VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI KARNATAKA-590018

A project report on

"VIRTUAL INTERACTION WITH SYSTEM USING OPENCV AND MEDIAPIPE"

Submitted in partial fulfillment of the requirement for the award of

BACHELOR OF ENGINEERING

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by:

ABDULLA KHAN	**1TJ18EC001**
ADARSH A	**1TJ18EC002**
ANANTHU SV	**1TJ18EC005**
ASHISH AMAN	**1TJ18EC007**

Under the guidance of:

Ms. SUKANYA PRASAD T

Assistant Professor
Department of Electronics and Communication Engineering
TJIT, Bengaluru

DEPARTMENT OF ELECTRONICS AND COMMMUNICATION ENGINEERING

T. JOHN INSTITUTE OF TECHNOLOGY

BENGALURU-560083

2021 – 2022

(Affiliated to Visvesvaraya Technological University)Approved by
AICTE, Govt. of India, New Delhi.
No. 88/1, Gottigere, Bannerghatta Road, Bengaluru-560083

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is certified that the project work entitled **"VIRTUAL INTERACTION WITH SYSTEM USING OPENCV AND MEDIAPIPE"** carried out by **ABDULLA KHAN (1TJ18EC001), ADARSH A (1TJ18EC002), ANANTHU SV (1TJ18EC005), ASHISH AMAN (1TJ18EC007),** bonafide student of **T John Institute of Technology, Bangalore** in partial fulfilmentfor seventh semester of Bachelor of Engineering in **Electronics and Communication Engineering** of **Visvesvaraya Technological University, Belagavi** during the year **2021-2022**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited.

The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

Signature of Guide	Signature of HOD	Signature of Principal
Ms. Sukanya Prasad T	**Mr. Anand Swamy A.S**	**Dr. P. Suresh Venugopal**
Assistant Professor Dept. of ECE, TJIT	Head of Department Dept. of ECE, TJIT	Principal TJIT

Name of Examiners	**Signature of Examiners**
1. _____	_____
2. _____	_____

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DECLARATION

We, hereby declare that the project entitled, "**Virtual Interaction with System using OpenCV and MediaPipe**" submitted to Visvesvaraya Technological University, Belagavi, is carried out at the Department of Electronics and Communication Engineering, T John Institute of Technology, Bengaluru under the guidance of **Ms. Sukanya Prasad T**, Assistant Professor. This report has not been submitted for the award of any Diploma of this or any other University.

Name	**USN**	**Signature**
1) ABDULLA KHAN	1TJ18EC001	_____
2) ADARSH A	1TJ18EC002	_____
3) ANANTHU SV	1TJ18EC005	_____
4) ASHISH AMAN	1TJ18EC007	_____

ACKNOWLEDGEMENT

The joy and satisfaction that accompany the successful completion of any task would be incomplete without thanking those who made it possible. We consider ourselves kind to be a part of **T. John Institute of Technology**, the institution which moulded us in all our endeavors.

We would like to express our sincere thanks to **Dr. P. Suresh Venugopal**, Principal and **Prof. Anand Swamy A S**, Head of Department, Department of ECE, for their valuable guidance and encouragement throughout our program.

We express our profound gratitude to the coordinators who have given valuable suggestions and guidance throughout the project. We would like to express our sincere gratitude to our guide **Ms. Sukanya Prasad T, Assistant Professor**, for her guidance, continuous support and motivation in completing the project successfully.

Finally, we take this opportunity to extend our earnest gratitude and respect to our parents, teaching and non-teaching staff of the department, the library staff and all our friends who have directly or indirectly supported us.

Name of the students

ABDULLA KHAN	1TJ18EC001
ADARSH A	1TJ18EC002
ANANTHU SV	1TJ18EC005
ASHISH AMAN	1TJ18EC007

ABSTRACT

With all the new technologies arriving in the field of AI, human computer interaction is becoming feasible. The main proposition is to develop software which intends human interaction with computer through air. Computer vision plays important role in detecting gestures of human hands. These hand gestures are employed to execute different operations. OpenCV and MediaPipe are prime libraries used for image processing and determining hand gestures respectively. This proposed project will allow user to interact with the computer virtually through air by detecting user's fingertips. To detect user's fingertip, we don't use any hardware parts, only computer webcam is enough to detect and output the same to user's screen. By detecting all landmarks provided by MediaPipe we will map it to various operations like virtual painting, mouse, keyboard, presentation etc. This system will be the most effortless and natural way of communication with the computer.

Table of Contents

LIST OF FIGURES

INTRODUCTION

CHAPTER 1

1. INTRODUCTION

With the rise of artificial intelligence (AI) and machine learning (ML) in many industries, it is logical that these states of art technologies would be applied toward visual expression. In today's world Artificial Intelligence systems can go one step further and take actions based on an understanding of the particular image. Image Processing focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system processes that image using efficient algorithms. Interactions between computers and humans should be as intuitive as conversations between two humans.

In today's age a lot of research is done for finding effective techniques and methods to make existing systems more reliable and efficient. One of the most important parameters to make system efficient and reliable is Human Computer Interaction (HCI). Human-computer interaction (HCI) is a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans, that is the users and computers.

Figure 1.1. Real-time image from camera

Figure 1.2. Real-time image processing using OpenCV

Computer vision is a field of artificial intelligence that trains computers to interpret and understand the visual world. Using digital images from cameras, videos and deep learning models, machines can accurately identify and classify objects and then process and react to what they see. Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high dimensional data from the real world in order to produce numerical or symbolic information e.g., in the forms of decisions.

1.1 OBJECTIVE OF PROPOSED PROJECT

The main aim of Air Canvas is to implement digital drawing and interacting with system using Artificial intelligence that maps hand gestures onto the screen. These hand gestures can be used to perform various operations like interacting with the computer's cursor, virtual keyboard to type without the mechanical keyboard, voice recognition to smartly interact with the computer, user-friendly power point presentation and to draw on the screen without stylus pen or any other similar device.

1.2 PROBLEM STATEMENT

In today’s day and age, there is a rise in Artificial Intelligence and Machine Learning. But our Human-Computer Interaction has not yet changed. We are using the same old technology of keyboard, mouse, stylus pen, etc. This project can be used to improve the Human-Computer Interaction. To establish a complete system for detecting, recognizing, and interpreting hand gesture recognition through computer vision using Python, OpenCV and MediaPipe.

LITERATURE SURVEY

CHAPTER 2

2. LITERATURE SURVEY

[1] S. Shriram, B. Nagaraj, J. Jaya, S. Shankar, P. Ajay, Deep Learning-Based Real-Time AI Virtual Mouse System Using Computer Vision to Avoid COVID-19 Spread - Journal of Healthcare Engineering, October 2021.

This paper illustrates how to control the mouse cursor functions by using the hand gestures instead of using a physical mouse. They achieved this by using a webcam or a built-in camera which detects the hand gestures and hand tip and processes these frames to perform the particular mouse functions. From the results of the model, they came with a conclusion that the proposed AI virtual mouse system has performed very well and has a greater accuracy compared to the existing models and also the model overcomes most of the limitations of the existing systems. Since the proposed model has greater accuracy, the AI virtual mouse can be used for real-world applications, and also, it can be used to reduce the spread of COVID-19, since the proposed mouse system can be used virtually using hand gestures without using the traditional physical mouse. The model has some limitations such as small decrease in accuracy in right click mouse function and some difficulties in clicking and dragging to select the text.

[2] Jay Patel, Umang Mehta, Dev Tailor, Devam Zanzmera, Kevin Panchel TEXT RECOGNITION BY AIR DRAWING – Conference on Computer Intelligence and Communication Technology, September 2021.

This paper illustrates how we can write (text) in front of a camera by drawing in the air without any external sensors. The text drawn by the user in the air is captured by the computer's camera, followed by the identification of the text. So, the video camera will be turned on at the time of capturing the written text. Now the particular object is defined based on its color to detect a movement done by the user. The color is captured by the lower and upper bound of HSV (Hue Saturation and Value), which finally leads to object detection at every instant. Lastly, the text will be recognized by the trained model. The model is trained by CNN (Convolution Neural Network) with an accuracy of 98.64% (training) and 98.24% (testing). Any background having a similar color to the object falsifies the result. OpenCV and Python programming language are used.

[3] S.U. Saoji, Nishtha Dua, Akash Kumar, Choudhary Bharat Phogat, AIR CANVAS APPLICATION USING OPENCV AND NUMPY IN PYTHON - International Research Journal of Engineering and Technology Volume: 08 Issue: 08 August 2021.

The paper focuses on developing a motion-to-text converter that can potentially serve as software for intelligent wearable devices for writing from the air. They used computer vision to trace the path of the finger. RCNN model was used to detect the fingertip. As finger is moved the webcam or any camera detects and draws on the screen. The generated text can also be used for various purposes, such as sending messages, emails, etc.

[4] Ahmad Puad Ismail, Farah Athirah Abd Aziz, Nazirah Mohamat Kasim, Kamarulazhar Daud, Hand gesture recognition on python and OpenCV - First International Conference on Electrical Energy and Power Engineering, June 2020.

This paper concentrates on how a system could detect, recognize and interpret the hand gesture recognition through computer vision with the challenging factors which variability in pose, orientation, location and scale. To perform well for developing this project, different types of gestures such as numbers and sign languages need to be created in this system. The image taken from the real time video is analyzed via Haar-cascaded Classifier to detect the gesture of hand before the image processing is done or in the other word to detect the appearance of hand in a frame. The detection of hand will be done using the theories of Region of Interest (ROI) via Python programming. The explanation of the results will be focused on the simulation part since the different for the hardware implementation is the source code to read the real-time input video. The developing of hand gesture recognition using Python and OpenCV can be implemented by applying the theories of hand segmentation and the hand detection system which use the Haar-cascade classifier.

[5] Fan Zhang, Valentin Bazarevsky, Andrey Vakunov, Andrei Tkachenka, George Sung, Chuo-Ling Chang, Matthias Grundmann, MediaPipe Hands: On-device Real-time Hand Tracking – Google Research, June 2020.

This paper presents a real-time on-device hand tracking solution that predicts a hand skeleton of a human from a single RGB camera for AR/VR applications. Their pipeline consists of two models: First, a palm detector, that is providing a bounding box of a hand. Second, a hand landmark model, that is predicting the hand skeleton. It is implemented via MediaPipe, a framework for building cross-platform ML solutions. They proposed a model and pipeline architecture which demonstrate real-time inference speed on mobile GPUs with high prediction quality.

[6] Shivangi Nagdewani, Ashika Jain, A REVIEW ON METHODS FOR SPEECH-TO-TEXT AND TEXT-TO-SPEECH CONVERSION - International Research Journal of Engineering and Technology (IRJET), May 2020.

This paper is a study of different methodology for Speech-To-Text and Text-To-Speech conversion that will be used in a voice-based email system. It is based on interactive voice response. They compare the various methods used for Speech-To-Text and Text-To-Speech conversions and to figure out the most efficient technique that can be adapted for both the conversion processes. They concluded that HMM is a statistical model therefore most suitable for both Speech-To-Text and Text-To-Speech conversions.

[7] Riza Sande, Neha Marathe, Neha Bhegade, Akanksha Lugade, Prof. S. S. Jogdand, Virtual Mouse using Hand Gestures - International Research Journal of Engineering and Technology Volume: 05 Issue: 04 | Apr-2018.

This paper presents a hand gesture-based system that allows users to control desktop mouse movements. To detect hand gesture movements, our system makes use of a desktop webcam. Their goal was to control mouse cursor functions with a simple camera rather than a traditional or standard mouse device. Using only a camera, the Virtual Mouse provides an infrastructure between the user and the machine. It enables the user to interact with a machine without the need for any mechanical or physical devices, and even allows to control mouse functions. They used different color on three fingertips for detecting the hand gestures. As the gestures changes it perform different mouse actions.

LIBRARIES

CHAPTER 3

3. LIBRARIES

To make the life of a programmer easy many libraries are used to reduce the size of the code and to reduce time. Libraries will have many precompiled codes that can be used for some specific operation. It contains message templates, documentation, functions and values. These functions can be called many times and programmer doesn't need to code again.

Python programming language is used since many open-source libraries are supported. It has a good quality of automatic memory management which allocates and deallocates memory. Syntax of this program is simple and it is mainly used in data science, machine learning, etc.

3.1 OpenCV

OpenCV (Open-Source Computer Vision Library) is a library mainly aims at real-time computer vision systems, developed by Intel. Computer Vision is a science and technology that is used to process images to obtain relevant information. It has many algorithms and those can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. Using such optimized algorithms, we can easily take the real-time input from the

camera and process it for various applications like image processing in hospital, segregation of cancer cells, number plate detection and so on. The real-time user inputs like hand gesture, eyeball movement can be mapped to a robotics.

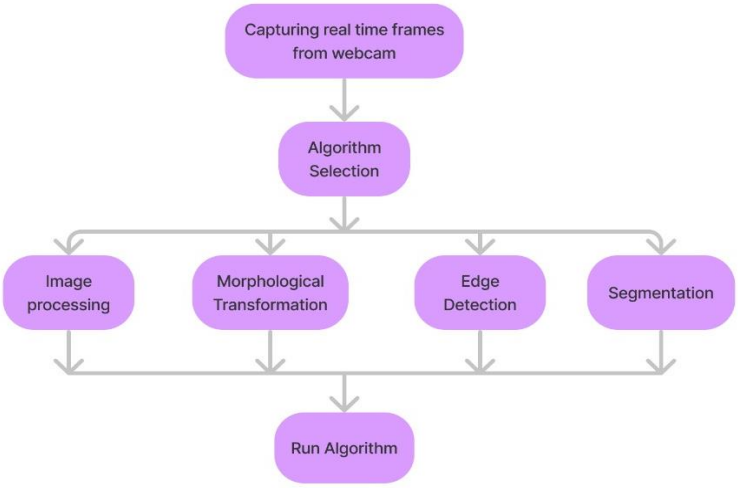

Figure 2.1 Flowchart how an OpenCV library is used for image processing

3.2 MEDIAPIPE

MediaPipe is a cross-platform framework for building multimodal applied machine learning pipelines. It is an open-source platform developed by Google. It is a high-fidelity hand and finger tracking solution. It employs machine learning (ML) to infer 21 3D landmarks of a hand from just a single frame. The 3D landmarks from the real-time hands are used to determine various user gesture and actions. Each landmark has an id employed to it which gives unique ability to find what action is made by user. The idea here is to use this emerging technology to train a system/application to find what the user action is. Communication through air is not so easy because lots of data maybe lost in real-time data transmission. To avoid such loss while image processing MediaPipe is efficiently used to reach all the landmarks properly from the user. As the advent of technology, we see a lot of improvement involved in robotics and other image processing fields. To control a robot with the user fingertip will be a cool idea to implement using this technology.

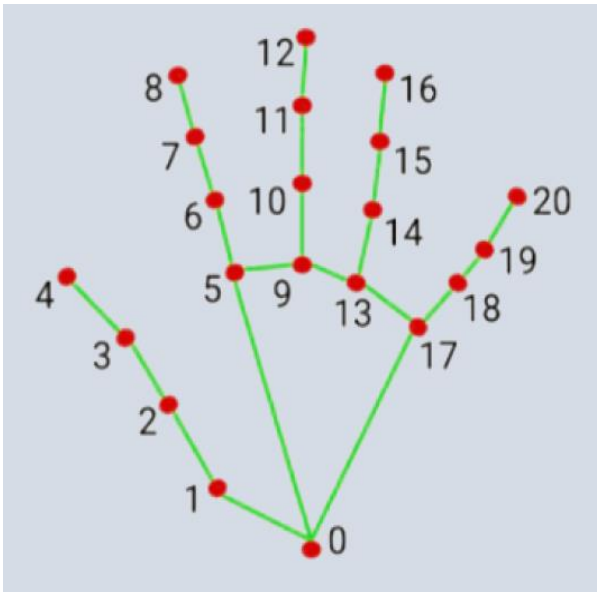

Figure 3.1. Landmark identification from Google MediaPipe library

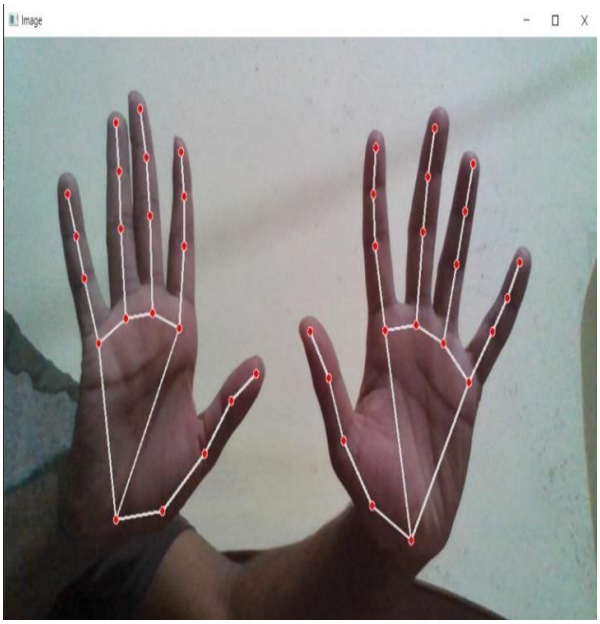

Figure 3.2. Real-time hand landmarks using MediaPipe library.

3.3 Numpy

It is a Python library that provides a multidimensional array object, various derived objects and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more. Using such efficient library to compute the data in real-time will reduce much of computation in programming. As we take real-time user inputs it's necessary to store those positions of fingers to a convenient store that is NumPy arrays. After storing the positions, computation on those data will be much easier compared to the conventional array in programming. Bit manipulation is very important when dealing

with image processing because image itself is considered as a multidimensional matrix of array. The set bits in array are always considered as the region where we find an element. The active region will have majority of set bits and edge is detected by considering the boundary of image.

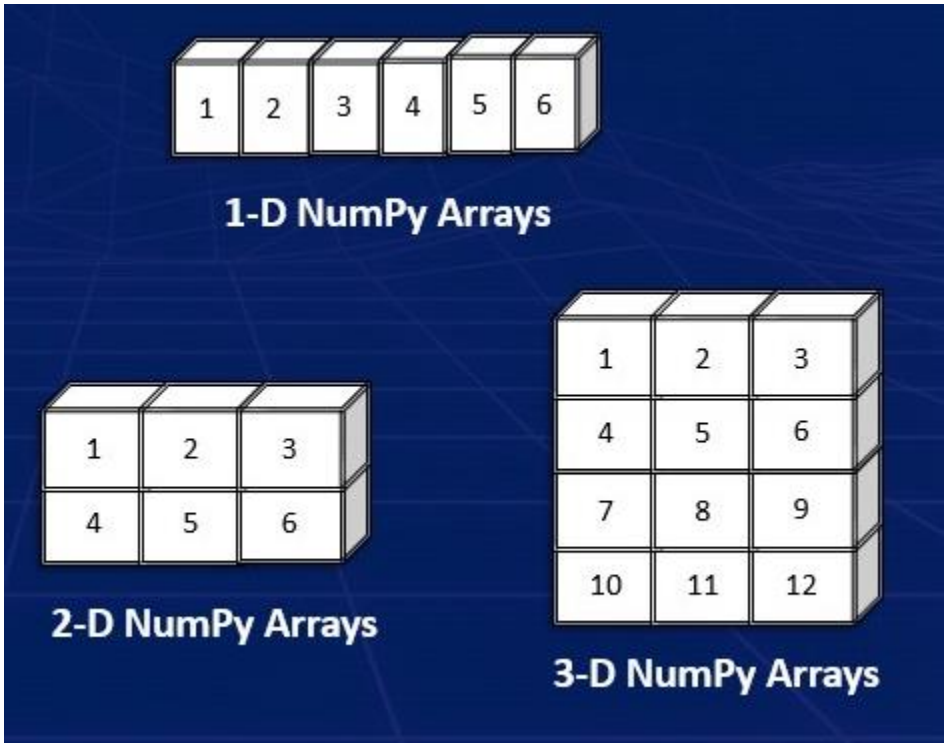

Figure 3.3. NumPy array in different dimensions

3.4 PyDirectInput

AutoPyGUI is a simple, cross-platform GUI automation library for Python. It includes functions for controlling the keyboard and mouse, and displaying alerts. But it only support for older version of python.

PyDirectInput replicate the functionality of the PyAutoGUI. It has all the functionality of mouse and keyboard. It supports all new versions of python. Creates click and move effect of cursor easily with simple methods provided by library.

3.5 Speech Recognition

Speech recognition is an interdisciplinary subfield of computer science and computational linguistics that develops methodologies and technologies that enable the recognition and translation of spoken language into text. Giving command to a human developed system is a common feature that is being implemented in all new technological projects. Interacting with the software using voice is very convenient way to work with computer. To enable this service a library of speech recognition is used as it is trained with more human voices and capable to recognize any human given command easily. Converting the user command to text is also important because to show what was said by user and recognized by system is matched.

3.6 PowerPoint to PDF

A set of Python scripts to convert PowerPoint (PPT/PPTX) files to Adobe PDF

- Convert.py - Converts a PowerPoint (PPT/PPTX) file into an Adobe PDF
- ConvertAll.py - Converts all PowerPoint (PPT/PPTX) files in a folder into Adobe PDFs
- ConvertHere.py - Converts all PowerPoint (PPT/PPTX) files the working folder into Adobe PDFs.
- It can also convert into other extensions such as jpg, png, etc.

3.7 Tkinter

Tkinter is a standard library in python used for creating Graphical User Interface (GUI) for Desktop Applications. With the help of it developing desktop applications is not a tough task. It is the standard Python interface to the Tcl/Tk GUI toolkit. Both Tk and tkinter are available on most Unix platforms, including macOS, as well as on Windows systems. It is not a thin wrapper, but adds a fair amount of its own logic to make the experience more pythonic.

As with most other modern Tk bindings, Tkinter is implemented as a Python wrapper around a complete Tcl interpreter embedded in the Python interpreter. It calls are translated into Tcl commands, which are fed to this embedded interpreter, thus making it possible to mix Python and Tcl in a single application.

Proposed System

CHAPTER 4

4. Proposed System

At first, image processing will be applied to each frame captured by the camera using OpenCV library. Image processing will extract only the region of interest from the frame. By this, it will reduce the computation and increase the efficiency. The region of interest will be user's hand which requires identifying different gestures. This region of interest will be given to mediapipe library algorithm and all the 21 hand landmarks consisting of (x, y), and relative depth will be obtained. Hand gestures can be identified by the hand landmark by measuring the distance between the points. For each hand gestures there will be different measurement and each hand gestures can be identified. Depending on the hand gestures different operation can be execute like virtual mouse, virtual keyboard, drawing on screen, presentation and many more.

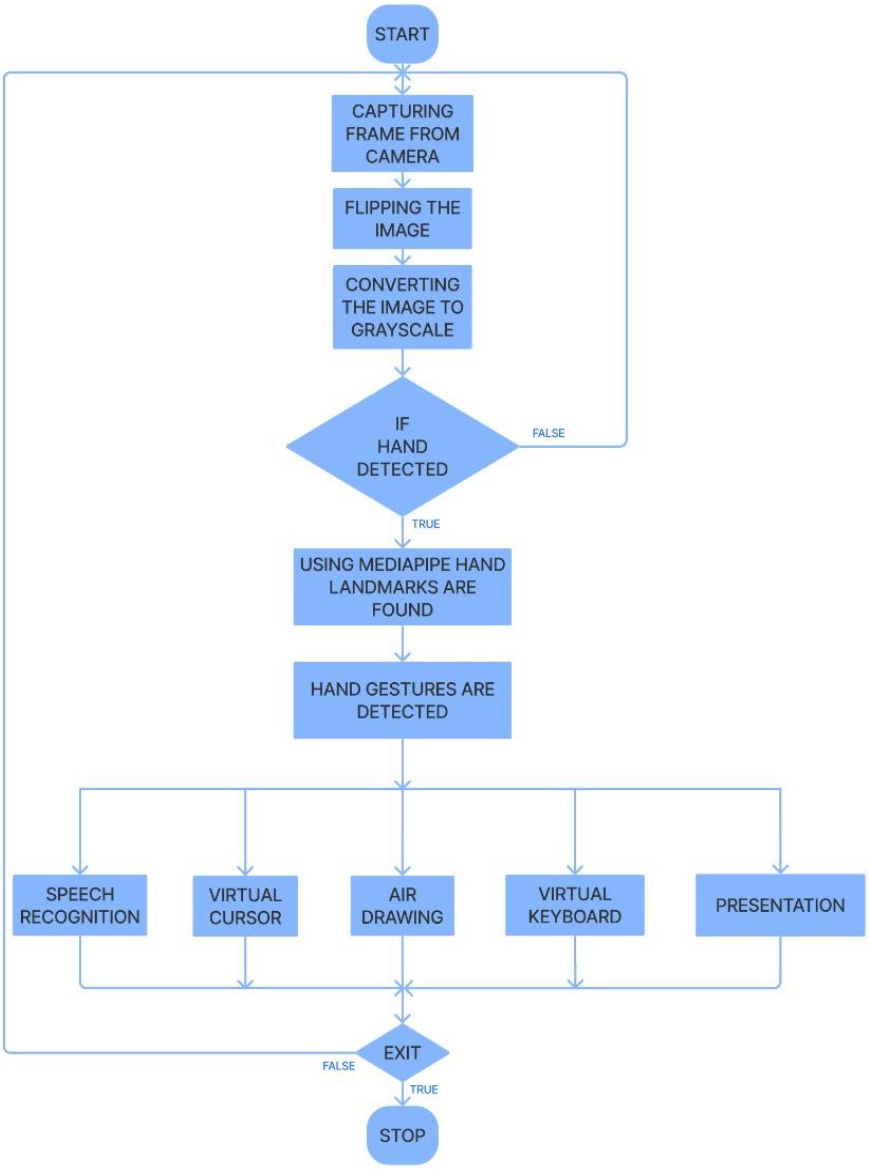

Figure 4.1 Flowchart to show how the system/Application will be developed

4.1 Working of the project

After opening the application, main menu window will get open and user can access any three-function painter, cursor and presentation as shown in fig: 4.1.1. When the user's hand is detected as shown in fig 4.1.2, user can control the fake cursor by using the hand gesture shown in fig: 4.1.3 and can select the function using the hand gesture shown in fig: 4.1.4.

Figure 4.1.1 Main Menu

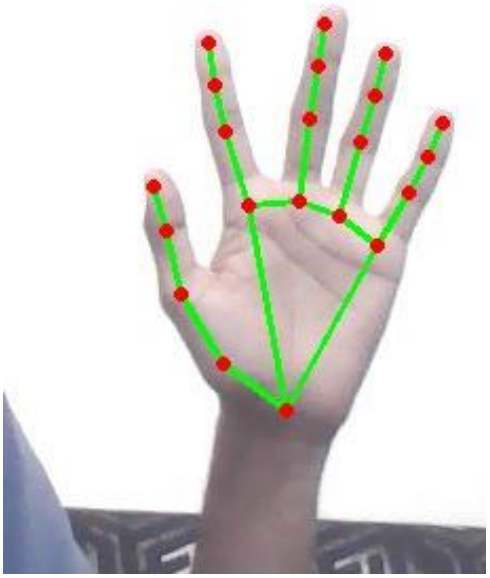

Figure 4.1.2. Hand Detection using MediaPipe

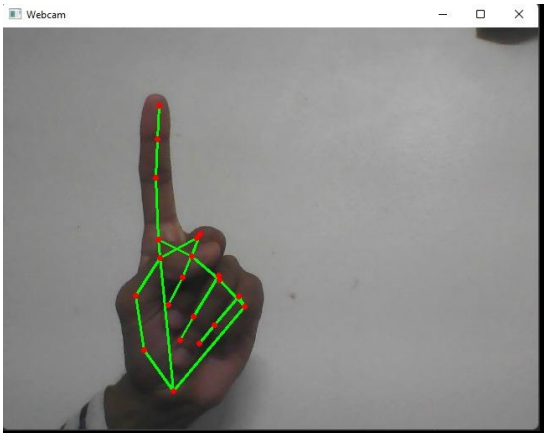

Figure 4.1.3 Cursor Control

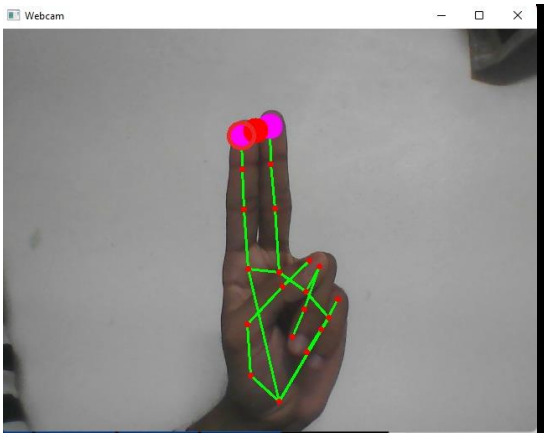

Figure 4.1.4 Selection

When Painter is selected a new window will pop-up as shown in fig: 4.1.5, here many operations can be access like pencil, eraser, pencil color selection, text using virtual keyboard, shapes, save and quit. By default, pencil operation is selected and user can draw on the screen by controlling the fake cursor using hand gestures as shown in fig 4.1.3 and color can be changed as shown in fig:4.1.6, similarly eraser operation is done. In text operation virtual keyboard is appeared and user can select the keys based on the requirements and speech to text can be done using Google API. In shapes operation basic shapes like square, rectangle, circle, triangle and line can be used. These text and shapes can be drag and drop in the canvas window by selecting and moving them with the hand gesture shown in fig 4.1.4. Save operation will take a screenshot and will save in a folder. Quit operation will close the Painter window and go back to main menu. Extra features like Clear Canvas, Undo, Size of the line as shown in fig 4.1.8 is present in the menu bar and more features can be added in future.

Figure 4.1.5 Painter Window

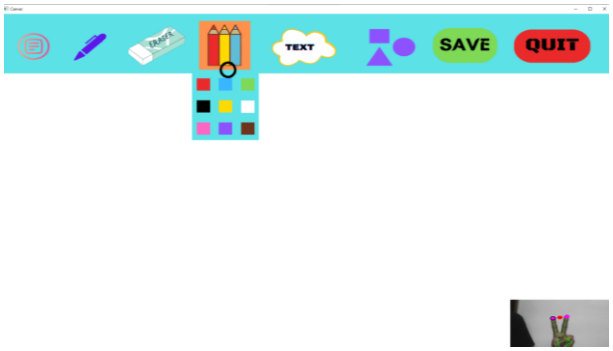

Figure 4.1.6 Color selection

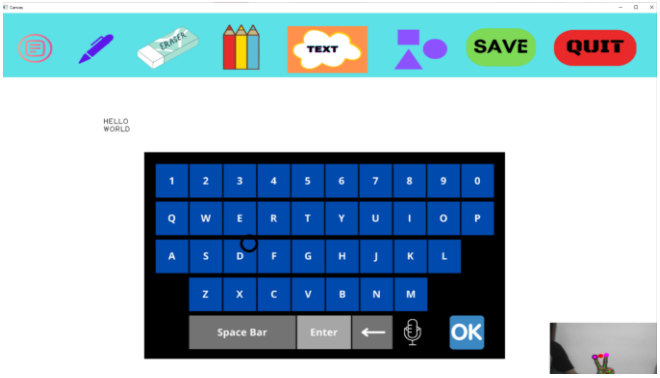

Figure 4.1.7 Keyboard

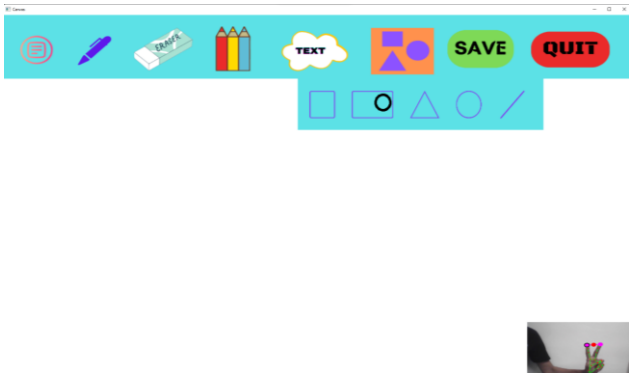

Figure 4.1.8 Shapes

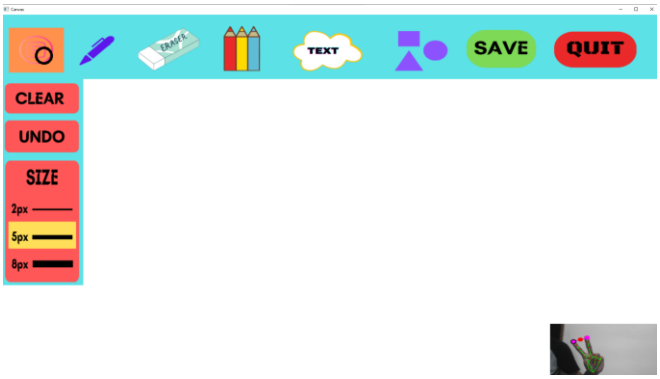

Figure 4.1.8 Menu bar

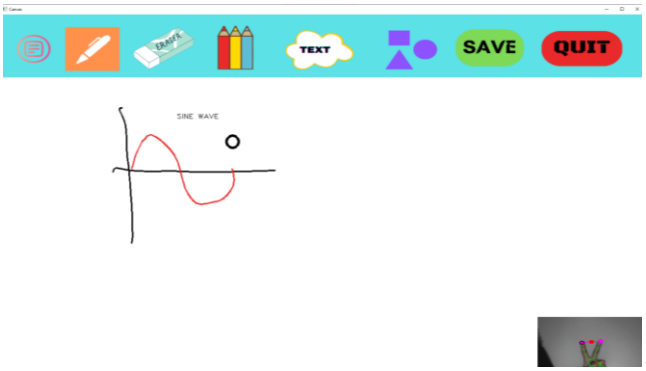

Figure 4.1.9 Painting

When Cursor is Selected Virtual mouse operation is executed by detecting hand gesture. When user hand is moved while keeping hand gesture shown in fig 4.1.3, mouse pointer can be hover on the screen. When hand gesture as shown in fig 4.1.4 left click operation can be performed.

When presentation operation is selected a file explorer will pop up and user can select any ppt file. After selection, the ppt file will be converted into images and user can change or move the slide using hand gestures as shown in fig 4.1.10 and fig 4.1.11.

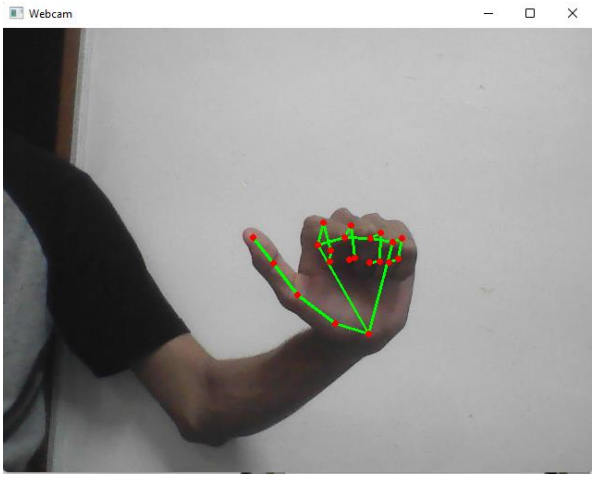

Figure 4.1.10 Left slide movement gesture

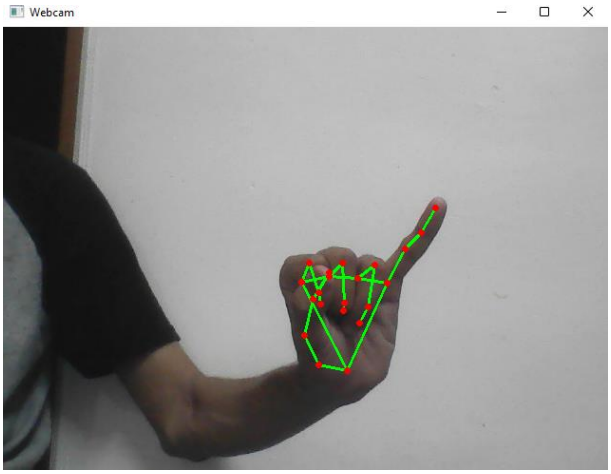

Figure 4.1.11 Right slide movement gesture

To draw or edit on the slide user can select the edit button, when the fake cursor is moved on top left corner the edit and quit button will be visible as shown in fig 4.1.12. When edit button is selected the current slide will be moved to the painter window and can get all the functions of it as shown in fig 4.1.13. To come back to presentation window user can select quit button and it will come back to the same slide and user can change the slide. If the cursor is moved to extreme right, a right arrow button is visible as shown in fig 4.1.14 and if user selects it, the slide will move to next slide. Similarly, if cursor is moved to extreme left, a left arrow button is visible as shown in fog 4.1.15 and if user selects it, the slide will move to previous slide. For first slide the previous button option will not be visible and can not be selected. Similarly for last slide next button option will not be visible and can not be selected.

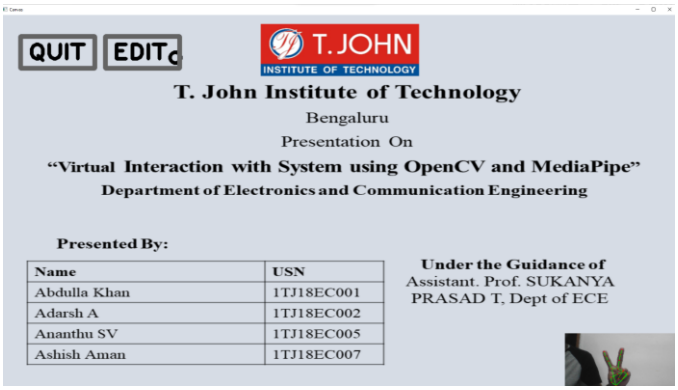

Figure 4.1.12 Presentation Window

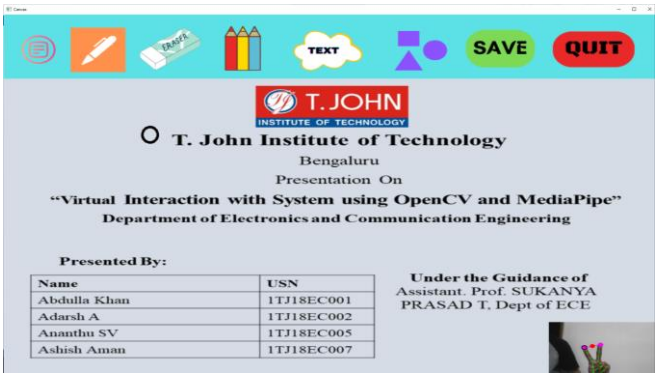

Figure 4.1.13 Editing Window

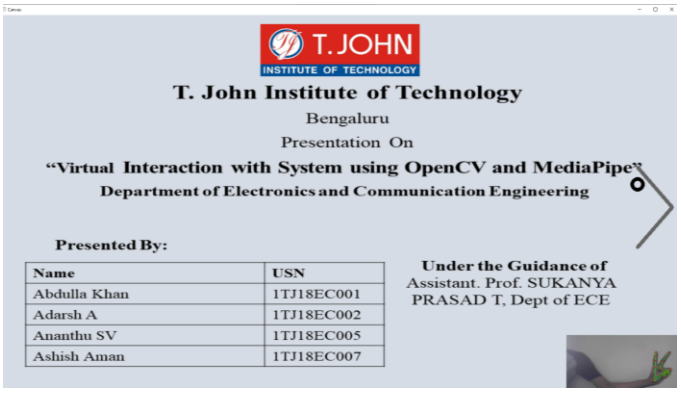

Figure 4.1.14 Next Slide Button

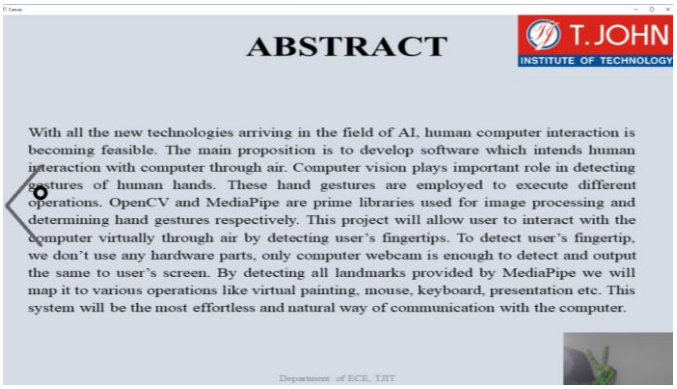

Figure 4.1.15 Previous Slide Button

Likewise, many operations can be done on the system using hand gestures and the user doesn't need to come closer to the system to interact with it. For presenters when they want to change the slide or want to draw anything they can stand away from the system and camera will capture user's hand gestures movement and user can interact with the system instead of using any hardware device.

4.2 APPLICATION

Using the new technology of virtual interaction, we can have lots of applications in the coming future, some of them are mentioned below. Advanced gaming like physical involvement in-game can be implemented which makes the gamers play like in a reality. Can be used for virtual presentation without the inconvenience of moving the slides with a mouse or keyboard. Virtual glasses can be replaced with virtual hands which allow live interaction on screen. Many electronic gadgets can be controlled using the fingertip of human beings which can be widely used in the field of robotics.

4.3 ADVANTAGES

➢ The virtual keyboard can be used to type onto the screen without the use of a mechanical keyboard using hand gestures.

➢ The cursor can be controlled by the user's fingertip to move around the screen and perform actions also.

➢ Detects the human speech and converts it to human-readable text.

➢ The operating system can be interacted using gesture control.

4.4 DISADVANTAGES

- Since we deal with images a high-quality camera is required to detect the user's fingertips.
- Enough amount of light is required for better results of the software.
- Reducing noise and optimizing for smaller devices is a challenging task.
- Faster processor is needed since it uses a lot of computational power.

CHAPTER 5

CONCLUSION

The idea here is to use a technique for efficient human computer interaction. Using the above-mentioned library, we are planning to build a system/application which will detect the human gestures and map it to the screen as inputs. This uses real-time camera interaction to send command to the application. Processing of image is done using OpenCV and MediaPipe to get the desired user active region. By this project we will be able to interact with the computer through air without any hardware or physical component. Wide usage in high-end gaming and robotics for real-time interaction this technique can be used. But will be needing a fair enough computational power to work smoothly and proper light to detect the hands.

REFERENCES

[1] S. Shriram, B. Nagaraj, J. Jaya, S. Shankar, P. Ajay, Deep Learning-Based Real-Time AI Virtual Mouse System Using Computer Vision to Avoid COVID-19 Spread - Journal of Healthcare Engineering, October 2021.

[2] Jay Patel, Umang Mehta, Dev Tailor, Devam Zanzmera, Kevin Panchel TEXT RECOGNITION BY AIR DRAWING – Conference on Computer Intelligence and Communication Technology, September 2021.

[3] S.U. Saoji, Nishtha Dua, Akash Kumar, Choudhary Bharat Phogat, AIR CANVAS APPLICATION USING OPENCV AND NUMPY IN PYTHON - International Research Journal of Engineering and Technology Volume: 08 Issue: 08 August 2021.

[4] Virtual Painting with OpenCV Using Python - International Journal of Scientific Research in Science and Technology, Issue November 2020.

[5] Megha S. Beedkar, Arti Wadhekar "A Research on Digital Art using Machine Learning Algorithm", Department of Electronics and Telecommunication Deogiri Institute of Engineering and Management Studies Aurangabad, India, Journal of Engineering Science Vol 11, Issue 7/July/2020.

[6] Ahmad Puad Ismail, Farah Athirah Abd Aziz, Nazirah Mohamat Kasim, Kamarulazhar Daud, Hand gesture recognition on python and OpenCV - First International Conference on Electrical Energy and Power Engineering, June 2020.

[7] Fan Zhang, Valentin Bazarevsky, Andrey Vakunov, Andrei Tkachenka, George Sung, Chuo-Ling Chang, Matthias Grundmann, MediaPipe Hands: On-device Real-time Hand Tracking – Google Research, June 2020.

[8] Shivangi Nagdewani, Ashika Jain, A REVIEW ON METHODS FOR SPEECH-TO-TEXT AND TEXT-TO-SPEECH CONVERSION - International Research Journal of Engineering and Technology (IRJET), May 2020.

[9] Riza Sande, Neha Marathe, Neha Bhegade, Akanksha Lugade, Prof. S. S. Jogdand, Virtual Mouse using Hand Gestures - International Research Journal of Engineering and Technology Volume: 05 Issue: 04 | Apr-2018.

KAS Knowledge As a Service

T. JOHN INSTITUTE OF TECHNOLOGY

IOS Press

Approved by All India Council for Technical Education (AICTE)
& Affiliated to Visvesvaraya Technological University (VTU)
#86/1, Gottigere P. O., Bannerghatta Road, Bangalore - 560083
Tel: 080 - 40250555, 080 - 49030555 | Fax: 080 49030509
Email: tjitprincipal@tjohngroup.com | Website: www.tjohncollege.com

CERTIFICATE OF PRESENTATION

This is to certify that Dr./Mr./Mrs. Abdulla Khan Prof./AP./RS./Student, Department of ECE / T JOHN INSTITUTE OF TECHNOLOGY has presented a paper titled Virtual Interaction with System using OpenCV and MediaPipe in the **International Conference on Advances in Parallel Computing Technologies and Applications (ICAPTA 2022)**, organised by T. John Institute of Technology, Bangalore, Karnataka, India, in Association with KAS Innovative India, Chennai on 27-28 January 2022.

Convenor
Dr. John T Mesia Dhas

KAS000033

Principal
Dr. P. Suresh Venugopal

KAS Knowledge As a Service

T. JOHN INSTITUTE OF TECHNOLOGY

IOS Press

Approved by All India Council for Technical Education (AICTE)
& Affiliated to Visvesvaraya Technological University (VTU)
#86/1, Gottigere P. O., Bannerghatta Road, Bangalore - 560083
Tel: 080 - 40250555, 080 - 49030555 | Fax: 080 49030509
Email: tjitprincipal@tjohngroup.com | Website: www.tjohncollege.com

CERTIFICATE OF PRESENTATION

This is to certify that Dr./Mr./Mrs. Adarsh.A Prof./AP./RS./Student,
Department of ECE/T.JOHN INSTITUTION OF TECHNOLOGY has presented a paper titled
Virtual Interaction with system using open CV and MediaPipe in the
International Conference on Advances in Parallel Computing Technologies and Applications (ICAPTA 2022),
organised by T. John Institute of Technology, Bangalore, Karnataka, India, in Association with KAS Innovative India, Chennai on 27-28 January 2022.

Convenor
Dr. John T Mesia Dhas

KAS000036

Principal
Dr. P. Suresh Venugopal

KAS Knowledge As a Service

T. JOHN INSTITUTE OF TECHNOLOGY

IOS Press

Approved by All India Council for Technical Education (AICTE)
& Affiliated to Visvesvaraya Technological University (VTU)
#86/1, Gottigere P. O., Bannerghatta Road, Bangalore - 560083
Tel: 080 - 40250555, 080 - 49030555 | Fax: 080 49030509
Email: tjitprincipal@tjohngroup.com | Website: www.tjohncollege.com

CERTIFICATE OF PRESENTATION

This is to certify that Dr./Mr./Mrs. Ananthu SV Prof./AP./RS./Student, Department of ECE / T John Institute of Technology has presented a paper titled Virtual Interaction with System using OpenCV and MediaPipe in the **International Conference on Advances in Parallel Computing Technologies and Applications (ICAPTA 2022)**, organised by T. John Institute of Technology, Bangalore, Karnataka, India, in Association with KAS Innovative India, Chennai on 27-28 January 2022.

Convenor
Dr. John T Mesia Dhas

KAS000019

Principal
Dr. P. Suresh Venugopal

KAS Knowledge As a Service

T. JOHN INSTITUTE OF TECHNOLOGY

IOS Press

Approved by All India Council for Technical Education (AICTE)
& Affiliated to Visvesvaraya Technological University (VTU)
#86/1, Gottigere P. O., Bannerghatta Road, Bangalore - 560083
Tel: 080 - 40250555, 080 - 49030555 | Fax: 080 49030509
Email: tjitprincipal@tjohngroup.com | Website: www.tjohncollege.com

CERTIFICATE OF PRESENTATION

This is to certify that Dr./Mr./Mrs. Ashish Aman Prof./AP./RS./Student,
Department of ECE / T John Institute of Technology has presented a paper titled
Virtual Interaction with System using OpenCV and MediaPipe in the

International Conference on Advances in Parallel Computing Technologies and Applications (ICAPTA 2022), organised by T. John Institute of Technology, Bangalore, Karnataka, India, in Association with KAS Innovative India, Chennai on 27-28 January 2022.

Convenor
Dr. John T Mesia Dhas

KAS000035

Principal
Dr. P. Suresh Venugopal