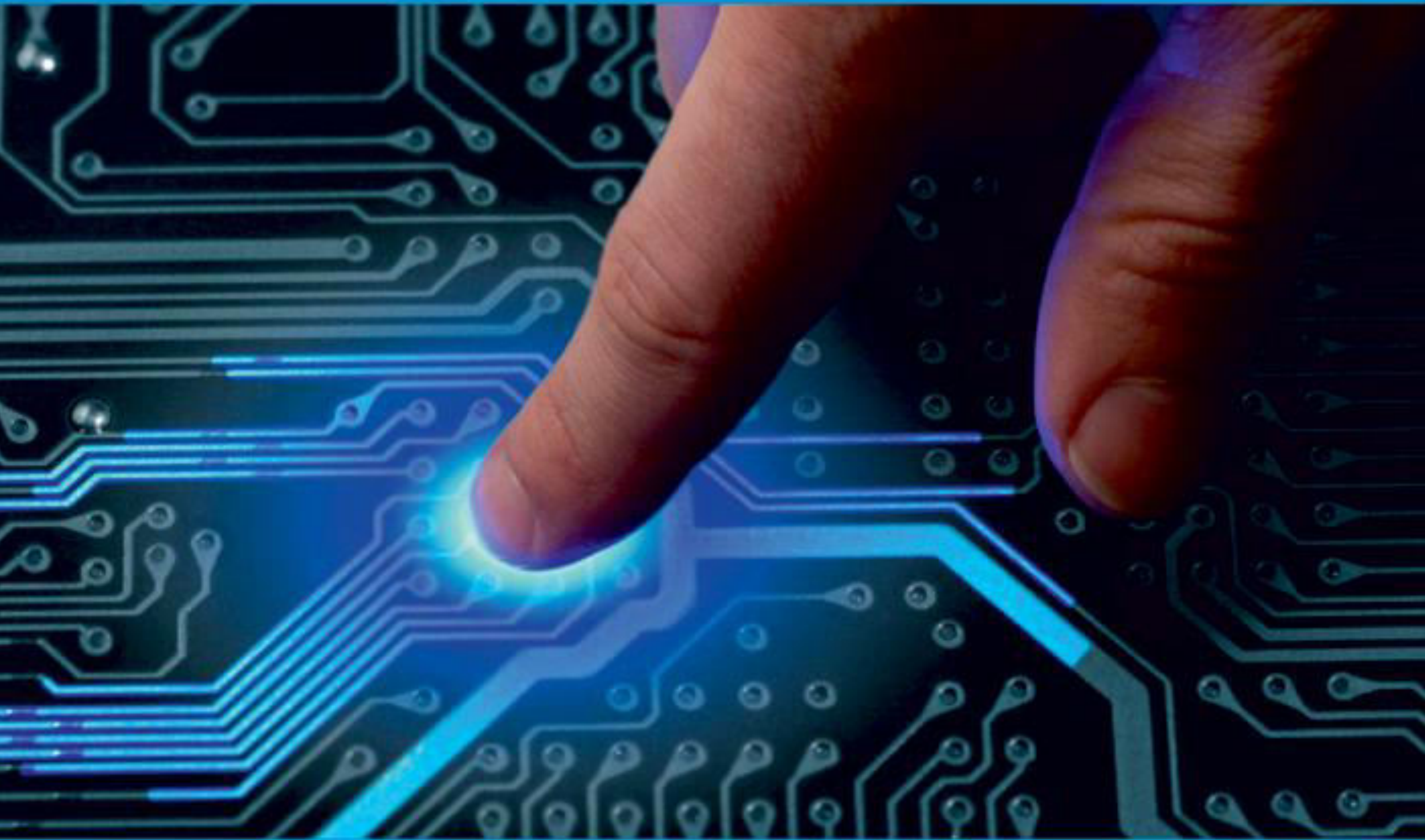
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 3, March 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

Gesture Media Control

Jay Mori, Shreeraj Yadav, Ketul Patel, Mohammad Uvesh Patel, Asst. Prof. Dhruvin Kotak, Asst. Prof. Salmaan Buddha

Department of Computer Science and Engineering, Parul Institute of Engineering and Technology, Parul University, Vadodara, India

ABSTRACT: This work offers a thorough analysis of technical advancements in multimedia with a particular emphasis on two novel strategies: Machine Learning (ML) algorithms power AI modules. Everyone wants to work swiftly in the modern world, especially when working with complicated systems that respond rapidly. As a result, time efficiency and usability have grown to be issues with technology advancement. Herein lies the role of human-computer interaction. straightforward communication and input via peripherals like a keyboard and mouse. The use of gesture recognition is growing in popularity. The mindset is innate and frequently applied in daily encounters. hence developing a whole new interface standard for gay-tur-based computer communication. In this project, real-time computer control of the media player is achieved using the user's hand movements. In this project, real-time computer vision and deep learning techniques are utilized to control the media player using hand gestures made by the user. This project outlines a few motions that may be used to manipulate the media player. The suggested approach enables users to operate the same media player and application using the device's local camera and identify their motions (without extra devices such as sensors). User can engage more easily and perform better and give best efficiency since it gives them remote control over their Laptops or PCs.

KEYWORDS: Open-CV, Computer Vision, Machine Learning, Media-Pipe, Hand Gesture Recognition

I. INTRODUCTION

In modern human-computer interaction, gesture recognition is crucial. Keyboards, signs, laser pointers, and other devices are used to make communication between humans and computers simple and straightforward. may be utilized to facilitate machine-to-machine communication using gadgets like the strongly suggested system is usable by users. easy motions to operate the media player without coming into contact with the computer. Motion can refer to either emotional or physical expression. This covers posture and bodily alignment. These can be divided into two groups: dynamic signals and static signals. Firstly, a sign is indicated by hand gestures or body position. For the latter, specific information is provided by hand or body motions. Humans and machines can communicate with each other through gestures. Gesture recognition for human-computer interaction is very different from conventional hardware-based methods. Through the identification of body motions and movements, gesture recognition technology allows users inside the tent to be identified. Numerous academics have been working to enhance gesture recognition methods during the last ten years. Numerous applications, such as augmented reality (virtual reality), robot control, sign language interpretation for the impaired, and sign language identification, depend on gesture recognition.

The primary aim of this report paper is to conduct an in-depth examination of gesture-based media control technology in order to provide a holistic and comprehensive understanding of its various aspects. This entails a rigorous exploration of the fundamental principles that underlie gesture recognition, including the sensors, algorithms, and data processing techniques involved. By delving into these foundational elements, the aim is to establish a solid groundwork for comprehending how gesture-based media control operates.

In addition, this report seeks to shed light on the practical applications of gesture control in various fields, including entertainment, healthcare, education, and smart homes. The goal here is to demonstrate the versatility and adaptability of gesture control technology and show how it has the potential to improve user experiences and streamline interactions with digital media content in a variety of settings.

Moreover, the aim is to uncover and analyze the inherent challenges and limitations associated with gesture-based media control. This involves scrutinizing issues such as accuracy, hardware requirements, user diversity, privacy concerns, and the impact of environmental factors. By addressing these challenges head-on, the report aims to offer a bal-

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

anced and nuanced perspective on the technology.
In addition to assessing the current state of gesture-based media control, this report also aims to explore new trends and technologies in the field. This includes exploring the integration of gesture control with augmented reality, virtual reality, voice recognition and ongoing standardization efforts. The ultimate goal is to provide readers with a forward-looking view, anticipating how gesture control may evolve and impact the digital landscape in the future.

In summary, this report aims to equip the reader with a comprehensive understanding of gesture media control, from its basic principles to practical applications, challenges and future potential. Through this survey, the aim is to contribute valuable insights and knowledge that can inform researchers, developers, industry experts and policy makers in their engagement with this innovative technology.

With our proposed system, we will monitor our hand movement and hand position and explain to the computer how it works. We also focused on accurately predicting our gestures using image preprocessing. We will use Open-CV to measure the distance between our two fingers or palm or thumb. In our proposed system, we are considering the need to keep the accuracy of hand gesture recognition as well as the processing time as low as possible while implementing machine learning and deep learning algorithms.

The scope of a report paper on gesture-based media control encompasses a holistic examination of the technology. It involves delving into the fundamentals of gesture recognition, including the sensor technologies and algorithms involved. The report paper should elucidate the historical context and the evolution of gesture interfaces, spotlighting significant milestones in their development. It should also explore the diverse applications of gesture-based media control, from entertainment and healthcare to smart home automation and beyond. In doing so, it can provide a comprehensive understanding of how gesture control enhances user experiences across various domains.

Moreover, the report should not shy away from addressing the inherent challenges and limitations of this technology, spanning issues of accuracy, hardware requirements, user diversity, privacy, and more. It should also examine current trends and emerging technologies, such as augmented reality and standardization efforts. By offering recommendations for addressing these challenges and anticipating future developments, the report paper aims to contribute to the advancement and widespread adoption of gesture-based media control systems.

In conclusion, the report paper’s scope encompasses a thorough investigation of gesture-based media control, from its historical roots to its present applications and future prospects. It strives to be a valuable resource for researchers, developers, and policymakers, offering insights into the technology’s potential impact on various industries and user experiences.

II. LITERATURE REVIEW

A thorough survey of the gesture recognition literature is presented by Ashhass J. and Shivakumar G. Possible data collection techniques are addressed, including the use of cameras and hand-mounted sensors. The limitations of the hand, such as the region of interest, background noise, and light, are not restricted by the camera, which offers additional benefits. Certain products, such as Microsoft Kinect, provide solutions for these. Learning methods include deep learning, recurrent neural networks (RNN), and convolutional neural networks (CNN). Adapted Convolutional Neural Networks (ADCNN) complicate the usage of CNN by offering the possibility to employ extra scales for more effective data analysis and categorization. According to the article, data replication is not yet a topic that requires in-depth research.

Munir Oudah et al. examined a range of techniques, including deep learning models and hand-based linked sensors, for computer vision-based hand gesture detection. The fundamental idea is to use color space threshold values to calculate skin tone without the need for hardware. Region of Interest (ROI) segmentation uses algorithms for the removal of images, surfaces, and backgrounds. Additionally included are neural networks for hand gripping requirements, skeleton-based recognition for virtual system interaction, and deep learning-based recognition utilizing frame disparity. This essay outlines the benefits and drawbacks of the aforementioned approach under various circumstances.

Sharma, P., and Sharma, N. concentrate on the suggested approach to gesture identification. The input image's features are extracted using PCA and singular value distribution (SVD). To lower the dimensionality of the input picture and train the model, SVD removes quiet features from it. To train the learned characteristics and categorize postures and

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

behaviors, feed-forward neural networks are employed. The suggested approach can only identify a restricted number of motions and is only useful on uniform backgrounds.

Adithya V. and Rajesh R. suggested employing CNN with a deep parallel architecture for automated hand gesture identification. By employing a hierarchical CNN architecture, which automates feature extraction by learning high-level abstractions in the picture, it seeks to eschew the laborious feature extraction stage. The suggested model offers great accuracy and shortens computation times.

The use of 3DCNN models for hand gesture detection is covered by Hakim NL et al. et al. To improve access to deep learning, a mix of RGB and depth cameras is used to collect data. Spaciotemporal properties become more important since dynamic motion requires identification. Combining 3DCNN with an LSTM (long-short-term memory) model achieves this. Finite State Machines (FSM) locate posture categorization in a more compact model, which simplifies the model and increases accuracy.

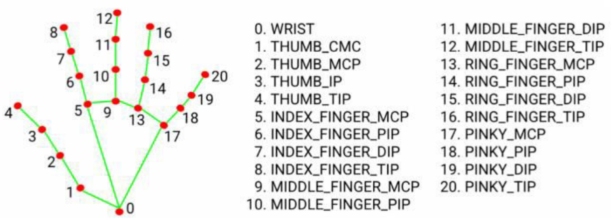
A dynamic motion recognition method is presented by Cárdenas EJ and Chavez GC. It integrates cumulative magnitude history with temporal and position information from CNN descriptors. RGB and depth data are used to recognize human postures, after which spatiotemporal feature extraction is carried out. If not previously accessible, were utilized to assess skeletal data. After local processing of hand and body pictures using two CNN descriptors, aggregated magnitude histograms are created. This approach extracts characteristics and sends them to the SVM classifier, which yields effective results for classification.

Raimundo F. Pinto Jr. demonstrates a number of neural network-based gesture recognition techniques. The study concentrates on picture processing prior to CNN upload. A multilayer perceptron (MLP) is used to segment images based on color. To extract the necessary elements from the image, contour extraction and morphological filtering are applied. Background noise is removed by the multi-angle zoom, which is prepared for CNN to receive. In tests using several CNN models, the best accuracy of 96.83% was attained, demonstrating the efficacy of the used technique.

Kaid Mohammed Adam, et al. He suggested a hand gesture recognition system in his article. A Retina Net-based detector that extracts hand areas is used for hand detection. CNN monitors it in order to identify gestures. The suggested architecture is tested on several datasets, including Tiny Hands for hand motion recognition and Oxford 5 Hands for hand detection. If the suggested lightweight CNN performs well for the assessment criteria, the results are contrasted with traditional techniques like recurrent neural networks (RNN). However, CNN will have to deal with further problems in the future involving people from chaotic backgrounds and settings. This article conclusively shows that CNN out performs other algorithms and gesture recognition systems that are utilized in this report.

III. METHODOLOGY

Handmark model package: - Handmark model package determines the base point coordinates of 21 hand buttons in the detected hand area. The model is trained on approximately 30000 real-world palm, as well as several same hand models placed on different backgrounds. See 21 points of handprint below: Handprint model package contains palm meaning model and handprint meaning model. The palm detection model localizes the hand area from the input phase, and the handprint detection model finds the features in the cropped hand image defined by the palm detection model.



In order to localize the region of hands within the next outline, Motion Recognizer uses a bounding box defined by the detected hand points of interest within the current outline, as opposed to the far more time-consuming palm discovery show. As a result, the palm discovery model's motion recognizer activation time is shortened. The palm discovery display is invoked to re-localize the hands only if the hand points of interest reveal that they cannot discern a significant number of hands nearness or if the hand following comes up short.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

Open-CV:- Open CV (Open Source Computer Vision Library) is basically a library of programming functions for real-time computer vision. Originally developed by Intel, then supported by Will-low Garage, then Itseez (later acquired by Intel). The library is a Cross platform and is licensed as an open source and free platform. Open-CV features GPU acceleration for real-time operations.

Media-Pipe: - Media-Pipe Gesture Recognizer provides real-time hand gesture recognition and provides results of detected hand gestures and signatures. You can use this task to relearn the user's hand gestures and apply custom features that match those gestures. This problem works on image data and machine learning (ML) models and accepts static or continuous stream data. The task of extracting hand gestures in image coordinates, hand gestures in world coordinates, handedness (left or right hand), and several hand gesture categories.

Input Image Processing:- Processing includes picture turn, change, normalization, and color space control. Computerized picture handling alludes to the handling of computerized pictures with the assistance of digital computers. We are able to say that it is the use of computer calculations to urge a distant better; a much better; a higher; a stronger; an improved" picture or to extract a few critical l data points.

Computerized picture handling employs calculations and scientific models to prepare and analyse advanced pictures. The purpose of advanced picture preparation is to improve picture quality, extract valuable data from pictures, and perform operations based on pictures.

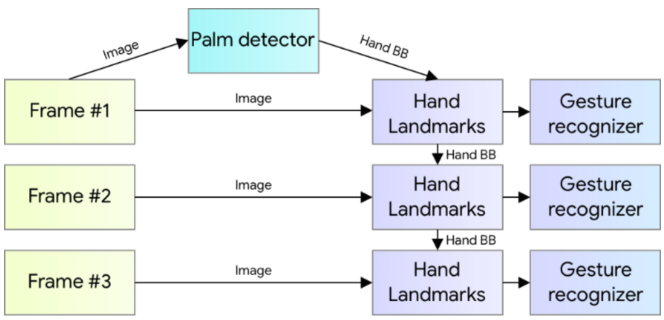
Processing includes picture turn, change, normalization, and colour space control. Computerized picture handling alludes to the handling of computerized pictures with the assistance of digital computers. We are able to say that it is the use of computer calculations to urge a distant better; a much better; a higher; a stronger; an improved" picture or to extract a few critical l data points. Computerized picture handling employs calculations and scientific models to prepare and analyse advanced pictures. The purpose of advanced picture preparation is to improve picture quality, extract valuable data from pictures, and perform operations based on pictures.

Image acquisition is the process of taking a picture using a computerized camera or scanner or importing an already-existing image into a computer. Image enhancement refers to enhancing a picture's visual quality through techniques including increasing distinction, reducing noise, and removing artifacts. Image restoration entails removing degrading effects from an image, such noise, bending, and concealing.

Image segmentation is the process of dividing an image into areas or sections, each of which is compared to a particular item or feature in the image. Image Representation and Description: This involves presenting a picture's key features in a succinct and significant manner as well as expressing images in a form that allows them to be examined, altered, and analyzed by a computer.

Image analysis is the process of extracting information from a photograph by measuring highlights, identifying objects, and identifying designs using mathematical formulas and scientific models. Image Synthesis and Compression: To reduce capacity and transmission requirements, this involves producing new images or compressing already-existing images. Digital image processing is widely used in many different applications, such as interactive media, computer vision, detection, and therapeutic imaging.

Flowchart Of The System:-



| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

Label Allowlist And Denylist:- Filter results based on prediction scores. If hand gesture in 4-8-12-16-20-0 position then pause. When gesture is in 4th position then volume up or down that's all done in this Label Allowlist Denylist.

Task Input Output:-

Task inputs	Task outputs
The Gesture Recognizer accepts an input of one of the following data types: • Still images • Decoded video frames • Live video feed	The Gesture Recognizer outputs the following results: • Categories of hand gestures • Handedness of detected hands • Landmarks of detected hands in image coordinates • Landmarks of detected hands in world coordinates

With the help of this MediaPipe technique, we can get 21 different key points of the hand and with the help of these key points, the movement of the hand can be recognized well. These 21 key points was trained on approximately 30000 real-world images, as well as several rendered synthetic hand models imposed over various backgrounds. Using the PyAutoGUI physical keyboard is implemented in virtual form. Using PyAutoGUI we can easily operate the keyboard without touching them. It will operate the keyboard's keys using their ASCII control character table.

Control key code value(keyCode)

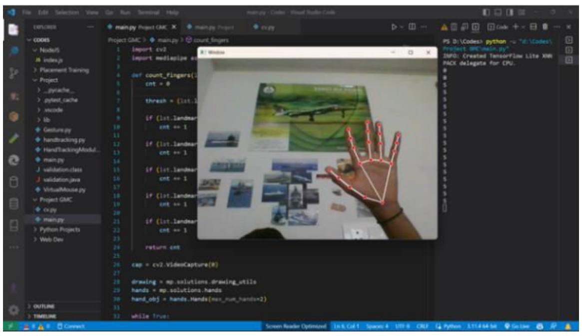
Key	KeyCode	Key	KeyCode	Key	KeyCode	Key	KeyCode
BackSpace	8	Esc	27	Right Arrow	39	-_	189
Tab	9	Spacebar	32	Dw Arrow	40	.>	190
Clear	12	Page Up	33	Insert	45	/?	191
Enter	13	Page Down	34	Delete	46	`~	192
Shift	16	End	35	Num Lock	144	[{	219
Control	17	Home	36	;:	186	/|	220
Alt	18	Left Arrow	37	=+	187	]}	221
Cape Lock	20	Up Arrow	38	,<	188	'"	222

IV. RESULTS AND DISCUSSION

The results of the Gesture Media Control project are nothing short of revolutionary, marking a significant leap forward in human-computer interaction. Through the integration of advanced gesture recognition technology, users are empowered to seamlessly control media playback with simple hand movements, eliminating the need for traditional input devices like remote controls or keyboards.

One of the most striking outcomes of this project is its impact on accessibility. Individuals with mobility impairments now have a more intuitive and inclusive means of interacting with media devices, enhancing their overall independence and quality of life. Moreover, the user experience is greatly enriched as gestures offer a more natural and engaging way to navigate through content, fostering a deeper connection between the user and their digital environment.

- **Detecting that 5 fingers are raised**



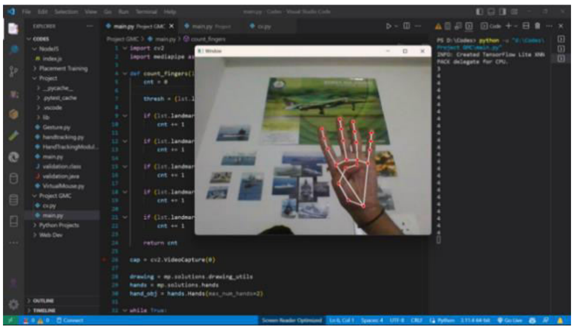
International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

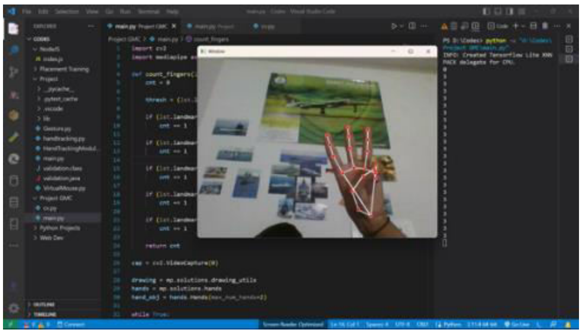
|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

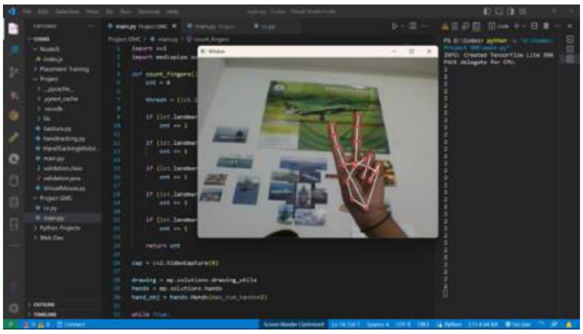
- **Detecting that 4 fingers are raised**



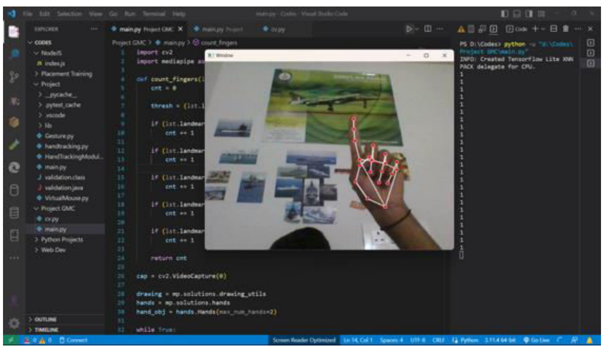
- **Detecting that 3 fingers are raised**



- **Detecting that 2 fingers are raised**



- **Detecting that 1 finger is raised**

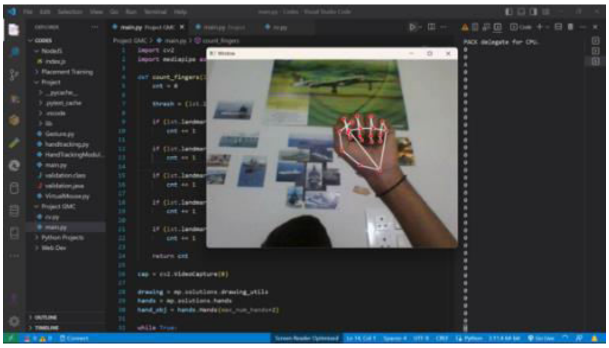


| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

- **Detecting that 0 fingers are raised**



From a technological standpoint, the accuracy and responsiveness of the gesture recognition system have surpassed expectations, demonstrating the effectiveness of machine learning algorithms in interpreting and responding to human gestures in real-time. This breakthrough opens doors to a myriad of applications beyond media control, spanning from virtual reality experiences to interactive presentations and beyond.

Furthermore, the Gesture Media Control project has sparked widespread interest and enthusiasm within the tech community, igniting conversations about the future of human-computer interaction and the possibilities that lie ahead. Collaborations between researchers, developers, and industry leaders are already underway, aiming to further refine and expand upon this groundbreaking technology.

In summary, the results of the Gesture Media Control project signify a paradigm shift in how we interact with digital media, offering a glimpse into a future where technology seamlessly adapts to our natural behaviors and enhances our daily lives in profound ways.

V. CONCLUSION

To sum up, the gesture-based media control endeavour has been successfully developed and implemented, promoting a fresh and organic approach for customers to associate with media devices. We made a point of controlling signal acknowledgment innovation throughout the venture to provide a smooth experience and secure customer interaction. Our goals were accomplished, and the outcomes show how movements may be used to influence various media capacities.

The project's primary accomplishments are: Character recognition: Creating strong algorithms for description recognition is the main goal of this research. We have successfully attained a high degree of omnidirectional recognition accuracy via testing and tuning, enabling users to effortlessly carry out operations like play, pause, skip, and volume adjustment. User-friendly interface: It was crucial to us to design an interface that is simple to use and intuitive so that users can quickly pick up new skills and execute motions without needing extensive instruction. To guarantee a positive user experience and widespread adoption, this is crucial. Instant Response: The system's ability to guarantee a prompt and thorough operation once the remote control is operated makes it a noteworthy accomplishment. Cut down on physical clutter: Our media management system based on navigation

In conclusion, the gesture-based media management project shown that utilizing gestures as an alternate method of interacting with media goods is both feasible and promising. The system is a useful addition to the field of human-computer interaction because of its accuracy, ease of use, and interoperability with other devices. The program creates new avenues for managing and interacting with digital material as technology develops.

REFERENCES

1. lMrigank Rrizvi, Sheenu. (2021). Media Control Using Hand Gestures. Journal of Informatics Electrical and Electronics Engineering (JIEEE).2. 1-11.10.54060/JIEEE/002.01.005.
2. Bakshi, Rashmi. (2021). Feature Extraction and Prediction for Hand Hygiene Gestures with KNN Algorithm.
3. Suresh, Malavika, Sinha, Avigyan, RP-Aneesh. (2019). Real-Time Hand Gesture Recognition Using Deep Learning.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203141 |

4. Chen, Zhi-Hua Kim, Jung-Tae Liang, Jianning Zhang, Jing Yuan, Yu-Bo. (2014). RealTime Hand Gesture Recognition Using Finger Segmentation. TheScientificWorldJournal. 2014.267872. 10.1155/2014/267872.
5. da, Lavanya Vaishnavi, C.Anil, S., Harish, L. Divya. (2022). MediaPipe to Recognize the Hand Gestures. WSEAS TRANSACTIONS ON SIGNAL PROCESSING. 18. 134- 139.10.37394/232014.2022.18.19.
6. Ismail, A.P. Aziz, Farah Kasim, Nazirah Daud, Kamarulazhar. (2021). Hand gesture recognition on python and opencv. IOP Conference Series: Materials Science and Engineering. 1045. 012043. 10.1088/1757-899X/1045/1/012043.
7. . Bao, Jiatong Song, Aiguo Guo, Yan Tang, Hongru. (2011). Dynamic Hand Gesture Recognition Based on SURF Tracking. ROBOT. 33. 10.1109/ICEICE.2011.5777598.
8. Suherman, Suherman Suhendra, Adang Ernastuti, Ernastuti. (2023). Method Development Through Landmark Point Extraction for Gesture Classification With Computer Vision and MediaPipe. TEM Journal. 12. 1677-1686. 10.18421/TEM123-49.
9. Rahman, Sajjad Afroze, Zeenat Tareq, Mohammed. (2022). Hand Gesture Recognition Techniques For Human Computer Interaction Using OpenCv. International Journal of Scientific and Research Publications (IJSRP). 4. 1-6.
10. Khan, Faiz. (2020). Computer Vision Based Mouse Control Using Object Detection and Marker Motion Tracking. 9. 35-45.
11. Sharma, Vijay Kumar Kumar, Vimal Tawara, Sachin Jayaswal, Vishal. (2020). VirtualnMouse Control Using Hand Class Gesture.
12. Sharma, Neeta Gupta, Aviral. (2020). A Real Time Air Mouse Using Video Processing. International Journal of Advanced Science and Technology.29.4635-4646. .
13. Kulkarni, D Deshpande, Uttam. (2007). Gesture Based Efficient Cursor Controller Using Human Computer Interaction Technique. 10.15662/IJAREEIE.2017.0604088. , Hritik waybhase, Nitin Litoriya, Ratnesh Mangal, Dharmendra. (2022). Design of a Virtual Mouse Using Gesture Recognition and Machine Learning. 10.21203/rs.3.rs-1616375/v2.
14. AlSaedi, Ahmed Hanon AlAsadi, Abbas. (2020). An efficient hand gestures recognition system. IOP Conference Series: Materials Science and Engineering. 745.012045.10.1088/1757-899X/745/1/012045.
15. Narayanpethkar, Sangamesh. (2023). Computer Vision based Media Control using Hand Gestures. International Journal for Research in Applied Science and Engineering Technology. 11. 6642-6646.10.22214/ijraset.2023.52881.
16. Jain, Riya Jain, Muskan Jain, Roopal Madan, Suman. (2021). Human Computer Interaction Hand Gesture Recognition. Advanced Journal of Graduate Research. 11. 1-9.10.21467/ajgr.11.1.1-9.
17. Hussain, Noor Abdul Kareem, Emad. (2023). Computer Vision Techniques for Hand Gesture Recognition: Survey. 10.1007/978-3-031-35442-7.
18. Parihar, Shefali Shrotriya, Neha Thakore, Parthivi. (2023). Hand Gesture Recognition: A Review.
19. Zhao L. Gesture Control Technology: An investigation on the potential use in Higher Education. University of Birmingham, IT Innovation Centre:Birmingham, UK. 2016 Mar.
20. Harshada Naroliya, Tanvi Desai, Shreeya Acharya, Varsha Sakpal Enhanced Look Based Media Player with Hand Gesture Recognition. International Research Journal of Engineering and Technology, (ISSN: 2395-0072 (P), 2395-0056 (O)).2018;5(3): 2032-35.
21. Yashas J, Shivakumar G. Hand Gesture Recognition: A Survey. In2019 International Conference on Applied Machine Learning (ICAML) 2019 May 25 (pp. 3-8). IEEE.

INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.379

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING