IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

Hand Gesture Recognition using Media Pipe and OpenCV

Yuvraj Gupta[1], Anshu Munda[2], Shagun Malhotra[3]
UG Scholars, Computer Science & Engineering Department[1,2]
Assistant Professor, Computer Science & Engineering Department[3]
Sunder Deep Engineering College, Ghaziabad, India

Abstract: *In years people have become really interested in hand gesture recognition. They want to find ways to interact with technology that feel more natural and don't require anything. Of using keyboards and mice users can control systems with just their hand movements. This has become easier because of improvements in computer vision. Now we can build systems that can see and track hand movements in time. Tools like Media Pipe help us find hand landmarks accurately. OpenCV helps us process video efficiently. Together Media Pipe and OpenCV make it possible to build gesture recognition systems that work in time. In this paper we present a hand gesture recognition system that uses Media Pipe and OpenCV. The system watches live video tracks hand movements and recognizes gestures using techniques. Our goal is to make a solution that's easy to use and works well without needing expensive hardware. We want to create a system that uses Media Pipe for hand landmark identification and OpenCV, for video processing. This way our hand gesture recognition system can work smoothly and accurately.*

Keywords: Hand Gesture Recognition, Computer Vision, Key Point Tracking, Human-Computer Interaction, OpenCV, Media Pipe

I. INTRODUCTION

We use technology every day. The way we use it is changing. Keyboards and mice are what we use most of the time. They are not always the best way to do things especially when we need to do something without touching anything. This is why people are looking for ways to interact with technology like using hand gestures.

We use hand gestures to talk to people all the time. If computers can understand what these gestures mean it will be easier to use them. This is really useful for things, like games, virtual reality and helper technologies, where we need to be able to control things smoothly.

The system uses something called Media Pipe to look at 21 points on our hand so it can see where our fingers are and what they are doing. It uses OpenCV to take video from a webcam and look at the pictures in time. By looking at the shape of our hand the system can see what gesture we are making and turn it into something that means something using rules or basic computer learning.

One of the advantages of this method is that it is simple and easy to use. It does not need equipment and can work well in real time. The system works well in lighting conditions and with different backgrounds. It keeps accuracy with little delay.

This makes it suitable for real-life applications. For example, you can control a computer, with hand gestures. It can also help with sign language communication. Another use is creating interfaces that do not require touching. Overall, this project shows that combining Media Pipe and OpenCV can make a gesture recognition system. To make it even better future improvements could include recognizing gestures. They could also use advanced learning techniques. This would make the system more accurate and flexible.

DOI: 10.48175/IJARSCT-33765

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

II. LITERATURE REVIEW

Hand gesture recognition is a growing field in human-computer interaction. It helps people control devices with hand movements without having to touch them. This technology has uses. The combination of Media Pipe and OpenCV has made gesture recognition systems better. They provide efficient solutions that researchers and developers can use. Media Pipe, a framework developed by Google helps devices understand video input. It can identify 21 points on a person's hand. Open CV, a library for image processing works well with Media Pipe. It helps analyze video frames and recognize gestures. Together they have made gesture recognition technology more accessible. This means people do not need hardware to use it.

The basic idea behind hand gesture recognition is to capture video frames. Then it extracts information about the hands shape and movement. Finally, it classifies these movements into gestures. Unlike methods that relied on manual analysis of hand shape and colour modern systems use deep learning. This helps them learn from video data or pre-identified hand landmarks. For hand gesture recognition to work in time it must process information quickly. It should do this in, then 100 milliseconds. This ensures a user experience.

III. PROPOSED SYSTEM

The hand gesture recognition system they are talking about is supposed to be really simple and easy to use. It is made to work with things like Media Pipe and OpenCV to figure out what people are doing with their hands when they are on a video.

The system starts by taking video from a webcam using OpenCV. Then it looks at each picture to see if there is a hand in it. When it finds a hand Media Pipe finds 21 points on the hand gesture recognition system, like the fingers and the joints on the hand. These points, on the hand gesture recognition system help it understand how the hand is moving and where it is.

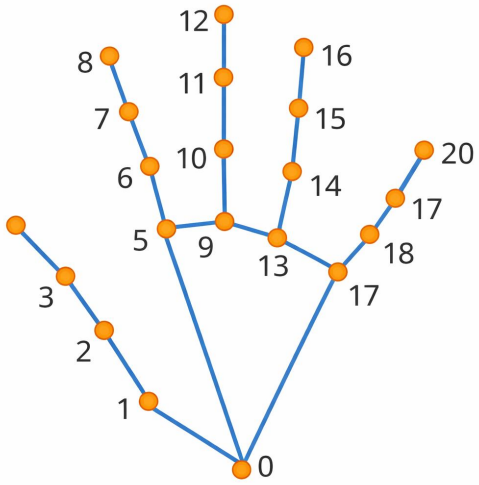


Fig 1: 21 (0-20) important points on the hand

The system looks at these points to figure out what gesture is being made. It sees which fingers are open and which are closed. It also measures how apart the fingers are. The system uses this information to match the hand movement to a gesture. Then it does what that gesture is supposed to do.

One of the good things, about this system is that it works right away. Users can interact with it easily without waiting. It does not need equipment or a lot of setups. This makes it easy for anyone to use the hand gesture system. The system is a way for people to interact with computers using hand gestures. The hand gesture system can be made better by adding more gestures or using new techniques to make it more accurate.colors which contrast well both on screen and on a black-and-white hardcopy, as shown in Fig. 1.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

IV. TYPES OF HAND GESTURE RECOGNITION

Hand gesture recognition is something that can be broken down into kinds based on how people do the gestures and how computers figure them out. The main kinds of hand gesture recognition are explained below.

1. Static Hand Gestures:

When we talk about hand gestures we are talking about gestures where our hand does not move. The computer can tell what the gesture is from one picture. For example, we can show numbers with our fingers give a thumbs-up sign or make a peace sign. These gestures are easy for the computer to recognize because they do not involve any movement, which makes them good for fast things.

2. Hand Gestures:

Dynamic hand gestures are different because they involve moving our hand. The computer has to look at pictures to understand what we are doing. For example, we can wave at someone swipe our hand or draw shapes in the air. Hand gesture recognition of gestures is more expressive but it is also harder for the computer to figure out because it has to track the movement and understand what is happening over time. Dynamic hand gestures, like these are a lot more complicated for the computer to recognize.

3. Vision-Based Gesture Recognition:

This kind of thing uses cameras to take pictures of your hand movements and figure out what you are doing by looking at the pictures. There are tools like Media Pipe and OpenCV that do this. People like to use it because it's cheap and you do not need any extra stuff.

4. Sensor-Based Gesture Recognition:

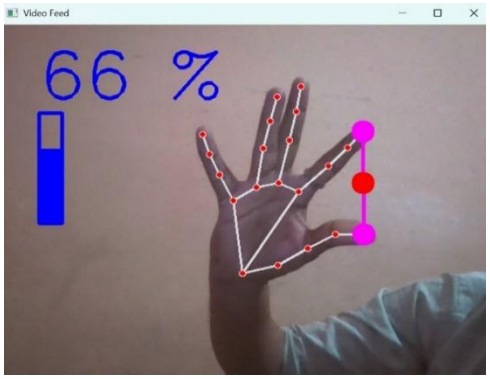
This way uses helpers like data gloves or things that can feel when you move to see what your hands are doing. These systems are usually really good at getting it right. They can be very expensive and might not be comfortable to wear every day. Vision-Based Gesture Recognition is different, from Sensor-Based Gesture Recognition because Vision-Based Gesture Recognition uses cameras and Sensor-Based Gesture Recognition uses sensors.

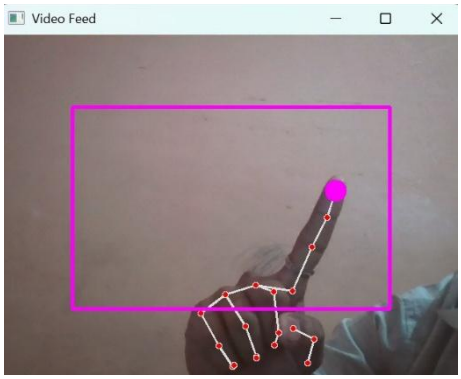
Summary

In terms gesture recognition can be:

• Static or Dynamic based on how it moves
• Vision-based or Sensor-based based on what technology it uses

Each type has its own good points. The choice depends on the application. It also depends on the cost and how accurate it needs to be.





IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

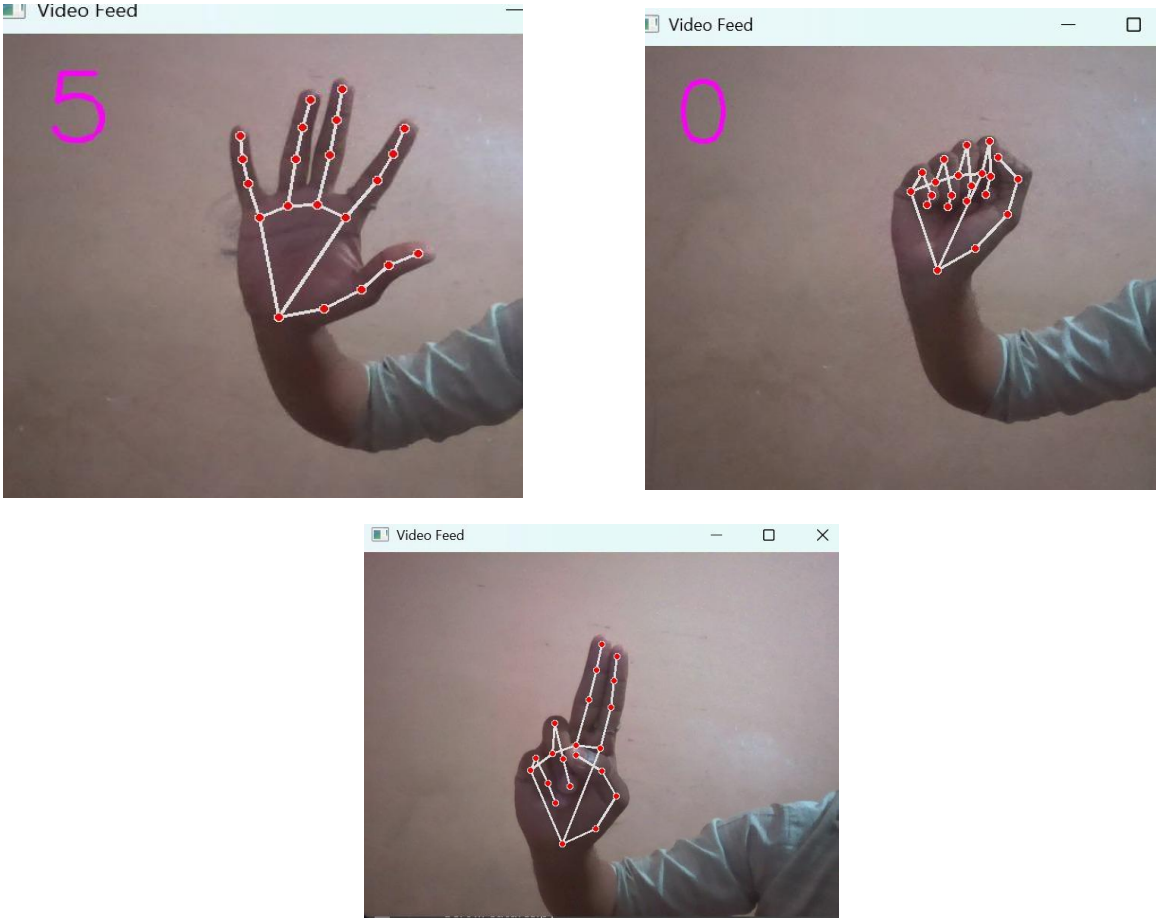


Fig 2: different hand gestures

V. METHODOLOGY

The system works in a way so it's easy to grasp and put into action. The main goal is to track hand movements with a webcam. Then it identifies gestures one step at a time using Media Pipe and OpenCV.

This way understanding and using the system is straightforward. The hand movements are captured through the webcam. Media Pipe and OpenCV are used to recognize the gestures step, by step.

1. Video Capture:

The process starts by switching on the webcam and recording video using OpenCV. We break this video into parts, which we call frames so the system can look at each one carefully.

2. Hand Detection and Tracking:

We look at each frame to see if there is a hand, in it. When we find a hand, we put marks on 21 spots, like the fingertips and the joints. The Video Capture and Hand Detection and Tracking process uses these spots to figure out the shape of the hand. How the hand is moving. The hand is what helps the system understand the movement.

3. Landmark Extraction:

The system collects the positions of 21 points on the hand after it is detected. This is, like making a hand map. The map is used to understand the gesture.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

FLOW CHART OF THE PROPOSED MODEL

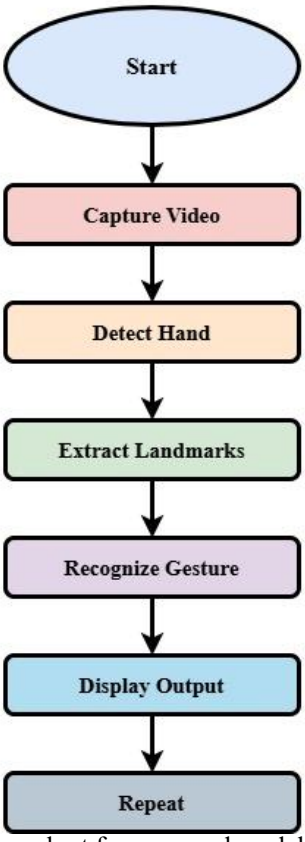


Fig 3: Flow chart for proposed model

4. Gesture Recognition:
The system then studies this hand map. It checks which fingers are open or closed and how apart they are. Based on this information it decides what gesture is being shown.

5. Output Display:
Once the gesture is recognized it is connected to an action like controlling something on the screen. The result appears away. This makes the interaction feel smooth.

6. Real-Time Processing:
All these steps happen fast and continuously. This allows the system to respond away without any delay.

VI. APPLICATION

1. Hand gesture recognition helps us interact with technology in a natural way. We can use hand movements instead of traditional input devices like keyboards and mice.

2. Human-Computer-Interaction:
When we use hand gestures, we can control the cursor, click, scroll or do actions easily. This makes interaction faster and more intuitive with hand gestures.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

3. Virtual-Reality-Gaming:
With hand gestures we can interact with environments in a real way. This makes the experience more immersive and fun with hand gestures.

4. Assistive-Technology:
Hand gesture recognition helps people with disabilities. They can. Use devices easily especially with basic sign language recognition using hand gestures.

5. Smart-Home-Control:
We can control things like lights, fans or TVs with hand gestures. This makes home automation easy to use with hand gestures.

6. Touchless-Systems:
Hand gesture recognition is useful in hospitals and public places. It helps keep things safe by minimizing physical contact, with hand gestures.

7. Education-Training:
Hand gestures can be used in learning. Students can control simulations or models with hand gestures easily.

VII. ANALYSIS

The system we are talking about does a job when we use it in real life situations. It is simple, to use. It does what we need it to do.
1. Accuracy:
The system gives us results when we make basic gestures and the room is well lit and the background is not too messy.
2. Performance:
The system works fast and we do not have to wait at all so we can interact with it right away and it feels smooth.
3. Ease-of-Implementation:
The system is really easy to set up and you do not need to buy equipment so students and developers can use it.
4. Robustness:
The system works well when everything is perfect but it does not work as well in bad light or when there is a lot of stuff in the background or when many hands are in the way.
5. Scalability:
Now the system only recognizes a few gestures but the system can be made better by adding more rules or using machine learning models to make the system recognize more gestures.
6. Future-Improvements:
We can make the system better by using techniques, like deep learning and by using better data and improving the way the system tracks things this will make the system more accurate and flexible and a better system.

VIII. RESULTS

The system was tested in time using a webcam to see how it does in everyday situations. It worked well.
In lighting the system worked great. It could track hand movements. Respond really fast which made it feel like the system was reacting to what the user was doing right away. The system is really fast. There is no delay between showing a hand gesture and getting a response from the system, which makes the hand gesture system comfortable to use without getting frustrated. The hand gesture system is very good at recognizing hand gestures, which is one of the best things, about the hand gesture system.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

The system has some problems. It does not work well in low light or when the background is too busy. The system also has trouble when people move their hands fast or when their fingers are partly hidden. This sometimes causes mistakes when the system is trying to recognize hand movements. With these small problems the system is good for simple things and it seems like it could be very useful. If we make some changes, to the system it will be even better. People can use it for real things.

XI. FUTURE SCOPE

The current hand gesture recognition system is good for tasks but it can be improved a lot. One easy way to make it better is to teach it to understand gestures. The system now only knows a basic gestures. If it could understand complex gestures, it would be really helpful, in everyday life. The hand gesture recognition system needs to recognize gestures to be more useful. It has to improve to work in real-life situations.

The system can be made smarter by using techniques like machine learning or deep learning. This helps it become more accurate and better at handling users hand shapes and environments. Another area to improve is its performance in conditions. For example, the system can be trained to work in low lighting, messy backgrounds or when parts of the hand are not clearly visible. In the future this system could be connected with technologies like reality augmented reality or smart home devices. This would let users control systems in a more natural way using just their hands. The system can also be developed for phones or small devices. This makes it more portable and accessible, for use. The system has a lot of potential to grow and become more accurate, flexible and useful in real-life applications.

X. CONCLUSION

In this paper we presented a hand gesture recognition system using Media Pipe and OpenCV. The main goal was to create a system that lets users interact with computers in a way using hand movements. This system detects and tracks hand gestures in time with good accuracy especially in normal lighting. It is fast easy to use. Does not need expensive hardware making it suitable for everyday use. Although the system works well it has some limitations, like reduced accuracy in lighting or complex backgrounds. These challenges can be improved with better techniques and further development. Hand gesture recognition can be implemented in an effective way using modern tools like Media Pipe and OpenCV. Media Pipe and OpenCV make it possible to create a system. With improvements our hand gesture recognition system has the potential to become even more reliable. It could be widely used in areas like touchless interaction, smart systems and assistive technologies. Hand gesture recognition systems like ours can help people interact with computers in a natural way. Our system is a step, towards making hand gesture recognition a technology.

AUTHORS AND AFFILIATIONS

Mr. Yuvraj Gupta is pursuing his B.Tech degree in Computer Science and Engineering from Sunder Deep Engineering College, Ghaziabad, affiliated to Dr. A.P.J. Abdul Kalam Technical University. His area of interest is Artificial Intelligence and Machine Learning and Robotics.

Mr. Anshu Munda is pursuing his B.Tech degree in Computer Science and Engineering from Sunder Deep Engineering College, Ghaziabad, affiliated to Dr. A.P.J. Abdul Kalam Technical University. His area of interest is Artificial Intelligence and Machine Learning.

Mr. Shagun Malhotra received his B.Tech degree from Guru Gobind Singh Indraprastha University, New Delhi and M.Tech degree from Maharshi Dayanand University, Rohtak. He is pursuing his PhD program from Delhi Skill & Entrepreneurship University, New Delhi. He is having a wide industrial experience of working with private as well as government organization. He has published various papers in international journals. He is now working as an Assistant Professor at Sunder Deep Engineering College, Ghaziabad, where he brings together academic expertise and a vast experience of industry. His area of interest is Artificial Intelligence and Machine Learning and IOT applications

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

ACKNOWLEDGMENT

The authors want to say thank you to Sunder Deep Engineering College and SDGI Global University for helping them and giving them the motivation they needed to finish this research work. The help and support they got from these schools was really great. It helped them a lot to finish this study.

The authors also want to thank the teachers and people who helped them with their study for being so helpful and giving them ideas and inspiration all the time they were working on this research and getting it published.

REFERENCES

[1]. Alexander, Ivan, Endra, M. Mirza, and D. Geraldo. 2025. "Computer Vision-Based Indonesian Sign Language Recognition System Using Media Pipe and SVM on Raspberry Pi." 2025 International Conference on Applied Artificial Intelligence, Data Engineering and Sciences (ICAIDES).

[2]. and, D. KAVIYA. 2025. "Open CV Based Hand Gesture Recognition for Virtual Keyboard Control System." INTERANTIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT.

[3]. Bansal, Vidhi, Sandali Sinha, R. Astya, Anil Kumar Sagar, and K. Sahu. 2025. "A Hybrid Approach to Sign Language Recognition Using Media Pipe and Machine Learning." 2025 IEEE International Students" Conference on Electrical, Electronics and Computer Science (SCEECS).

[4]. Chang, Yaoyu, and Jiayin Song. 2025. "Research on Human-Computer Interaction Technology Based on Media pipe Contactless Gesture Recognition." 2025 IEEE 7th International Conference on Power, Intelligent Computing and Systems (ICPICS).

[5]. Devika, Anushree Raj, P. O, and Khadersab Adamsab. 2025. "AI-Powered Vision System Using OpenCV and Media Pipe for Real-Time Silent Emergency Hand Gesture Recognition in Privacy-Constrained Spaces for Women's Safety." 2025 International Conference on Intelligent Systems and Pioneering Innovations in Robotics and Electric Mobility (INSPIRE).

[6]. Dhabe, Priyadarshini, Rutuja Kulkarni, Anchit Chedge, Hana Khan, Sanyog Jadhav, and Shreya Dighe. 2025. "GestureX: A Real-Time Hand Gesture Recognition System for Intuitive Human-Computer Interaction." 2025 International Conference on Computing Technologies & Data Communication (ICCTDC).

[7]. Djuwitaningrum, Endang Ratnawati, and Dimas Pangestu. 2025. "Implementation of a Virtual Mouse Based on Hand Gesture Recognition Using Media Pipe and OpenCV." Jurnal Ilmu Pengetahuan Dan Teknologi.

[8]. Guia, Jayson T., Joseph Michael E. Aramil, John Carlo Torres, Alice M. Lacorte, Carolyn Matira, Alden Nathan Go, Joel S. Enriquez, and J. P. Calvez. 2025. "Euclidean Distance-Based Hand Gesture Recognition for Virtual Mouse Control in Human-Computer Interaction." International Conference on Emerging Technological Trends.

[9]. katkar, Pratik, and Dr. Manisha Kshirsagar. 2025. "Motion-Based Gesture Recognition for Emoji Communication in Deaf and Mute Individuals." International Journal for Sciences and Technology.

[10]. Kumari, S., Alok Kushwaha, Sunidhi Singh, Reddypally Saikomal, and Agrawal Kishor. 2025. "Hand Gesture Recognizer." International Journal for Sciences and Technology.

[11]. Patil, S. 2025. "Real-Time Sign Language & Gesture Recognition for Speech-Impaired Individuals." International Journal for Research in Applied Science and Engineering Technology.

[12]. Pawar, Prof. J. S., Swapnil Dhagdi, Om Bande, Vighnesh Belkar, and Omprakash Bedage. 2025. "Hand Gesture Recognition in Human-Computer Interaction: A Comparative Review of Sensor, Vision, and Deep Learning Approaches." INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT.

[13]. Putri, Risma Dwi Tjutarjo, Lasmadi Lasmadi, Anggraini Kusumaningrum, Riani Nurdin, and Yenni Astuti. 2025. "Hand Gesture-Based Human-Computer Interaction Using Media Pipe and OpenCV." AVITEC.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 12, April 2026
Impact Factor: 8.2

[14]. Rizaldi, M., Rudi Heriansyah, Nazori Suhandi, and Korespondensi. 2025. "Pengenalan Gerakan Tangan Untuk Kontrol Slide Presentasi Menggunakan Framework Media pipe, OpenCV, Dan Model LSTM." Jurnal Publikasi Teknik Informatika.

[15]. Yep, Yong Kin, Y. Goh, Tsung Heng Chiew, Kar Mun Chin, Jia Jan Ong, and K. Eu. 2025. "AI-Driven Hand Gesture Recognition for Robotic Arm Control." 2025 5th International Conference on Artificial Intelligence, Robotics, and Communication (ICAIRC).