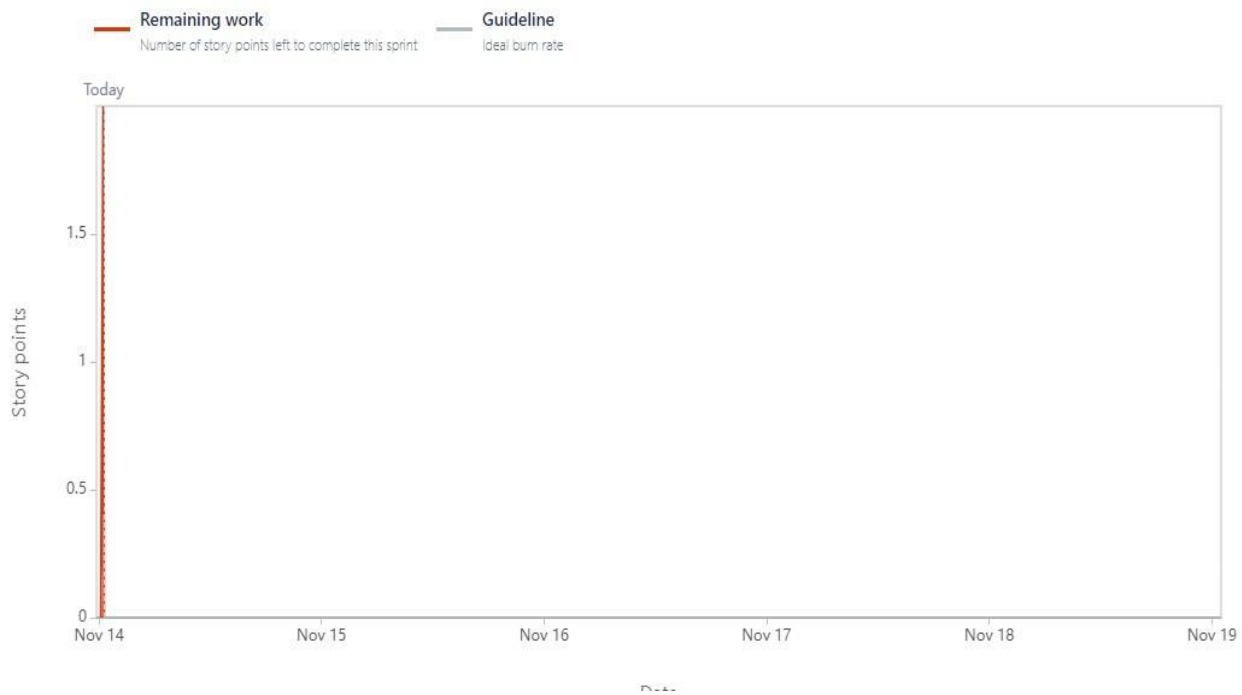
Date - October 31st, 2022 - November 5th, 2022



Date - November 7th, 2022 - November 12th, 2022



Date - November 14th, 2022 - November 19th, 2022



7. CODING & SOLUTIONING

7.1 Feature 1

The proposed solution is based on Convolutional neural network. A Convolutional neural network, or CNN, is a deep learning neural network designed for processing structured arrays of data such as images. Convolutional neural networks are widely used in computer vision and have become the state of the art for many visual applications such as image classification, and have also found success in natural language processing for text classification.

7.1.1 Import The ImageDataGenerator Library

Image data augmentation is a technique that can be used to artificially expand the size of a training dataset by creating modified versions of images in the dataset. The Keras deep learning neural network library provides the capability to fit models using image data augmentation via the ImageDataGenerator class. The ImageDataGenerator class is imported from keras.

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

7.1.2 Configure ImageDataGenerator Class

ImageDataGenerator class is instantiated and the configuration for the types of data augmentation. There are five main types of data augmentation techniques for image data; specifically:

- Image shifts via the width_shift_range and height_shift_range arguments.
- Image flips via the horizontal_flip and vertical_flip arguments.
- Image rotations via the rotation_range argument.
- Image brightness via the brightness_range argument.
- Image zoom via the zoom_range argument.

```
train_datagen = ImageDataGenerator(rescale=1./255, shear_range=0.2,
zoom_range=0.2, horizontal_flip=True)
```

```
test_datagen = ImageDataGenerator(rescale=1./255)
```

7.1.3 Apply ImageDataGenerator Functionality To Train set And Test set

To apply ImageDataGenerator functionality for Training set use flow_from_directory function. This function will return batches of images from the subdirectories 0,1,2,3,4,5 together with labels 0 to 5{'0': 0, '1': 1, '2': 2, '3': 3, '4': 4, '5': 5}

Arguments:

directory: Directory where the data is located. If labels is "inferred", it should contain subdirectories, each containing images for a class. Otherwise, the directory structure is ignored.

batch_size: Size of the batches of data. Default: 32.

target_size: Size to resize images to after they are read from disk.

class_mode:

- ‘int': means that the labels are encoded as integers (e.g. for sparse_categorical_crossentropy loss).
- 'categorical' means that the labels are encoded as a categorical vector (e.g. for categorical_crossentropy loss).
- 'binary' means that the labels (there can be only 2) are encoded as float32 scalars with values 0 or 1 (e.g. for binary_crossentropy).
- None (no labels).

ImageDataGenerator functionality to Trainset and Testset by using the following code

```
train_data= train_datagen.flow_from_directory (r 'D:\Dataset\train', target_size=(128,128), batch_size=8, class_mode='categorical', subset='training', color_mode= 'grayscale')
```

```
test_data = test_datagen.flow_from_directory(r'D:\Dataset\test', target_size=(128,128),batch_size=8,class_mode='categorical',color_mode='grayscale')
```

7.1.4 Importing The Model Building Libraries

Import the necessary libraries required for model building

```
import tensorflow as tf
import keras
import numpy as np
from tensorflow.keras import layers,losses
from tensorflow.keras.models import Sequential, Model, load_model
from tensorflow.keras.models import Sequential, Model, load_model
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from keras import regularizers
from keras.layers import BatchNormalization
```

7.1.5 Initializing The Model

Sequential model is a linear stack of layers. We can create a Sequential model by passing a list of layer instances to the constructor: from keras.models import Sequential from keras as follows.

```
model = Sequential()
```

7.1.6 Adding CNN Layers

We are adding a convolution layer with activation function as "relu" and with a small filter size (3,3) and number of filters (32) followed by a max pooling layer. Max pool layer is used to down sample the input. Flatten layer flattens the input. It does not affect the batch size.

```
model.add(BatchNormalization(input_shape = (128,128,1)))
model.add(Convolution2D(32, (3,3), activation ='relu', input_shape = (128, 128, 1)))
model.add(MaxPooling2D(pool_size=2))
model.add(Convolution2D(filters=6,kernel_size=4,padding='same',activation='relu'))
model.add(MaxPooling2D(pool_size=2))
model.add(Convolution2D(filters=128,kernel_size=3,padding='same',activation='relu
))
model.add(MaxPooling2D(pool_size=2))
model.add(Convolution2D(filters=128,kernel_size=2,padding='same',activation='relu
))
model.add(MaxPooling2D(pool_size=2))
model.add(MaxPooling2D(pool_size=2))
```

7.1.7 Adding Dense Layers

Dense layer is deeply connected neural network layer. It is most common and frequently used layer.

```
model.add(Dense(units=128,activation = 'relu'))
model.add(Dense(units=64,activation = 'relu'))
model.add(Dense(units=32,activation = 'relu'))
model.add(Dense(units = 6, activation = 'softmax'))
```

Understanding the model is very important phase to properly use it for training and prediction purposes. Keras provides a simple method, summary to get the full information about the model and its layers. The following code represents that.

model.summary()

7.1.8 Compiling the model

The compilation is the final step in creating a model. Once the compilation is done, we can move on to training phase. Loss function is used to find error or deviation in the learning process. Keras requires loss function during model compilation process. Optimization is an important process which optimizes the input weights by comparing the prediction and the loss function. Here we are using adam optimizer. Metrics is used to evaluate the performance of your model. It is similar to loss function, but not used in training process.

```
model.compile(optimizer='adam',loss=losses.categorical_crossentropy,metrics=['accu
racy'])
```

7.1.9 Train the model on IBM

Next, the process of training the model with image dataset is done. fit_generator functions used to train a deep learning neural network

Arguments:

steps_per_epoch: it specifies the total number of steps taken from the generator as soon as one epoch is finished and next epoch has started. We can calculate the value of steps_per_epoch as the total number of samples in your dataset divided by the batch size.

Epochs: an integer and number of epochs we want to train our model for.

validation_data can be either:

- an inputs and targets list

- a generator
- an inputs, targets, and sample_weights list which can be used to evaluate
- the loss and metrics for any model after any epoch has ended.

validation_steps: only if the validation_data is a generator then only this argument can be used. It specifies the total number of steps taken from the generator before it is stopped at every epoch and its value is calculated as the total number of validation data points in your dataset divided by the validation batch size.

The model is trained on IBM Cloud platform

```
model.fit_generator(train_gen,epochs=25,
steps_per_epoch=18000//32,steps_per_epoch=18000//32, validation_steps=3600//32)
```

7.1.10 Save the model

The model is saved with .h5 extension as follows. An H5 file is a data file saved in the Hierarchical Data Format (HDF). It contains multidimensional arrays of scientific data.

```
model.save(r'D:\IBM Project\gesture.h5')
```

7.2 Feature 2

7.2.1 Create HTML Pages

We use HTML to create the front end part of the web page. Here, we created 3 html pages- Home.html, Intro.html and Index.html. Home.html displays home page. Intro.html displays introduction about the hand gesture recognition. Index.html accepts input from the user (live video) and predicts the values. We also use JavaScript-main.js and CSS-main.css to enhance our functionality and view of HTML pages.

7.2.2 Build Python Code

Flask is a web framework written in python for server-side scripting. The step by step procedure for building the backend application is given below.

MediaPipe is a Framework for building machine learning pipelines for processing time-series data like video, audio, etc. This cross-platform Framework works in Desktop/Server, Android, iOS, and embedded devices like Raspberry Pi and Jetson Nano.

App starts running when "__name_" constructor is called in main. render_template is used to return html file. "GET" method is used to take input from the user. "POST" method is used to display the output to the user.

MediaPipe is used detect the hand using the co-ordinates from the live video and passes this as input to the deep learning model.

The deep learning model after getting the input from camera processes it and predicts the output. With respect to the predicted gesture, Resize, Blur, Rotation and Rectangle operations are done.

The following code illustrates the overall process

```
import mediapipe as mp
import numpy as np
from flask import Flask, render_template, request
import cv2
import os
from keras.models import load_model
app = Flask(__name__)
@app.route("/")
def home():
    return render_template("home.html")

@app.route("/process", methods=['GET', 'POST'])
def process():
    if request.method == 'POST':
        upload_image = request.files['upload_image']
        img=upload_image.read()
        npimg = np.fromstring(img, np.uint8)
```

```
    model1 = load_model('gesture.h5')
    mpHands = mp.solutions.hands
    hands = mpHands.Hands(max_num_hands=1, min_detection_confidence=0.5,
min_tracking_confidence=0.5)
    mpDraw = mp.solutions.drawing_utils
    cap = cv2.VideoCapture(0)
    while True:
        _, frame = cap.read()

        h, w, c = frame.shape

        frame = cv2.flip(frame, 1)
        framergb = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)

        result = hands.process(framergb)
        res = ''

        if result.multi_hand_landmarks:
            landmarks = []
            for handslms in result.multi_hand_landmarks:
                x_max = 0
                y_max = 0
                x_min = w
                y_min = h
                for lm in handslms.landmark:
                    x = int(lm.x * w)
                    y = int(lm.y * h)

                    landmarks.append([x, y])
                    if x > x_max:
                        x_max = x
                    if x < x_min:
                        x_min = x
                    if y > y_max:
                        y_max = y
                    if y < y_min:
                        y_min = y
```

```
                cv2.rectangle(frame, (x_min - 5, y_min - 5), (x_max + 5, y_max + 5), (0,
255, 0), 2)
                framegray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
                hand = framegray[y_min - 5:y_max + 5, x_min - 5:x_max + 5]
                hand = cv2.resize(hand, (128, 128))
                hand = hand / 255
                hand = hand.reshape(128, 128, 1)
                hand = np.expand_dims(hand, axis=0)
                mpDraw.draw_landmarks(frame, handslms,
mpHands.HAND_CONNECTIONS)
                prediction = model1.predict(hand)
                res = np.argmax(prediction)
                image1 = cv2.imdecode(npimg, cv2.IMREAD_COLOR)
                image1= cv2.resize(image1, (400, 400))
                if res==1:
                    resized = cv2.resize(image1, (200, 200))
                    cv2.imshow("Resizing", resized)
                    key=cv2.waitKey(3000)

                    if (key & 0xFF) == ord("1"):
                        cv2.destroyWindow("Resizing")

                elif res==2:
                    blurred = cv2.GaussianBlur(image1, (21, 21), 0)
                    cv2.imshow("Blurred", blurred)
                    key=cv2.waitKey(3000)
                    if (key & 0xFF) == ord("3"):
                        cv2.destroyWindow("Blurred")

                elif res==3:
                    (h, w, d) = image1.shape
                    center = (w // 2, h // 2)
                    M = cv2.getRotationMatrix2D(center, -45, 1.0)
                    rotated = cv2.warpAffine(image1, M, (w, h))
                    cv2.imshow("OpenCV Rotation", rotated)
                    key=cv2.waitKey(3000)
                    if (key & 0xFF) == ord("2"):
```

```
                    cv2.destroyWindow("OpenCV Rotation")


                elif res==4 :
                    cv2.rectangle(image1, (480, 170), (650, 420), (0, 0, 255), 2)
                    cv2.imshow("Rectangle", image1)
                    cv2.waitKey(0)
                    key=cv2.waitKey(3000)
                    if (key & 0xFF) == ord("0"):
                        cv2.destroyWindow("Rectangle")


                else:
                    continue

            #cv2.putText(frame, str(res), (10, 50), cv2.FONT_HERSHEY_SIMPLEX,
                    #1, (0, 0, 255), 2, cv2.LINE_AA)
            cv2.imshow("Output", frame)

            if cv2.waitKey(1) == ord('q'):
                break

        cap.release()
        cv2.destroyAllWindows()

    return render_template("index.html")


@app.route("/intro")
def intro_page():
    return render_template("intro.html")

@app.route("/index")
def index_page():
    return render_template("index.html")

@app.route("/back")
```

```
def back():
    return render_template("home.html")
```

7.2.3 Run the application

At last, the flask application is run using the following command.

```
if__name__ == '_main_':
        app.run(debug=True)
```

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
Hom Page _TC _OO 1	Funct ional	Ho me Pag e	Verify user is able to see the home page when user clicked on the applicatio n link	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2.Verify whether the home page of the application displayed or not	App licat ion Url	Home Page should be displa yed	Worki ng as expect ed	Pass
Hom Page _TC _OO 2	UI	Ho me Pag e	Verify the UI elements in Home Page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Verify the UI Component	App licat ion Url	Applic ation should show the 'Get Starte d'	Button is not visible	Fail

					s of the home page by checking the 'Get Started' button.		button		
Hom Page _TC _OO 3	UI	Ho me Pag e	Verify the UI elements in Home Page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Verify the UI Component s of the home page by checking the'Get Started' button.	App licat ion Url	Applic ation should show the 'Get Starte d' button	Worki ng as expect ed	Pass
Hom Page _TC _OO 4	Funct ional	Ho me Pag e	Verify whether the user is able to move to intro page or not?	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button 3. Verify whether the user is able to move to intro page or not?	App licat ion Url	User should naviga te to intro page	Not naviga ted to intro page	Fail
Hom Page _TC	Funct ional	Ho me Pag	Verify whether the user is	1. Laptop 2.Internet Connection	1. Enter URL in the browser	App licat ion	User should naviga	Worki ng as expect	Pass

_OO5		e	able to move to intro page or not?	3. Web cam	and click enter. 2. Click on the 'Get Started' button 3. Verify whether the user is able to move to intro page or not?	Url	te to intro page	ed	
Intro Page_TC_OO1	Functional	Intro Page	Verify user is able to open the intro page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2.Click on the 'Get Started' button 3. Verify whether the user is able to open the intro page or not?	Application Url	Intro page should be opened	Working as expected	Pass
Intro Page_TC_OO2	UI	Intro Page	Verify the UI elements in Intro Page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3.Verify the following UI	Application Url	UI components should be displayed on the screen.	UI components not displayed	Fail

					Components of the intro page a. Intro Text b. Proceed button c. Back button				
Intro Page_TC_OO3	UI	Intro Page	Verify the UI elements in Intro Page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3.Verify the following UI Components of the intro page a. Intro Text b. Proceed button c. Back button	Application Url	UI components should be displayed on the screen.	Working as expected	Pass
Intro Page_TC_OO4	Functional	Intro Page	Verify whether the user is able to navigate to index page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button.	Application Url	Index page should be opened	Working as expected	Pass

					3. Click on 'Proceed' button. 4.Verify whether the index page is opening or not				
Intro Page_TC_OO5	Functional	Intro Page	Verify whether the user is able to navigate back to the home page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on 'Back' button. 4.Verify whether the home page is opening or not	Application Url	Home Page should be displayed	Home page not opened	Fail
Intro Page_TC_OO6	Functional	Intro Page	Verify whether the user is able to navigate back to the home page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on 'Back' button. 4.Verify whether the home page	Application Url	Home Page should be displayed	Working as expected	Pass

					is opening or not				
IndexPage_TC_OO1	Functional	Index Page	Verify whether the user is able to open the index page or not	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on 'Proceed' button. 4.Verify whether the index page is opening or not	Application Url	Index page should be opened	Working as expected	Pass
IndexPage_TC_OO2	UI	Index Page	Verify the UI elements in Intro Page	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Verify the following UI Components of the index page a. File	Application Url	UI components should be displayed on the screen.	Working as expected	Pass

					upload button b. Video Capture button c. Image display field d. Back button				
IndexPage_TC_OO3	Functional	Index Page	Verify whether the user is able to upload the image or not.	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the upload file button. 5. Choose an image from gallery. 6. Upload the image. 7. Verify whether the image is uploaded or not.	Image from local system	Image should be uploaded	Image not uploaded	Fail
IndexPage_T	Functional	Index Pag	Verify whether the user is	1. Laptop 2.Internet Connection	1. Enter URL in the browser	Image fro	Image should be	Working as expect	Fail

C_OO4		e	able to upload the image or not.	3. Web cam	and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the upload file button. 5. Choose an image from gallery. 6. Upload the image. 7. Verify whether the image is uploaded or not.	m local system	uploaded	ed	
IndexPage_TC_OO5	Functional	Index Page	Verify whether the user uploaded image is displayed on the screen or not.	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the upload file button.	Image from local system	Image should be displayed on the screen.	Working as expected	Fail

					5. Choose an image from gallery. 6. Upload the image. 7. Verify whether the image is displayed on the screen or not.				
IndexPage_TC_OO6	Functional	Index Page	Verify whether the system is capturing live video	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the capture video button. 5. Verify whether the live video is captured or not.	Live Video	Live video should be captured	Working as expected	Fail
IndexPage_TC_OO7	Functional	Index Page	Verify whether the model predicts the	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter.	Live Video	Gesture should be predic	Wrong prediction	Fail

			correct gesture		2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the capture video button. 5. Verify whether the system predicts the correct gesture or not.		ted correctly.		
IndexPage_TC_OO8	Functional	Index Page	Verify whether the model predicts the correct gesture	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the capture video button. 5. Verify whether the system predicts the	Live Video	Gesture should be predicted correctly.	Working as expected	Pass

					correct gesture or not.				
IndexPage_TC_OO9	Functional	Index Page	Verify whether the system is performing the correct task with respect to the gesture	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the capture video button. 5.Verify whether the system is performing the correct task with respect to the gesture	Live Video	Task should be performed with respect to the gesture.	Wrong gesture	Fail
IndexPage_TC_OO10	Functional	Index Page	Verify whether the system is performing the correct task with respect to the gesture	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed'	Live Video	Task should be performed with respect to the gesture.	Working as expected	Pass

					button. 4. Click on the capture video button. 5.Verify whether the system is performing the correct task with respect to the gesture				
IndexPage_TC_OO11	Functional	Index Page	Verify whether the user is able to quit the screen after performing tasks	1. Laptop 2.Internet Connection 3. Web cam	1. Enter URL in the browser and click enter. 2. Click on the 'Get Started' button. 3. Click on the 'Proceed' button. 4. Click on the capture video button. 5.Analyze the task performed 6.Press 'q' to quit	Pressing ‘q’	Camera screen should be closed	Working as expected	Pass

8.2 User Acceptance Testing

8.2.1 Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the A Gesture Based Tool for Sterile Browsing of Radiology Images project at the time of the release to User Acceptance Testing (UAT).

8.2.2 Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	0	1	2	0	3
Duplicate	0	0	0	0	0
External	2	1	1	0	4
Fixed	2	2	3	0	7
Not Reproduced	0	0	0	0	0
Skipped	0	0	0	0	0
Won't Fix	0	0	0	0	0
Totals	4	4	6	0	14

8.2.3 Test Case Analysis

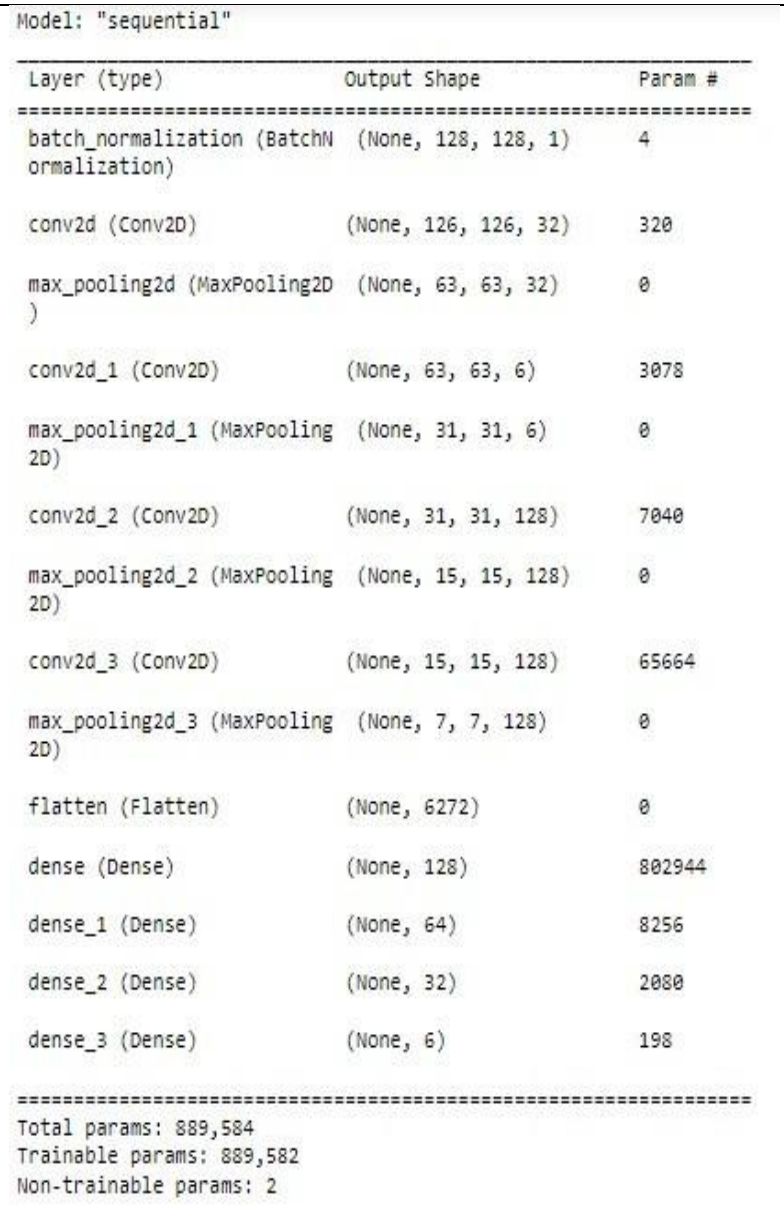
This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Home Page	5	0	2	3
Intro Page	6	0	2	4
Index Page	11	0	3	8

9. RESULTS

9.1 Performance Metrics

The performance of the solution is measured in terms of validation accuracy and the loss in every epoch. The model summary and the accuracy is given as follows.

S.No.	Parameter	Values	Screenshot
1.	Model Summary	-	

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 batch_normalization (BatchN  (None, 128, 128, 1)      4
 ormalization)

 conv2d (Conv2D)             (None, 126, 126, 32)      320

 max_pooling2d (MaxPooling2D  (None, 63, 63, 32)       0
 )

 conv2d_1 (Conv2D)           (None, 63, 63, 6)         3078

 max_pooling2d_1 (MaxPooling  (None, 31, 31, 6)        0
 2D)

 conv2d_2 (Conv2D)           (None, 31, 31, 128)       7040

 max_pooling2d_2 (MaxPooling  (None, 15, 15, 128)      0
 2D)

 conv2d_3 (Conv2D)           (None, 15, 15, 128)       65664

 max_pooling2d_3 (MaxPooling  (None, 7, 7, 128)        0
 2D)

 flatten (Flatten)           (None, 6272)              0

 dense (Dense)               (None, 128)               802944

 dense_1 (Dense)             (None, 64)                8256

 dense_2 (Dense)             (None, 32)                2080

 dense_3 (Dense)             (None, 6)                 198

=================================================================
Total params: 889,584
Trainable params: 889,582
Non-trainable params: 2
```

2.	Accuracy	Training Accuracy – 99.92% Validation Accuracy – 99.86%	Epoch 1/20 562/562 [==========] - 308s 546ms/step - loss: 0.2178 - accuracy: 0.9182 - val_loss: 0.0014 - val_accuracy: 1.0000 Epoch 2/20 562/562 [==========] - 306s 545ms/step - loss: 0.0386 - accuracy: 0.9880 - val_loss: 0.0068 - val_accuracy: 0.9978 Epoch 3/20 562/562 [==========] - 299s 532ms/step - loss: 0.0192 - accuracy: 0.9948 - val_loss: 7.7184e-04 - val_accuracy: 1.0000 Epoch 4/20 562/562 [==========] - 306s 545ms/step - loss: 0.0137 - accuracy: 0.9960 - val_loss: 0.0032 - val_accuracy: 0.9983 Epoch 5/20 562/562 [==========] - 310s 552ms/step - loss: 0.0184 - accuracy: 0.9940 - val_loss: 5.2546e-04 - val_accuracy: 1.0000 Epoch 6/20 562/562 [==========] - 312s 556ms/step - loss: 0.0150 - accuracy: 0.9949 - val_loss: 1.4421e-05 - val_accuracy: 1.0000 Epoch 7/20 562/562 [==========] - 304s 541ms/step - loss: 0.0073 - accuracy: 0.9978 - val_loss: 0.0120 - val_accuracy: 0.9967 Epoch 8/20 562/562 [==========] - 309s 550ms/step - loss: 0.0111 - accuracy: 0.9966 - val_loss: 0.0011 - val_accuracy: 0.9994 Epoch 9/20 562/562 [==========] - 313s 556ms/step - loss: 0.0067 - accuracy: 0.9982 - val_loss: 2.7600e-05 - val_accuracy: 1.0000 Epoch 10/20 562/562 [==========] - 311s 553ms/step - loss: 0.0124 - accuracy: 0.9962 - val_loss: 4.3617e-04 - val_accuracy: 1.0000 Epoch 11/20 562/562 [==========] - 311s 552ms/step - loss: 0.0071 - accuracy: 0.9978 - val_loss: 2.4401e-04 - val_accuracy: 1.0000 Epoch 12/20 562/562 [==========] - 310s 552ms/step - loss: 0.0035 - accuracy: 0.9992 - val_loss: 0.0021 - val_accuracy: 0.9989 Epoch 13/20 562/562 [==========] - 303s 539ms/step - loss: 0.0090 - accuracy: 0.9975 - val_loss: 0.0017 - val_accuracy: 1.0000 Epoch 14/20 562/562 [==========] - 299s 533ms/step - loss: 0.0082 - accuracy: 0.9976 - val_loss: 1.9254e-05 - val_accuracy: 1.0000 Epoch 15/20 562/562 [==========] - 308s 549ms/step - loss: 0.0072 - accuracy: 0.9982 - val_loss: 1.5410e-04 - val_accuracy: 1.0000 Epoch 16/20 562/562 [==========] - 307s 545ms/step - loss: 0.0078 - accuracy: 0.9974 - val_loss: 1.8354e-04 - val_accuracy: 1.0000 Epoch 17/20 562/562 [==========] - 306s 545ms/step - loss: 0.0020 - accuracy: 0.9996 - val_loss: 1.1681e-05 - val_accuracy: 1.0000 Epoch 18/20 562/562 [==========] - 307s 546ms/step - loss: 0.0074 - accuracy: 0.9981 - val_loss: 1.8610e-04 - val_accuracy: 1.0000 Epoch 19/20 562/562 [==========] - 300s 534ms/step - loss: 0.0051 - accuracy: 0.9986 - val_loss: 1.1064e-04 - val_accuracy: 1.0000 Epoch 20/20 562/562 [==========] - 304s 540ms/step - loss: 0.0026 - accuracy: 0.9992 - val_loss: 0.0037 - val_accuracy: 0.9986

10. ADVANTAGES & DISADVANTAGES

10.1 Advantages

The main advantage of the system is that it prevents surgeon's focus shift and change of location while achieving, rapid intuitive interaction with image databases. The system allows the surgeon to use his/her hands, their natural work tool. Non-verbal instructions by hand gesture commands used in this project are

intuitive and fast. This system assists surgeons while performing operations at a fast rate without any physical contact. Customers are highly benefited as the surgeries can be performed without touching any pointing devices. It also saves time. It can also be placed in other industries like banking. It can also help blind people.

10.2 Disadvantages

The disadvantage of this system is that the system is quite expensive as it requires expensive cameras and other devices to capture images and process it

11. CONCLUSION

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 of gestures can be added thereby increasing this tool's functionality and usabilityfor 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: [GitHub - https://github.com/IBM-EPBL/IBM-Project-6782-1658837170](https://github.com/IBM-EPBL/IBM-Project-6782-1658837170)