A GESTURE- BASED TOOL FOR STERILE BROWSING OF RADIOLOGY IMAGE

Bachelor of Engineering

In

Computer Science and Engineering

Submitted by

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Content

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1 Introduction

1.1 Project Overview:-

Recently, strong efforts have been carried out to develop intelligent and natural interfaces between users and computer-based systems based on human gestures. Gestures provide an intuitive interface to both humans and computers. Thus, such gesture-based interfaces can not only substitute the common interface devices but can also be exploited to extend their functionality.

In this project we use gestures to browse images obtained during radiology. Gestures refer to non-verbal form of communication made using hands. 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. 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.

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 sterility.

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 - 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.

Literature Survey

2.1 Existing problem:

It Use of doctor-computer interaction devices in the operation room (OR) requires new modalities that support medical imaging manipulation while allowing doctors' hands to remain sterile, supporting their focus of attention, and providing fast response times.

This paper presents “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. Navigation and other gestures are translated to commands based on their temporal trajectories, us of attention, and providing fast response times. This project,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.

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. 1 In this paper, we suggest the use of hand gestures as an alternative to existing interface techniques, offering the major advantage of sterility. Even though voice control also provides sterility, the noise level in the operating room (OR) deems it problematic.

- Surgeons kept their focus of attention between the patient and the surgical point of interest on the touch-screen navigation system.
- A short distance between the surgeon and the patient was maintained during most of the surgery.
- The surgeon had to move close to the main control wall to discuss and browse through the patient's MRI images.

2.2 Reference:

1. Schultz M, Gill J, Zubairi S, Huber R, Gordin F. “Bacterial contamination of computer keyboards in a teaching hospital,” Infect Control Hosp. Epidemiol 2003;4(24):302-303. [PubMed] [Google Scholar]

2. Nishikawa A, Hosoi T, Koara K, Ngoro D, Hikita A, Asano S, Kakutani H, Miyazaki F, Sekimoto M, Yasui M, Miyake Y, Takiguchi S, Monden M. “Face MOUSE: A Novel Human-Machine Interface for Controlling the Position of a Laparoscope,” IEEE Trans. on Robotics and Automation 2003;19(5):825-841. [Google Scholar]

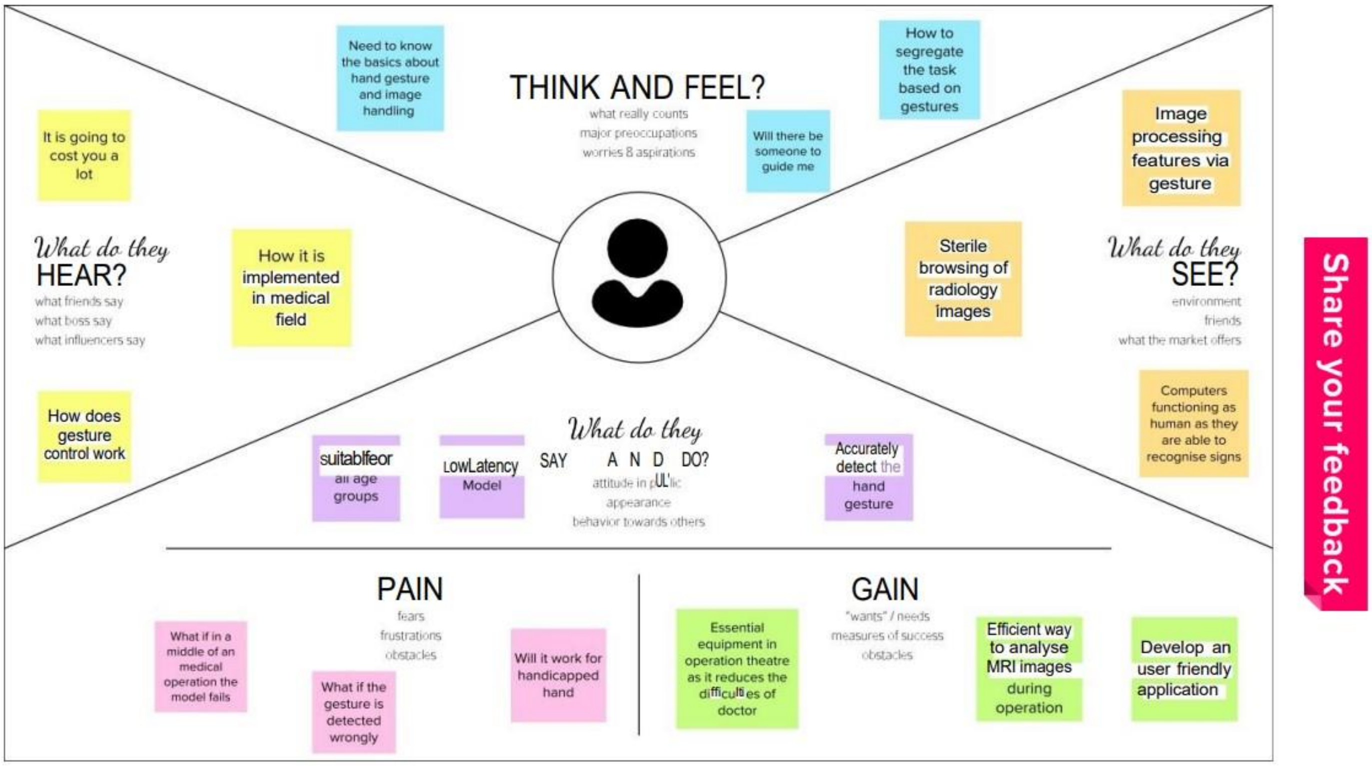
3. Smith KR, Frank KJ, Bucholz RD. “The NeuroStation- a highly accurate, minimally invasive solution to frameless stereotatic neurosurgery,” Comput Med Imaging Graph 1994;18:247-256. [PubMed] [Google Scholar]

2.3 Problem Statement definition:

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.

IDEATION & PROPOSED SOLUTION

3.1 Empathy Map:



3.2 Ideation & Brainstorming:

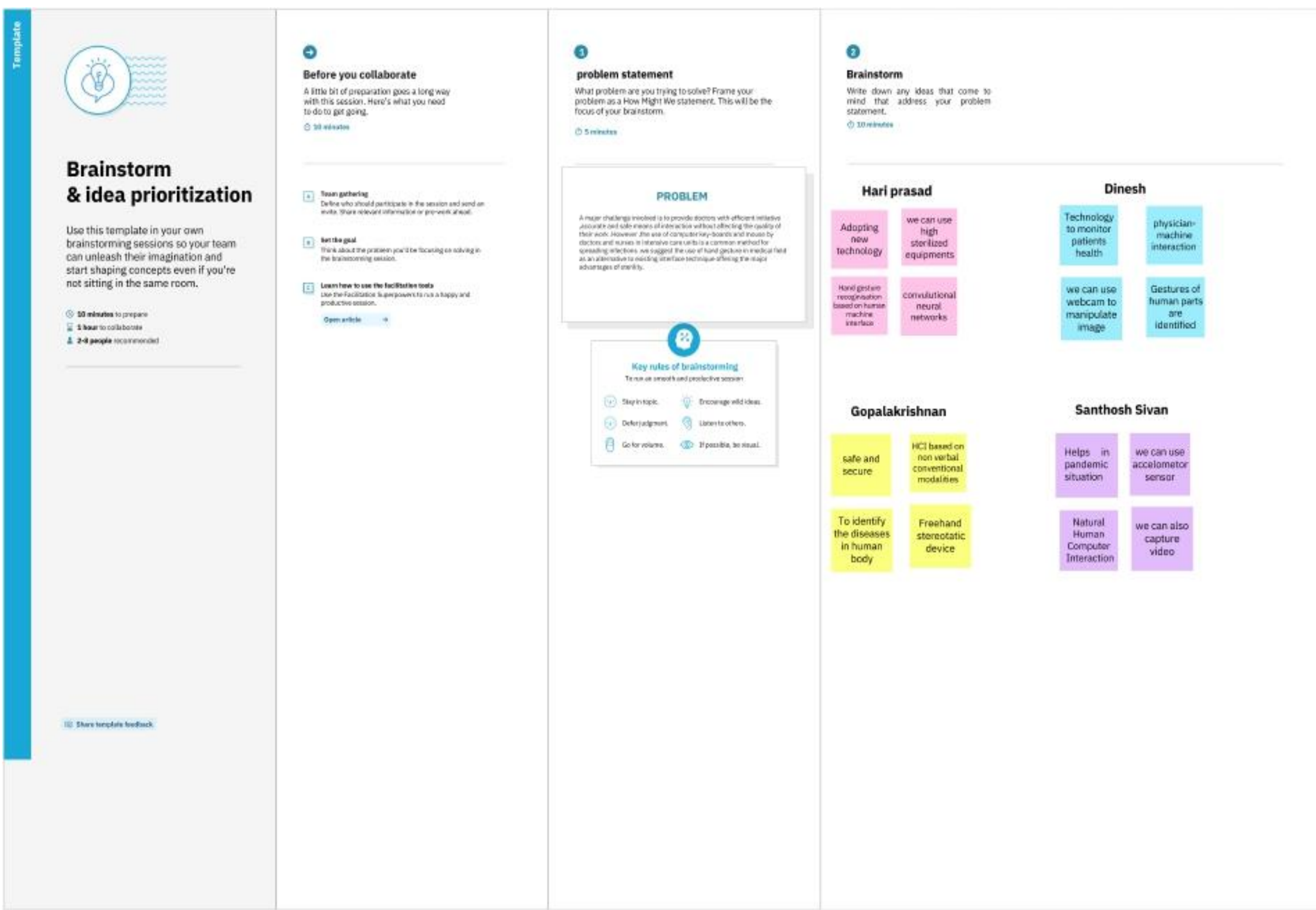
- ➢ In order to provide surgeons with a more efficient, comfortable, precise, and sterile interaction technique, the feet and hands can be an effective means of accomplishing this goal in comparison to other modalities, such as voice or gaze interaction or using Radar Sensor.

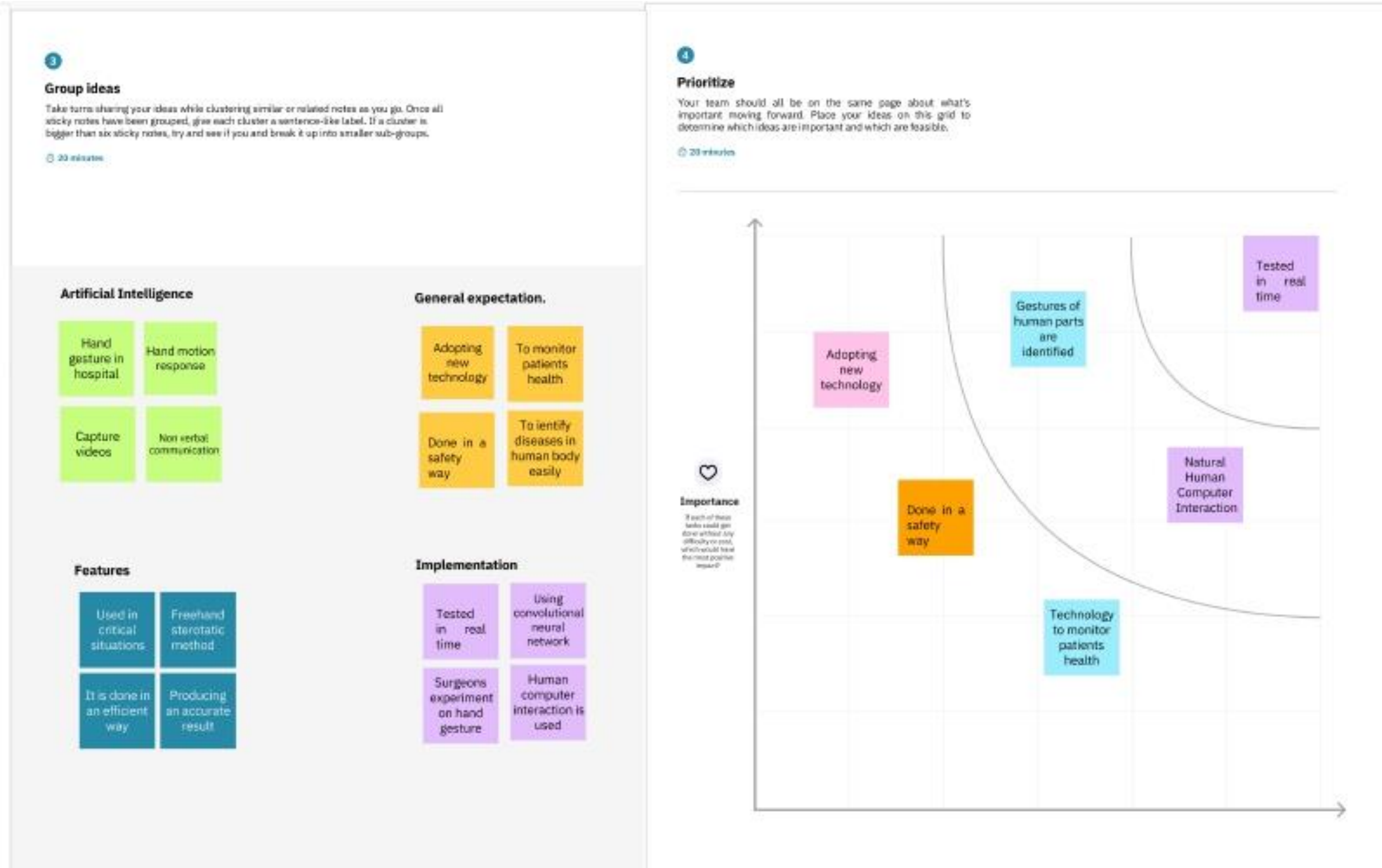
- ➢ Touch-less gesture interaction is an option to interact with imaging systems, displays, and controllers without breaking the sterility barrier. The system utilizes nothing but a camera with good quality and can follow the hand of the user in 2 dimensions and identify up to four mouse-defined hand motions.

- Recent progress in gaming technologies provides innovative opportunities for motion tracking and human-machine interaction. In the field of healthcare, sensors like Microsoft® Kinect (2015) have been used for detecting postures.

  Using electromyography technology to capture gesture instead of the camera, therefore it is less affected by the external factors such as light and obstruction. The disadvantage of high computational cost.

- Voice command is another type of touchless communication but its commands are discrete rather than hand gestures which are able to perform analog commands. On the other hand, voice command has other disadvantages such as its low accuracy due to existence of noise in surgery rooms.




3
Group ideas
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.
20 minutes
Artificial Intelligence
Hand gesture in hospital
Hand motion response
Capture videos
Non verbal communication
General expectation.
Adopting new technology
To monitor patients health
Done in a safety way
To ientify diseases in human body easily
Features
Used in critical situations
Freehand sterotatic method
It is done in an efficient way
Producing an accurate result
Implementation
Tested in real time
Using convolutional neural network
Surgeons experiment on hand gesture
Human computer interaction is used
4
Prioritize
Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.
20 minutes
Importance
Tested in real time
Gestures of human parts are identified
Adopting new technology
Natural Human Computer Interaction
Done in a safety way
Technology to monitor patients health

3.3 Proposed Solution:

S.NO	PARAMETER	DESCRIPTION
1.	Problem Statement (Problem to besolved)	Hand Gesture tool to do Contactlessnavigation of radiology images to simplify the communication of Doctors with machines.
2.	Idea / Solution description	The technology used to assist doctors by taking hand gestures asinput and perform necessary actions in machines.
3.	Novelty / Uniqueness	These Gesture helps us to visualize theWords and help Gain the Listener’s Attention.
4.	Social Impact / CustomerSatisfaction	The proposed system should maintaina good balance between complexity, accuracy and applicability.
5.	Business Model (Revenue Model)	The revenue model is based on the integration of this technology in radiology devices the business will beeither tie up with companies or specific sale of machines.
6.	Scalability of the Solution	The proposed approach allows the learning of new gestures with no needof recording real subjects.

3.4 Problem Solution fit:

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Doctor who performs medical operations (surgery).

6. CUSTOMER CONSTRAINTS CC

The customers must reduce the usage of power consumption.

They should maintain a stable connection to run the software.

5. AVAILABLE SOLUTIONS AS

Before Doctors used the assistant to process the images.

But now a days with the help of this gesture-based tool the doctors can blur, rotate and resize the images accordingly without anyone help.

Explore AS, differentiate

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

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

Customer should understand the software properly so that he/she can work efficiently with software.

Without knowledge of software, customer can feel difficulties to use the software.

9. PROBLEM ROOT CAUSE RC

Customer think that these technologies are expensive right now. So, that's why some kind of delay occurs in implementation.

7. BEHAVIOUR BE

If customer faces some issues in the designed software, then they will contact our technical team.

The technical team will resolve the issues which are faced by our customers.

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

Identify strong TR & EM

3. TRIGGERS TR

Since software allows the surgeon to keep hand remain sterile, which triggers the customer to use software.

4. EMOTIONS: BEFORE / AFTER EM

Before customer used hands for analysing patient's description at their place.

But now a days customer uses the software (gesture tool) ,so customer feeling smart.

10. YOUR SOLUTION SL

The Gesture-based tool is completely based on the hand moment and it act accordingly to its trained datasets.

It will be helpful to the doctors to do their surgeries in quick and easier way.

8. CHANNELS of BEHAVIOUR CH

Online:
Extracts channels from behavior block.

Offline:
Extracts channels from behavior block and is used for customer's deployment.

Identify strong TR & EM

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 the trained CNN model from the cloud
FR-2	Capturing the images	After capturing the images in camera we have to upload the images in the system
FR-3	Performing gestures	After classifying, identify the correct image by the gesture and it should perform the operation
FR-4	Model rendering	After capturing the image the algorithm will start its processing task
FR-5	Sterile browsing	The sterile browsing can be performed after identifyingthe gestures
FR-6	Visibility of images	After completing all the processes ,a user can be able tosee the images

4.2. Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	This system helps to have the control over images without having direct contact with system which avoids the harmful rays and is ease of use
NFR-2	**Security**	This system is protected and only authorized userscan access it
NFR-3	**Reliability**	After installing the Application,the system will predict the gesture and performs sterile browsing
NFR-4	**Performance**	The system responds to a user in seconds and the hardware and software works well
NFR-5	**Availability**	It is accessible by authorised user from anywhere atany time whenever there is an emergency
NFR-6	**Scalability**	This system allows more number of users at a time and there is no loss can be identified

PROJECT DESIGN

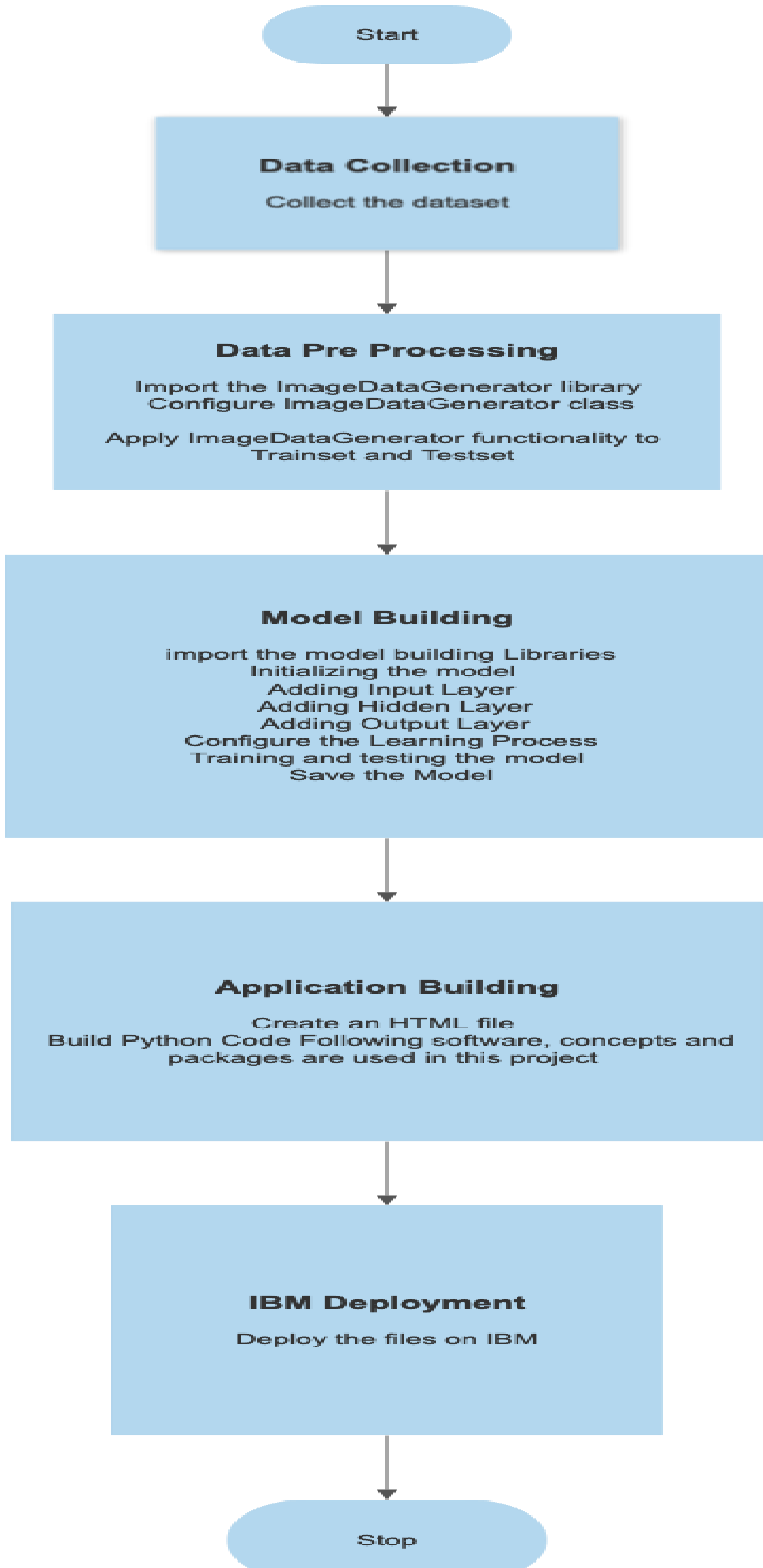
5.1. Data Flow Diagrams:

- User interacts with the **UI (User Interface)** to upload the image as input.
- Depending on the different gesture inputs different operations are applied to the input image.
- Once model analyses the gesture, the prediction with operation applied on image is showcased on the UI.

To accomplish this, we have to complete all the activities and tasks listed below:

- **Data Collection.**
  - Collect the dataset or Create the dataset
- **Data Pre processing**
  - Import the ImageDataGenerator library
  - Configure ImageDataGenerator class
  - Apply ImageDataGenerator functionality to Trainset and Testset
- **Model Building**
  - Import the model building Libraries
  - Initializing the model
  - Adding Input Layer
  - Adding Hidden Layer
  - Adding Output Layer
  - Configure the Learning Process
  - Training and testing the model
  - Save the Model
- **Application Building**
  - Create an HTML file
  - Build Python Code Following software, concepts and packages are used in this project
- **Anaconda navigator**
- **Python packages:**
  - open anaconda prompt as administrator
  - Type "pip install Tensor Flow" (make sure you are working on python 64 bit)
  - Type "pip install opencv-python"
  - Type "pip install flask"

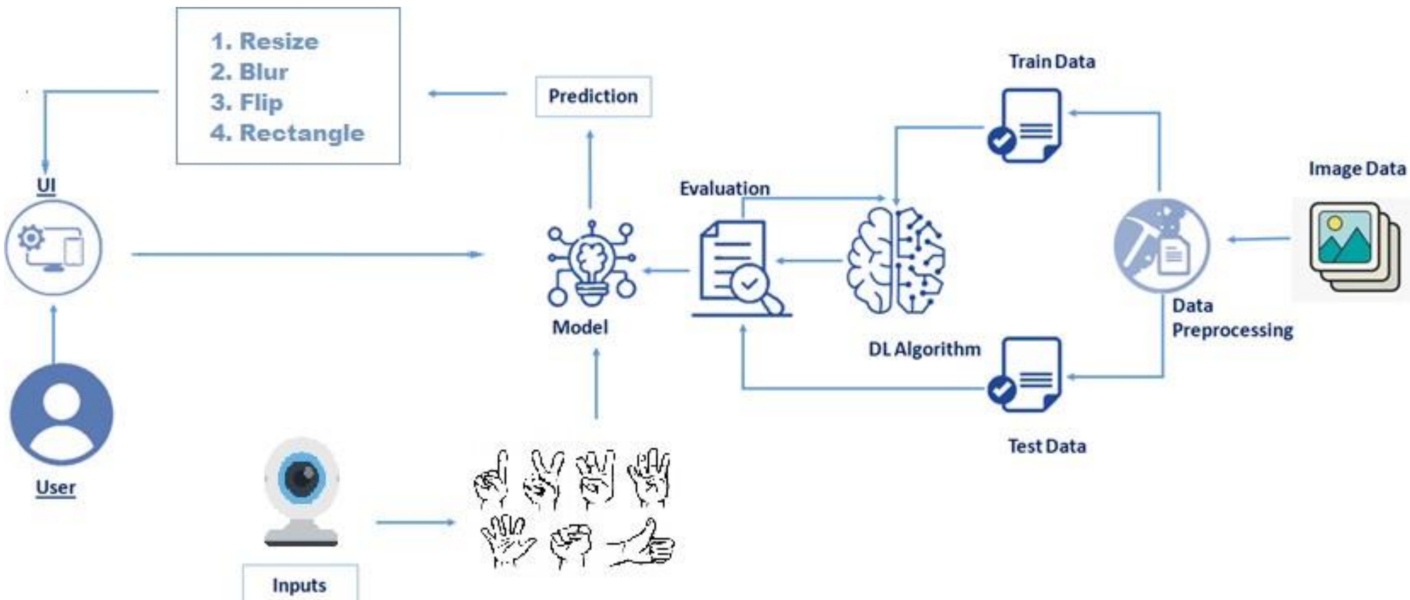
FLOW CHART:


Start
Data Collection
Collect the dataset
Data Pre Processing
Import the ImageDataGenerator library
Configure ImageDataGenerator class
Apply ImageDataGenerator functionality to Trainset and Testset
Model Building
import the model building Libraries
Initializing the model
Adding Input Layer
Adding Hidden Layer
Adding Output Layer
Configure the Learning Process
Training and testing the model
Save the Model
Application Building
Create an HTML file
Build Python Code Following software, concepts and packages are used in this project
IBM Deployment
Deploy the files on IBM
Stop

5.2. Solution & Technical Architecture:

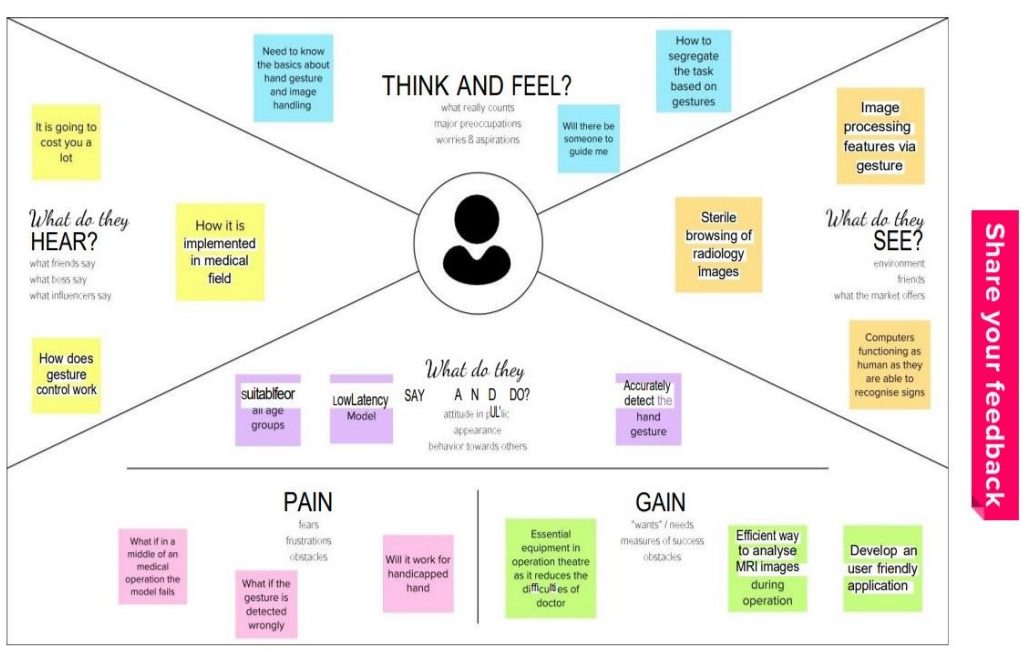
This hand based gesture tool developed can be mainly used in the medical industry to browseimages without compromising the sterility. However it can also be used in different industries while presenting certain ideas, duringmeetings, and can be used by teachers while teaching.

Architecture:



5.3. User Stories:

It Use of doctor-computer interaction devices in the operation room (OR) requires new modalities that support medical imaging manipulation while allowing doctors' hands to remain sterile, supporting their focus of attention, and providing fast response times.



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	Hari Prasad J Dinesh S Gopala Krishnan K Santhosh Sivan S
Sprint-1	Access UI	USN-2	As a user, I will use the software and operate onthe UI	1	Medium	Hari Prasad J Dinesh S Gopala Krishnan K Santhosh Sivan S
Sprint-2	Launching Camera	USN-3	As a user, I can open the camera from the software to perform gesture	1	Low	Hari Prasad J Dinesh S Gopala Krishnan K Santhosh Sivan S
Sprint-2	Upload images fromlocal system	USN-4	As a user, I can upload images to the software from the local system	2	Low	Hari Prasad J Dinesh S Gopala Krishnan K Santhosh Sivan S
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Perform gestures	USN-5	As a user, I can perform various gesture with respect to system specification for processing	2	Medium	Hari Prasad J Dinesh S Gopala Krishnan K Santhosh Sivan S
Sprint-4	Output	USN-6	As a user. I can see the sterile browsers image with respect to the gesture performed, display on the screen	2	High	Hari Prasad J Dinesh S Gopala Krishnan K Santhosh Sivan S

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	30 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	06 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	15 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

CODING & SOLUTIONING

Training the Model:

- Once after splitting the data into train and test, the data should be fed to an algorithm to build a model.

- There are several Machine learning algorithms to be used depending on the data you are going to process such as images, sound, text, and numerical values.

- The algorithms that you can choose according to the objective that you might have it may be Classification algorithms are Regression algorithms.

1. First we, **Importing The Model Building Libraries**:

```
import numpy as np
import tensorflow
import keras
from google.colab import drive
drive.mount('/content/drive')
from tensorflow.keras.models import Sequential
from tensorflow.keras import layers
from tensorflow.keras.layers import Dense, Flatten
from tensorflow.keras.layers import Conv2D, MaxPooling2D
from keras.preprocessing.image import ImageDataGenerator
```
[2]

2. Initializing the Model:

Sequential model is a linear stack of layers. You can create a sequential model by passing a list of layer instances to the constructor from Keras. Models import Sequential from Keras**.**

3. Adding CNN Layers:

- For information regarding CNN Layers reer to the link.
- 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.
- Maxpool layer is used to down sample the input.
- Flatten layer flattens the input. Does not affect the batch size.

```
classifier.add(Conv2D(32,(3,3), input_shape=(64,64,1), activation='relu'))
classifier.add(MaxPooling2D(pool_size=(2,2)))
classifier.add(Conv2D(32,(3,3), activation='relu'))
classifier.add(MaxPooling2D(pool_size=(2,2)))
classifier.add(Flatten())
```

4. Adding Dense Layer:

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

```
classifier.add(Dense(units=128, activation='relu'))
assifier.add(Dense(units=6, activation='softmax'))
classifier.summary()
```

```
Output exceeds the size limit. Open the full output data in a text editor
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_3 (Conv2D)           (None, 62, 62, 32)        320

 max_pooling2d_3 (MaxPooling  (None, 31, 31, 32)       0
 2D)

 conv2d_4 (Conv2D)           (None, 29, 29, 32)        9248

 max_pooling2d_4 (MaxPooling  (None, 14, 14, 32)       0
 2D)

 flatten_1 (Flatten)         (None, 6272)              0

 dense (Dense)               (None, 128)               802944

 dense_1 (Dense)             (None, 6)                 774

 dense_2 (Dense)             (None, 128)               896

 dense_3 (Dense)             (None, 6)                 774
```

5. Configure the Learning Process:

- 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 optimize 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 processTrain the Model

6. Train the Model:

Now, let us train our model with our image dataset. **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.

```
classifier.fit_generator(
    generator = x_train, steps_per_epoch = len(x_train),
    epochs = 20, validation_data = x_test, validation_steps = len(x_test)
)
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future
version. Please use `Model.fit`, which supports generators.
  This is separate from the ipykernel package so we can avoid doing imports until

Output exceeds the size limit. Open the full output data in a text editor
Epoch 1/20
198/198 [==============================] - 160s 807ms/step - loss: 1.8016 - accuracy: 0.1684 - val_loss: 1.7928 - val_accuracy: 0.1667
Epoch 2/20
198/198 [==============================] - 7s 35ms/step - loss: 1.7978 - accuracy: 0.1347 - val_loss: 1.7919 - val_accuracy: 0.1667
Epoch 3/20
198/198 [==============================] - 7s 35ms/step - loss: 1.7981 - accuracy: 0.1582 - val_loss: 1.7923 - val_accuracy: 0.1667
Epoch 4/20
198/198 [==============================] - 7s 35ms/step - loss: 1.7958 - accuracy: 0.1465 - val_loss: 1.7918 - val_accuracy: 0.1667
Epoch 5/20
198/198 [==============================] - 7s 35ms/step - loss: 1.7961 - accuracy: 0.1549 - val_loss: 1.7920 - val_accuracy: 0.1667
Epoch 6/20
198/198 [==============================] - 7s 36ms/step - loss: 1.7971 - accuracy: 0.1397 - val_loss: 1.7918 - val_accuracy: 0.1667
Epoch 7/20
198/198 [==============================] - 7s 35ms/step - loss: 1.7977 - accuracy: 0.1465 - val_loss: 1.7922 - val_accuracy: 0.1667
Epoch 8/20
198/198 [==============================] - 7s 35ms/step - loss: 1.7978 - accuracy: 0.1229 - val_loss: 1.7919 - val_accuracy: 0.1667
Epoch 9/20
```

Testing the Model:

Evaluation is a process during development of the model to check whether the model is best fit for the given problem and corresponding data.

Load the saved model using load_model:

```
from tensorflow.keras.models import load_model
om tensorflow.keras.preprocessing import image
model = load_model("gesture.h5") #loading the model for testing
path = "C:\Users\darsh\OneDrive\Pictures\Desktop\Smart Bridge\Project Smart Interns\Dataset\test\1\1.jpg"
```

Taking an image as input and checking the results:

```
#loading of the image
img = image.load_img(path,
                     color_mode='grayscale',
                     target_size= (64,64))
x = image.img_to_array(img)#image to array
x.shape
type(x)
x = np.expand_dims(x,axis = 0)
pred = model.predict_classes(x)#predicting the classes
pred
```

By using the model we are predicting the output for the given input image

```
index=['0','1','2','3','4','5']
sult=str(index[pred[0]])
result
```

```
'5'
```

The predicted class index name will be printed here.

```
result = []
index=['0','1','2','3','4','5']
for i in p:
    result.append(index[i[0]])

print(result)
```

```
['0', '0', '0', '0', '0', '1', '1', '1', '1', '1', '2', '2', '1', '2', '2', '3', '3', '3', '3', '3', '4', '4', '4', '4', '4', '5', '5', '5', '5',
```

Save the Model:

After building the model we have to save the model. In other words, it's the process of converting a Python object into a byte stream to store it in a file/database, maintain program state across sessions or transport data over the network. wb indicates write method and rd indicates the read method.

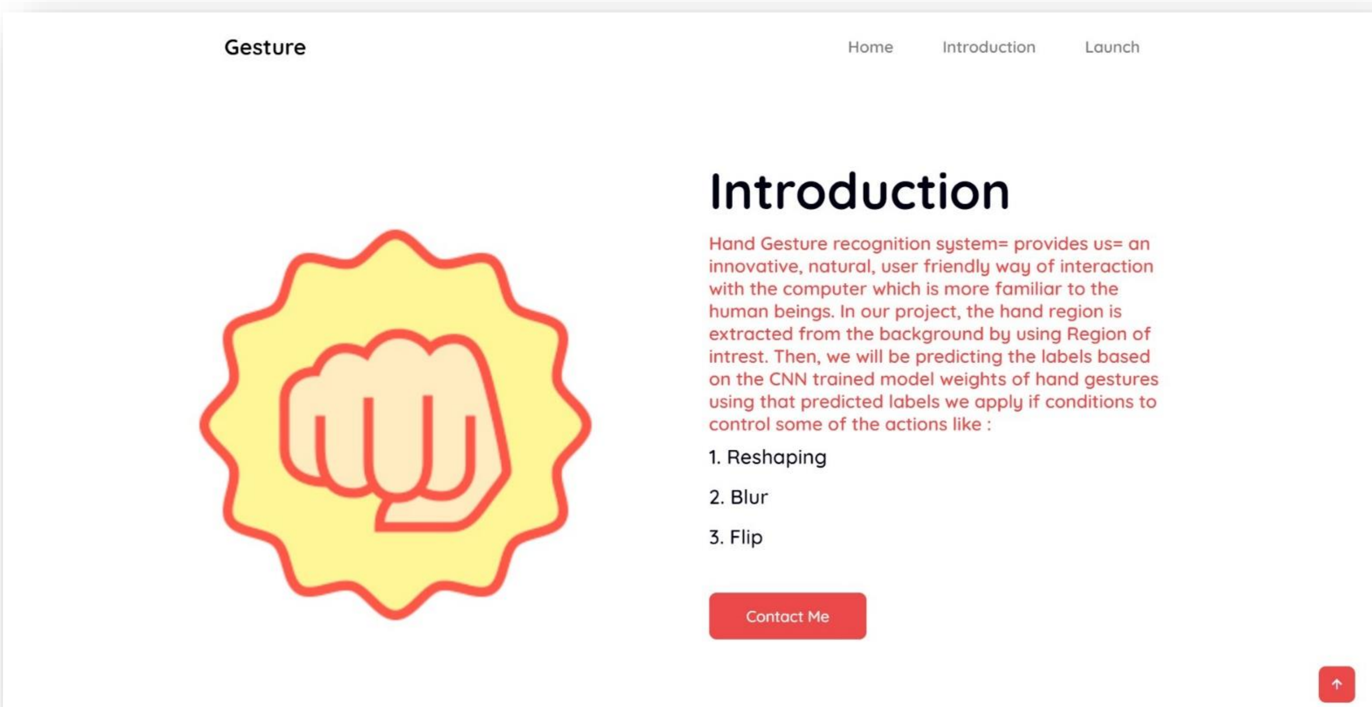
```
classifier.save('gesture.h5')
```

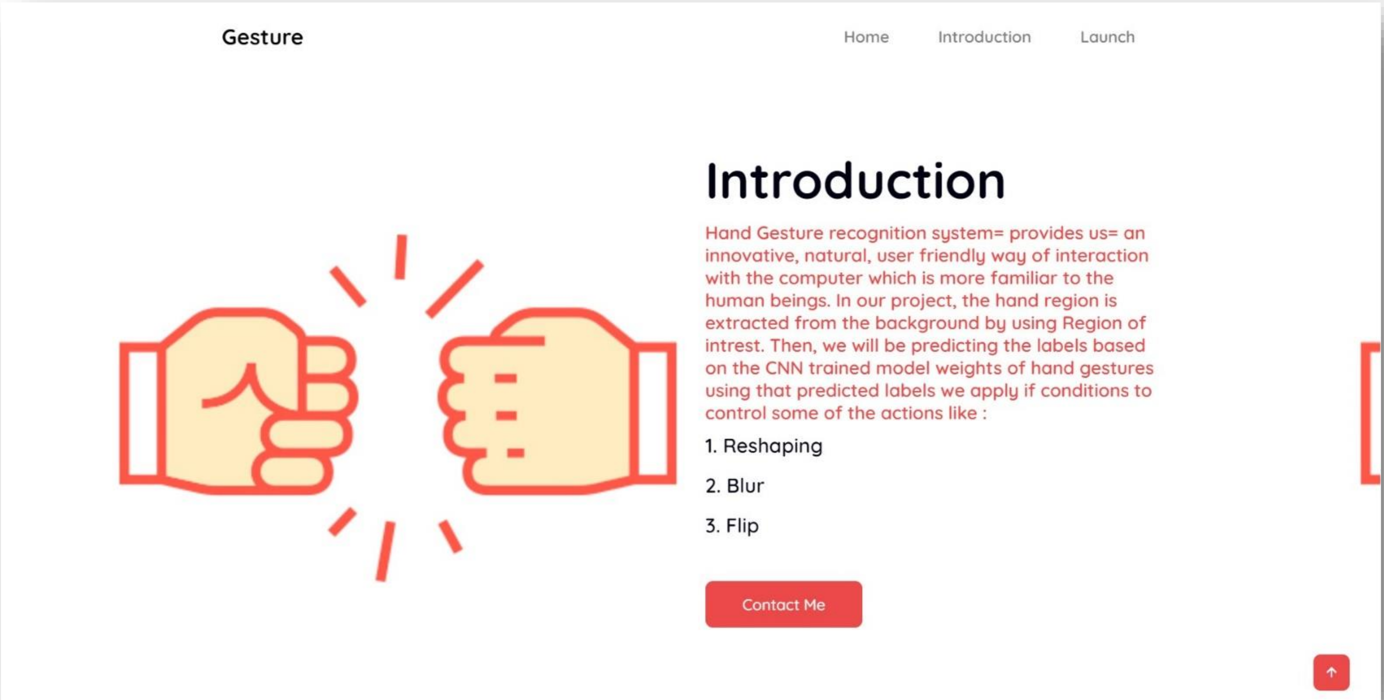
Results

Final findings (Output) of the project along with screenshots.

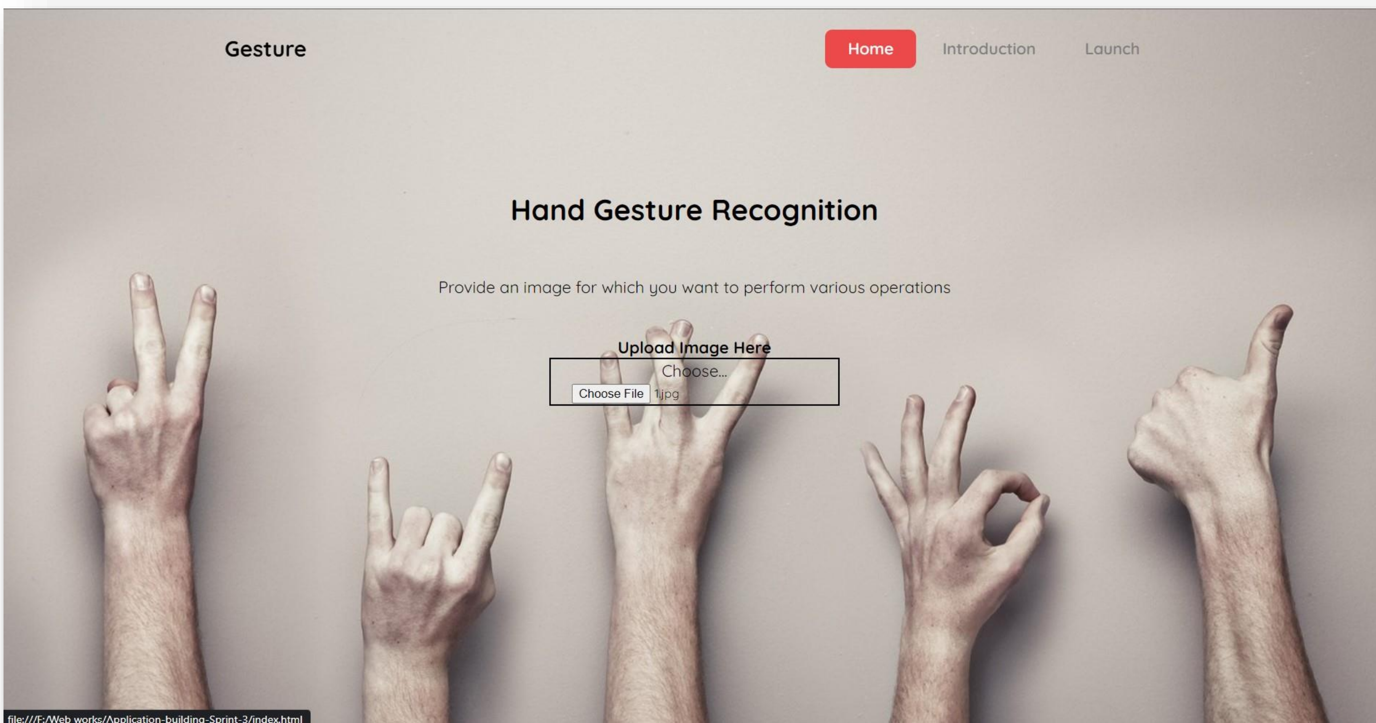
Home page:

Intro Page:

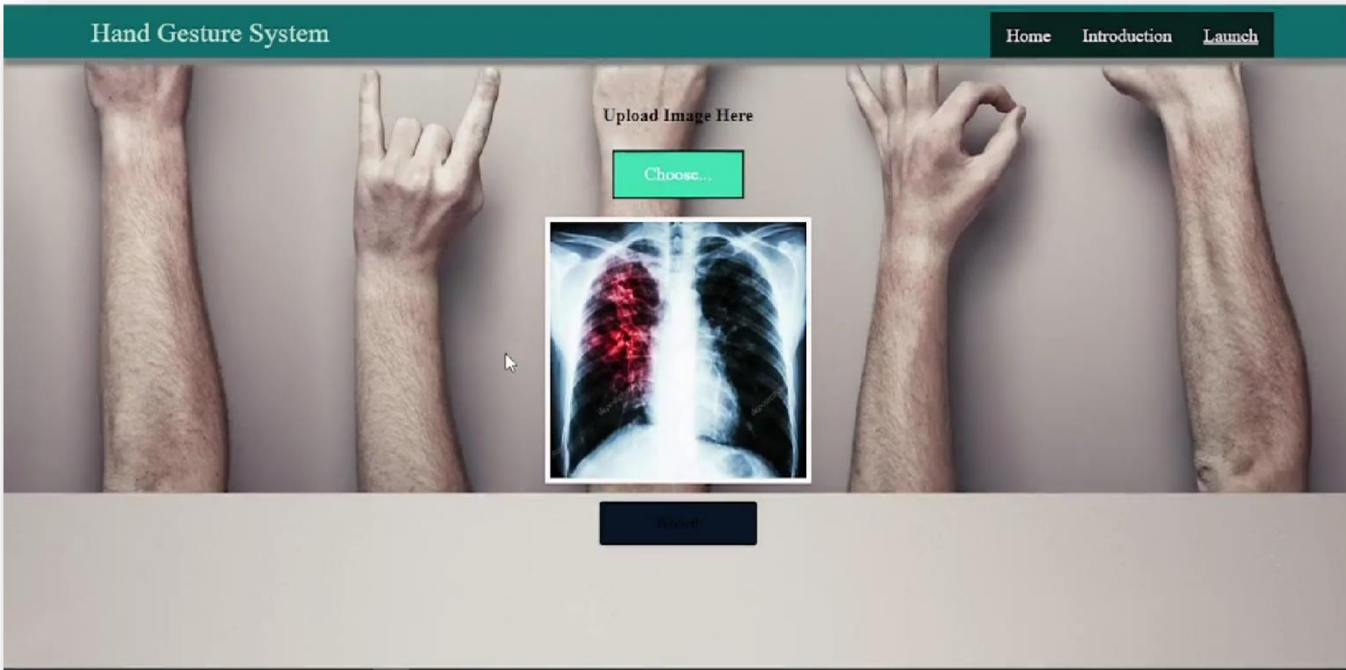



Gesture
Home
Introduction
Launch
Introduction
Hand Gesture recognition system= provides us= an innovative, natural, user friendly way of interaction with the computer which is more familiar to the human beings. In our project, the hand region is extracted from the background by using Region of intrest. Then, we will be predicting the labels based on the CNN trained model weights of hand gestures using that predicted labels we apply if conditions to control some of the actions like :
1. Reshaping
2. Blur
3. Flip
Contact Me

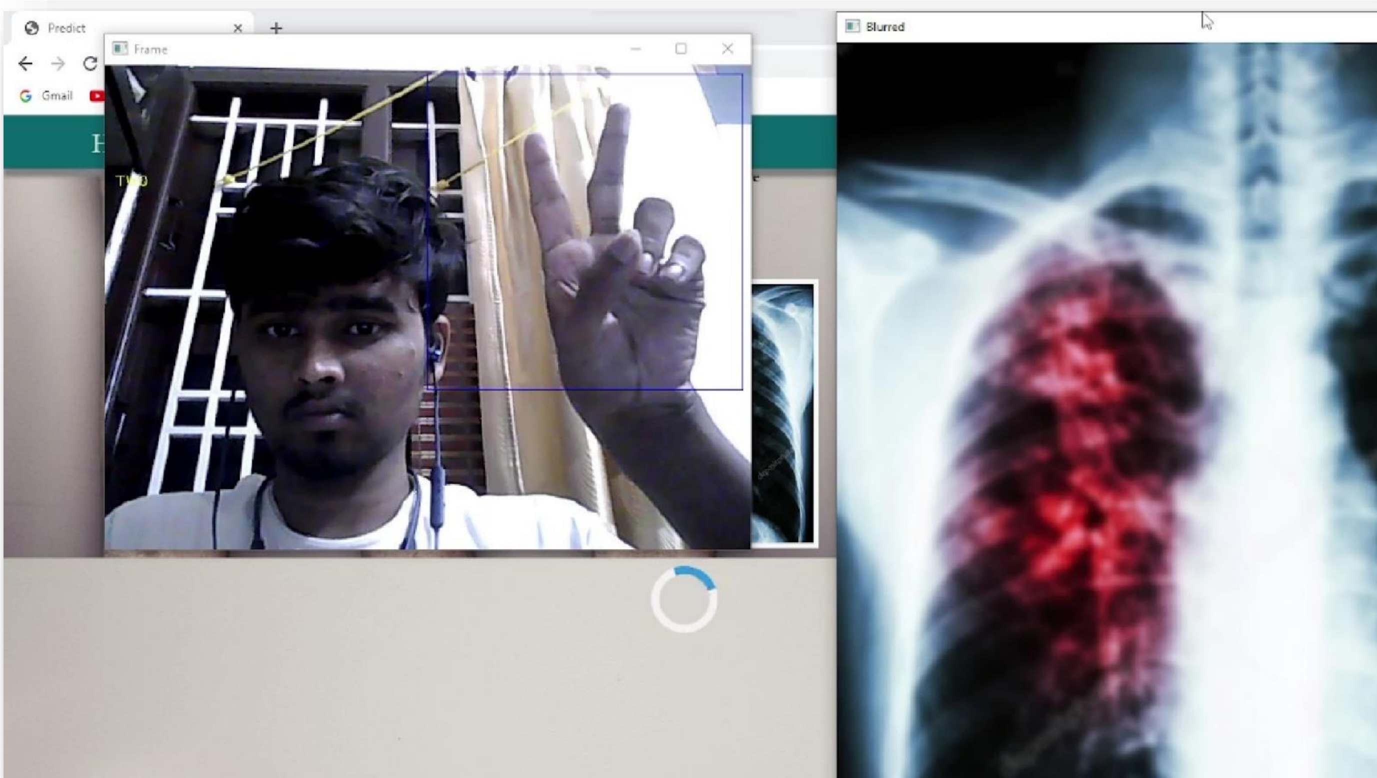
Launch Page

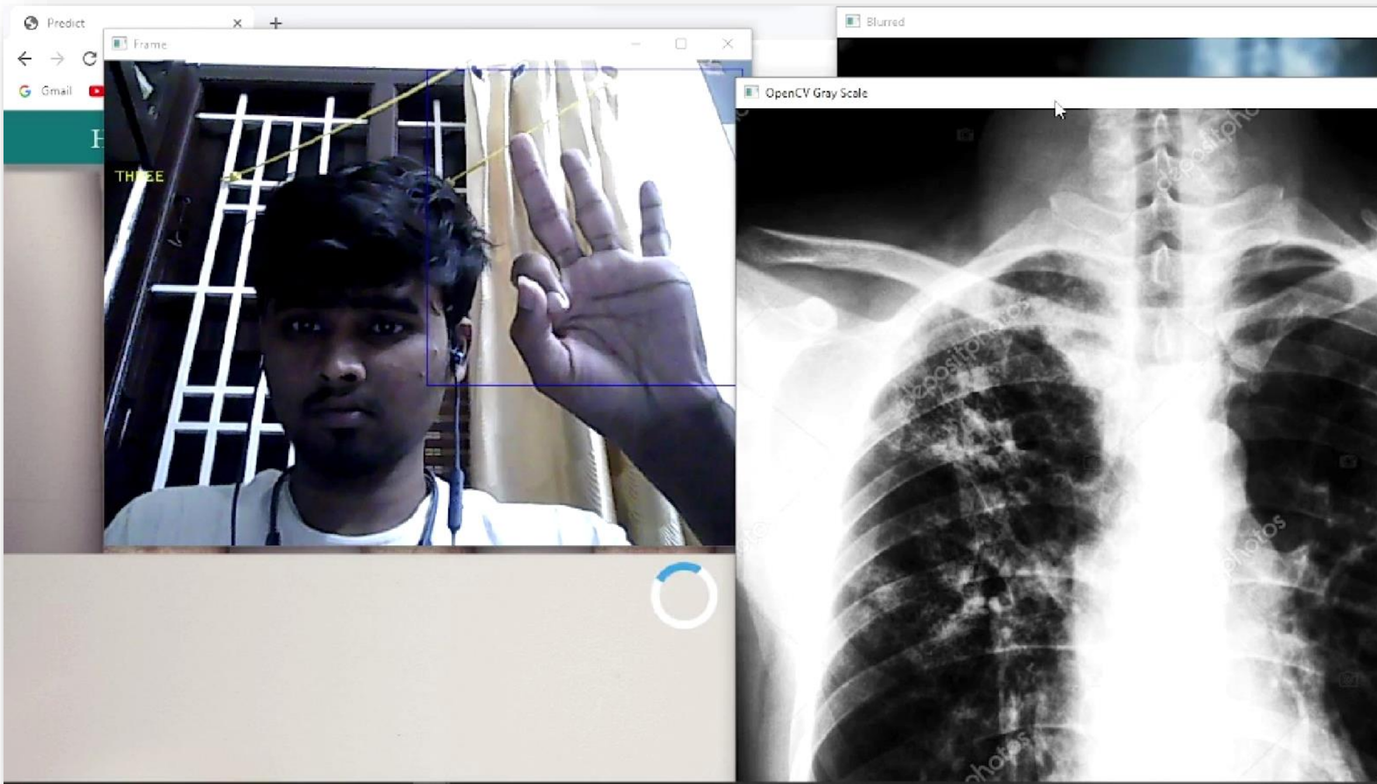

Gesture
Home
Introduction
Launch
Hand Gesture Recognition
Provide an image for which you want to perform various operations
Upload Image Here
Choose...
Choose File
1.jpg

Upload image:



Prediction results:





Through this project we found that we can maintain the sterility of an operation theater, etc. By using hand based gesture tools to browse the images obtained.

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 savetime.
- 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 captureimages and process it.

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.

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 use abilityfor 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.

Appendix

Source Code:

Project GitHub link - https://github.com/IBM-EPBL/IBM-Project-41170-1660639917

Project Demo Link:

https://drive.google.com/file/d/1xiwJtRVJn49mUVhsEEhSwAxbkNuplcCa/view?usp=share_link