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Recognition and Automation System for Hand Gestures

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Abstract

Our efforts were mainly focused to have machine and software interaction during this project. We were determined to build a small rotor car with miniature components and have it establish connection with our laptop through several media. Software is coded in python and detects hand gestures and our attempt was to amplify these gestures in the form of signals which are discussed later. The goal was to achieve mechanical movement of any nature or mechanical response using a non-mechanical approach. In this project we drove a small mechanical rotor car using various small commands generated by our hand gestures hence achieving our objective and supporting our research. We discovered through this project that a machine – software interaction is possible and can be amplified beyond imagination. In this project let us explore one simple but fascinating possibility of such phenomenon.

INTRODUCTION

Our aim is to establish a connection between mechanical devices and software to and to operate a small motor car using hand gesture recognition algorithm. There are several parts in our society which are not able to access certain privileges normally through physical touch. Handicapped people are not able to drive a car, or turn on or off lights if they don't have needed parts or may have been paralyzed. In order to enhance and improve life experience we are attempting to build a bridge between electronic devices and software interfaces to explore possibilities for these people. Some situations require hands free interaction with the electronic appliances like quarantine situations, we will just test this phenomenon on a smaller scale and prove that such technology bridge exists and can be used for greater good of society.

We are using hand gestures to send data to an Arduino Uno chip using the PyFimata library, set conditions based on the gestures that the code reads, and further use these gestures to operate robots (by extracting the important points from the Python library). Left tilt, right tilt, forward tilt, backward tilt and no tilt are the hand motions used to drive the robot in a left, right, forward, backward and stop respectively. With this capability, the robot can be utilised as a wheelchair or other object by using hand gestures, which offers a more schematic method of directing it. With the use of wireless connection, it is simpler to communicate with the robot in a user friendly manner because human hand motions are natural. The robot's movement depends upon the hand gestures. The objective of this project is to build a wireless bridge between hand gesture and a robot using an Arduino Uno.

LITERATURE REVIEW

A real-time system and algorithm to recognize hand gestures can be created using a number of earlier studies on hand gesture identification as a guide. There are a number of techniques that employ various strategies to use various algorithms for a variety of purposes. These Human-Computer interactions (HCI) methods vary from simple keyboard inputs to advanced vision-based gesture recognition systems. Hand gesture recognition is one of the most exciting and important HCI methods. Hand gesture recognition opens up a very interesting research domain as it can be used to enable communication for many applications such as mobile phones, smart TVs, robot controls, medical devices, access control systems, smart vehicles, and so on [1][2].

The author proposed the the vision based static hand gesture recognition techniques [5]. The work presented used Support Vector Machine (SVM), Artificial Neural Network, Naive Bayes and K-Nearest Neighbor (K-NN) classifiers as the training methods to recognize the features extracted. In contrast, another author proposed the approach which gives best classification accuracy was achieved using Euclidean distance and Eigen vector, but this result is for a very small dataset, and the best result was a dataset containing nearly 720 images that used Support vector machine for classification of images; also, using Artificial Neural Network provided an accuracy of 89.48% [3][14].

The author presents the scenario; vision-based hand gesture recognition has become a highly emerging research area for the purpose of human computer interaction. Such recognition systems are deployed to serve as a replacement for the commonly used human-machine interactive devices such as keyboard, mouse, joystick etc. in real world situations [6]. One of the authors implemented two distinct methods of vision-based hand gesture detection and one method based on data from a glove. These are methods for detecting both static and live hand gestures. The glove used in the data glove-based approach featured five flex sensors. According to the results, the vision-based technique was more dependable and steady than the data glove-based technique. Gestures of the hands were determined by analyzing the contours that the picture segmentation had captured. This might be utilized with a cutting-edge data glove called YoBu to gather information for gesture detection and display the results in the form of robot movement [9].

The author proposed approach which uses a novel skin color segmentation technique to control mouse movement. The system uses morphological operations like structuring elements and blob counting. their system can remove other skin like objects from the background [12]. The other author implemented the approach consists of a gesture extraction phase followed by a gesture recognition phase. An image gesture database is collected through the application and used as training information to be used in the gesture recognition stage. They provide two different translation paradigms: 1) English characters (alphabet) and 2) complete words or phrases. In the method to recognize individual characters, the hand gesture image is processed by combining image segmentation and edge detection to extract morphological information and then processed by the gesture detection stage that recognizes the corresponding alphabet letter [13].

The surface electromyography (sEMG) sensors with wearable hand gesture devices were the most acquisition tool used in the work studied, also Artificial Neural Network (ANN) was the most applied classifier, the most popular application was using hand gestures for sign language, the dominant environmental surrounding factor that affected the accuracy was the background color, and finally the problem of overfitting in the datasets was highly experienced [7][8][11].

A hand gesture-based interface for commanding a flexible robot is presented by the author. Here, a camera was utilized to track the people and gather information about the robot's movement. However, it enables the robot's tracing capabilities and displays automated output [10]. Human gesture recognition was presented and shown by the author as one of the primary problems with the hand gesture recognition framework. to obtain precise and suitable values for hand movement recognition that can communicate with PC programmes and automated robot applications [4].

The results of Islam et al. (2017) provide a substantial contribution to the advancement of real-time gesture recognition software. The trade-offs of deep learning-based models and conventional classifiers are fundamentally understood thanks to their comparison of machine learning algorithms. Their focus on ASL-based recognition also fits with the larger goal of using computer vision technologies to improve accessibility.

The study's real-time processing and classification methodology is applicable to our

System and can be used as a model to maximize the accuracy of gesture detection through the use of OpenCV, MediaPipe, and deep learning methods. Our technology can guarantee high precision in hand gesture detection by utilizing similar methodologies, which will improve the user experience overall [1].

For gesture-controlled automation systems, Parvini and Shahabi's (2017) findings are extremely pertinent. By increasing robustness against environmental changes like shifting lighting or background clutter, their biomechanical method enhances vision-based procedures. The study's emphasis on motion dynamics is in line with robotic control applications' requirement for real-time processing.

A hybrid gesture recognition system that integrates biomechanical limitations with vision-based detection (using OpenCV and MediaPipe) should greatly improve accuracy and responsiveness in the context of our study. Our system can accomplish smoother and more natural gesture-based robotic control by integrating dynamic tracking algorithms, which will improve user intuitiveness [14].

The results of Bretzner et al. (2002) offer important information for creating reliable models for hand gesture recognition. Their multi-scale color feature method improves gesture segmentation and classification and is in line with contemporary deep learning-based vision techniques. Furthermore, gesture-driven robotic systems can benefit from the incorporation of particle filtering to provide stability and ongoing tracking in changing settings.

The accuracy of gesture identification in our system could be greatly increased by combining multi-scale feature extraction with real-time tracking algorithms like particle filtering. Our Arduino-controlled robotic car can perform better thanks to this method, which guarantees responsive and fluid gesture-based navigation. Furthermore, the study's suggested hierarchical model can be modified to categorize increasingly intricate hand motions, increasing the system's adaptability and versatility [12].

The discoveries of Zhihan Lv et al. (2015) give basic bits of knowledge into touchless interaction advances utilizing wearable vision-based gadgets. Their approach adjusts with advanced AI-driven signal acknowledgment frameworks, which depend on computer vision and machine learning calculations to upgrade real-time interaction.

In our Framework, consolidating vision-based touch-free interaction can make strides gesture-controlled mechanical frameworks by dispensing with the require for physical controllers. Executing real-time movement following and profundity estimation strategies from this think about might altogether upgrade the responsiveness and accuracy of hand gesture-based route frameworks in mechanical technology, savvy homes, and assistive devices.[6]

The consider by M. Yasen and S. Jusoh (2019) highlights critical progressions in hand signal acknowledgment, classifying procedures into vision-based and sensor-based approaches. Vision-based strategies, utilizing cameras and profound learning, empower non-intrusive interaction but confront challenges such as lighting varieties and foundation commotion, influencing precision. On the other hand, sensor-based strategies, counting EMG and accelerometers, offer higher exactness but require wearable equipment, making them less user-friendly. The think about finds that machine learning calculations like CNNs, SVMs, and HMMs have made strides motion classification, however real-time preparing remains a challenge due to computational limitations. Addi-tionally, signal likeness frequently leads to misclassification, requiring progressed include extraction and division methods. The investigate underscores the wide appropriateness of signal acknowledgment in assistive innovation, shrewd domestic computerization, VR/AR, and restorative recovery. Be that as it may, crevices stay, especially within the need of standardized datasets, making it troublesome to generalize models over diverse client socioeconomics. Moreover, foundation complexity and lighting irregularities proceed to influence acknowledgment exactness in real-world situations. The versatility of AI-driven models for real-time motion preparing in low-power gadgets remains an issue, with motion acknowledgment in energetic and swarmed settings still requiring optimization. The ponder proposes that future investigate ought to investigate crossover models combining vision and sensor information, as well as lightweight profound learning models that can be conveyed proficiently in wearable and versatile applications. Finally, coordination multi-modal inputs, such as combining discourse and signals, remains an underexplored zone that seem encourage upgrade gesture-based human-computer interaction [16].

The think about by H. Cooper, B. Holt, and R. Bowden (2011) gives an in-depth ex-ploration of sign dialect acknowledgment (SLR) utilizing computer vision and machine learning procedures. The inquire about emphasizes that sign dialect acknowledgment may be a complex issue due to the combination of hand developments, facial expressions, and body pose, which all contribute to meaning. The consider highlights that vision-based acknowledgment frameworks are broadly utilized for programmed sign dialect interpretation, leveraging highlight extraction methods to distinguish hand shape, direction, and movement flow. In any case, real-time acknowledgment remains a challenge due to tall changeability in sign motions over distinctive clients and situations. The investigate illustrates that Covered up Markov Models (HMMs) and Energetic Time Distorting (DTW) are viable in classifying successive hand signals, however they battle with nonstop sign acknowledgment in characteristic discussions.

In spite of headways, the consider recognizes a few investigate crevices. One major issue is the need of expansive, differing datasets for preparing strong SLR models, constraining general-izability over distinctive sign dialects. Moreover, impediment and foundation complexity regularly diminish the system's precision, making signal division diffi-cult in real-world settings. The integration of facial expressions and hand motions remains immature, in spite of its significance in completely deciphering sign dialect communication. Besides, adaptability of profound learning models for real-time preparing in low-power gadgets is still a challenge, particularly for wearable applications. The ponder recommends that cross breed approaches, combining vision-based models with sensor-based information, might upgrade precision and flexibility. Future research should focus on profound learning-based real-time sign acknowledgment, making strides multi-modal combination procedures, and making versatile models able of dealing with varieties in sign dialect structure and client behavior [17].

The think about by A. Wadhawan and P. Kumar (2021) gives a orderly survey of sign dialect acknowledgment (SLR) frameworks, highlighting progressions over the past decade. Whereas noteworthy advance has been made, a few basic inquire about holes stay within the field of gesture-based communication frameworks.

One of the essential inquire about crevices is the need of a all inclusive, large-scale dataset cov-ering different sign dialects. Most existing SLR models are prepared on little, region-specific datasets, making it troublesome to create generalized acknowledgment mod-els that work over distinctive dialects and lingos. Also, persistent sign dialect acknowledgment (CSLR) remains a challenge, as current models battle with motion division, move location, and co-articulation impacts in normal sign dialect discussions.

Another key restriction is natural affectability in vision-based frameworks, where lighting varieties, occlusions, and complex foundations altogether diminish acknowledgment exactness. Whereas profound learning procedures such as CNNs, RNNs, and Transformer models have progressed classification, their tall computational taken a toll makes real-time sending challenging, especially on low-power gadgets and implanted frameworks. The consider too highlights the need of integration between facial expressions and hand motions, which is significant for exact sign dialect interpre-tation.

Besides, multi-modal combination approaches, combining vision-based and sensor-based procedures (e.g., EMG, accelerometers, and flex sensors), are still in early stages of inquire about, with restricted real-world usage. The nonappearance of stand-ardized assessment measurements over distinctive SLR considers moreover prevents coordinate per-formance comparisons between models[18].

The think about by Anshal J, Heidy S, and Emmanuel A. (2017) presents an edge detec-tion and cross-correlation-based approach for American Sign Dialect (ASL) interpretation, pointing to make strides precision in signal acknowledgment frameworks. The re-search highlights that edge location methods, such as Canny and Sobel channels, essentially upgrade hand signal division by diminishing foundation commotion and moving forward boundary discovery. This permits for superior motion classification in vision-based ASL acknowledgment frameworks.

The cross-correlation strategy is utilized to coordinate extricated hand motions with predefined ASL images, guaranteeing higher acknowledgment precision compared to con-ventional template-matching approaches. The framework is able of recognizing inactive hand signs with tall accuracy, making it appropriate for real-time ASL interpretation applications. Besides, the think about illustrates that edge discovery calculations are successful in dealing with lighting varieties and complex foundations, tending to common challenges in vision-based sign dialect acknowledgment.

In any case, the ponder too distinguishes key confinements in real-time ASL interpretation. One major challenge is that the framework basically centers on inactive motions, missing the capacity to prepare energetic, persistent sign dialect groupings. Also, hand introduction varieties and occlusions decrease classification precision, driving to potential misinterpretations. The inquire about too emphasizes the require for a bigger, differing dataset to make strides demonstrate generalization over diverse clients and environ-ments.

The discoveries propose that joining edge location with profound learning models may advance improve acknowledgment precision, empowering more vigorous real-time ASL interpretation frameworks. Future progressions in motion following, grouping modeling, and multi-modal learning (such as consolidating facial expressions and movement following) may address the confinements distinguished in this ponder[13]. The consider by Mostafa Karbasi, Zeeshan Bhatti, Parham Nooral-ishahi, Asadullah Shah, and Seyed Mohammad Reza Mazloom-nezhad (2017) investigates real-time hand discovery utilizing profundity pictures and remove estimation with a Kinect camera. The inquire about centers on making strides motion acknowledgment precision by leveraging depth-sensing innovation, which gives more strong hand division compared to conventional RGB-based discovery strategies.

The discoveries highlight that profundity pictures captured by Kinect cameras empower way better separation between closer view and foundation, decreasing blunders caused by lighting varieties and cluttered situations. The ponder proposes a distance-based sifting ap-proach, where hand locales are extricated by measuring their nearness to the camera. This strategy upgrades motion acknowledgment strength by disposing of foundation clamor and progressing real-time following execution.

One critical advantage of the approach is its capacity to handle vary-ing hand sizes and occlusions by altering separate limits dynam-ically. The framework is competent of identifying both inactive and energetic signals with tall accuracy, making it appropriate for intelligently appli-cations in virtual reality (VR), gaming, and assistive innovation.

Be that as it may, the consider distinguishes certain impediments and investigate crevices. Whereas depth-based discovery makes strides division, the precision diminishes when hands cover or when numerous clients are show within the outline. Also, Kinect cameras have restrictions in open air situations due to infrared impedances, influencing the system's ap-plicability in non-controlled settings. The think about too emphasizes the require for coordination machine learning models to improve motion classification past straightforward distance-based strategies.

Future investigate ought to investigate combining profundity imaging with AI-driven highlight extraction strategies, such as Convolutional Neural Systems (CNNs) and Repetitive Neural Systems (RNNs), to im-prove signal acknowledgment exactness. Furthermore, multi-camera set-ups and sensor combination might encourage improve discovery in real-world applications, making hand motion acknowledgment more versatile and adaptable for different client intuitive.

Methodology

There are various steps involved in this system from detecting hand gestures to control robot.

Hand Gesture Recognition: We are utilizing the Hands model from Mediapipe solutions together with the OpenCV and mediapipe tools in Python to detect the motions. Google's open-source Mediapipe technology is used for processing media. It is platform-friendly or cross-platform, as we might say. Cross-platform refers to being able to run on several platforms, including Android, iOS, and the web. A Python package called OpenCV is created specifically to address computer vision issues. Numerous object-oriented programming languages, including C++, Python, Java, etc., are supported by OpenCV. It works with a variety of operating systems, including Windows, Linux, and MacOS.

Establishing interface between Python IDE and Aurdino IDE using pyFirmata: The Firmata intermediate protocol, which by default uses a serial port, connects an embedded device to a host computer. Along with the Arduino IDE's support for Firmata, the Arduino platform serves as the industry standard reference implementation for Firmata. We needed a module which declared all the pins and its functions to Arduino. In order to do that we create a microcontroller module. In python we import the library using "import pyfirmata as py" also we are going to define what port our arduino is connected to, that can be checked in the device managers in arduino IDE then we pass that port number to Arduino method which is only for Arduino Uno.

In When the software is executed, webcam is opened with the help of OpenCV where the user have to give gestures like rock, paper, scissors. Now the during this activity the small motor vehicle is connected with a data cable to the laptop for allowing data transfer or commands from pc to arduino chips. We have coded rock gesture for forward, paper gesture for backwards, scissors gesture for left and yo gesture for right. When these gestures are given and detected by the software it sends the commands to arduino and the motor vehicle moves accordingly to the software.

Electronics Hardware Implementation: We are going to start it off with hardware implementation and construction. All the five different approaches, we implemented the Machine Learning Approach particularly in this project as it is most efficient and makes our arduino uno integration easier.

The following figure (Fig. 1) shows how the MediaPipe Hands module returns the coordinates of 20 points on fingers.

Fig.1. *MediaPipe Hands*

STEPS (Motor Car Construction)

1. We are using a metal mouting board to make a base chasis for our motor car which will accommodate both Arduino Uno and Motor Driver Module and our both motor wheels.
2. We are going to connect the two motor wheels to the L298N motor driver module which is going to decide the speed and direction of motor rotation.
3. After that we will connect motor driver module needed ports to the arduinouno ports to take commands from arduino.
4. Connections were made as shown in the following schematic. We pasted the L298N motor driver module at the bottom of the metal plate along with the two motor wheels and we pasted a 12V battery supply at the top in our case we are going to give the power output from outside as an adapter. We pasted Arduinouno at the top of the motor.

The figure (Fig. 2) illustrates the construction of the motor car, with the details provided as follows:

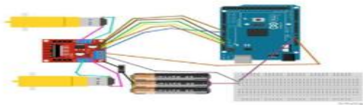

Fig.2. Motor CAR Construction

The following figure (Fig. 3) presents the hardware model we developed for our research.

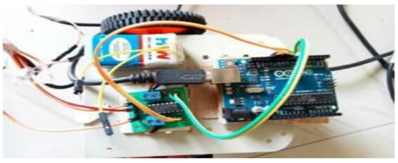

Fig.3. Hardware Model

STEPS (Arduino Uno Connection and Code):

1. Arduino Uno is connected with an USB port cable to the laptop where we are going to upload the code through Arduino IDE.
2. We are using firmata sketch in Arduino IDE in order to integrate it with python pyfirmata interface so that we can run our python code and use Arduino with it instead of coding in arudino itself. It makes the job as well as task easier.
3. We start Arduino IDE and we go to examples and then we go to firmata from there we go to StandardFirmata Sketch so that we can flash our arduinouno and make our arduino understand pyfirmata program.
4. Select the USB port to which your arduinouno is connected.
5. After that we uploaded that firmata sketch into our arduinouno model. In this way we flashed our arduinouno chipset.
   Now our arduinouno is set for pyfirmata python interface program. We can run our python program to manipulate the arduinouno according to our needs

Technology

Through the use of Human Gesture Recognition technology, a web camera can interpret human gestures and transmit the information to a computer for use as input and device control. We analysis the technique as a input from camera then tracking a hand and segmentation so that we get a exact gesture of a hand, feature extraction and then gesture recognition. For that we are using OpenCV, Mediapipe and some libraries of python.

OpenCV: The computer vision algorithm known as OpenCV (Open-source computer vision) is frequently used for machine learning, image processing, and picture modification. In our project we are recognizing the gesture of human hand.

MediaPipe: The MediaPipe Framework is used to create machine learning pipelines for processing time-series of data, such as video, audio, and other types of data. The Framework is compatible with numerous operating systems and embedded devices, including desktop, laptop, iOS, Android, Raspberry Pi, and Jetson Nano [15].

Here, for gesture recognition and proved as a palm we used MediaPipe. It uses high-fidelity hand and finger tracking technology and machine learning. Support Vector Machines (SVM) and the Histogram of Oriented Gradient are used in the technique for recognizing human gestures (HOG). The CNN model is also used to categorize gestures

Implementation

In this project we recognized hand gesture using web cam and detect the hand gesture using some python libraries such as OpenCV, MediaPipe etc. It recognized the palm and count fingers thus gesture input generated. Using hand gestures i.e. the important concepts from the Python library are extracted, conditions are made based on the gestures that the code reads, data is sent to the Arduino using the PyFirmata library, and the gestures are then used to drive the robot. Here the propose of the project an Arduino based interaction tool using Machine Learning Python approach to control robot (small vehicle, electronic devices etc.). It allowing the users to control motor based car with gestures, similar way in given flow chart using web cam generate the gesture input then goes to sensing chip, data processed and then gesture segmentation takes place and recognized as a output such as the motion of robot (small car) right tilt, left tilt, forward tilt, backward tilt, and no tilt, respectively, are used to move the robot in a left-to-right direction, forward, backward, and to halt it. Our quantitative evaluation findings demonstrate that our system accurately recognizes and controls car movement within a suitable working range and achieves high hand gesture recognition accuracy for a fluid user experience.
The figure below (Fig. 4) illustrates the entire working process, detailing the flow from input to output. It shows how the system processes the input data, performs necessary operations, and generates the final output, providing a clear overview of each step involved.

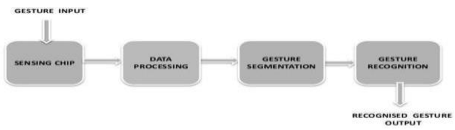

Fig.4. Input output Implementation

The following figures 5, 6, 7 and 8 depict various gestures that were tested using our algorithm. These examples demonstrate the algorithm's ability to recognize and interpret different hand movements, showcasing its effectiveness in gesture detection and classification. Each figure highlights a distinct gesture, providing visual evidence of the testing process and results

Fig.5. Recognized thumbs up gestures of the hand and verified as the thumbs up signal.

Fig.6. Recognized rock gestures of the hand and verified as the rock signal.

Fig.7. Recognized fist gestures of the hand and verified as the fist signal.

Fig.8. Recognized stop gestures of the hand and verified as the stop signal

Thus according conditions set in arduino , when the following gestures are given in software corresponding moving commands are given to arduino chip and the motor moves accordingly establishing a connection.

Result Analysis

After giving rock gesture the car moves forward, and after giving all other gestures the motor moves efficiently in set directions. There was no delay between the gesture input and mechanical output. Software worked flawlessly and the detection of hand gestures was accurate.

Conclusion

Gesture recognition technology is the tipping point, and more smart devices will become a part of our daily life in the future. It enables us to seamlessly manage non-touchable technological gadgets in order to build a hybrid reality that is highly interactive, fully immersive, and versatile. The technology has several uses in a variety of fields that are further changing human-computer interaction. In this project our propose an Arduino based interaction tool using Machine Learning Python approach to control robot (small vehicle, electronic devices etc.), For the system, we created a pipeline for information flow that consisting of hardware

(Arduino chip, L298N motor driven model, webcam, pc/laptop) and software(Python, Arduino IDE, Jupyter Notebook, Anaconda Distribution Navigator) allowing the users to allowing the users to control motor based car with gestures. We built a gesture detection model, which can jointly detect hand gesture in the view and control target devices. Our quantitative evaluation findings demonstrate that our system accurately recognises and controls car movement within a suitable working range and achieves high hand gesture recognition accuracy for a fluid user experience.
It's actually a completely integrated, extremely sophisticated technology that calls for employees with specific talents and suitable experience in order to guarantee positive outcomes. We successfully established bridge network between a device and a software. This interaction is based on gestures and a virtual panel, and it may be scaled to match future interface needs. We want to increase the tool's ability to communicate with more sophisticated systems, like industrial manipulators, consumer robots, and military systems.

References

MdMohiminul Islam, Sarah Siddiqua, and JawataAfnan. “Real time hand gesture recognition using different algorithms based on american sign language”, International conference on Imaging, Vision & Pattern Recognition (ICIVPR), 2017 IEEE International Conference on, pages 1–6. IEEE, 2017.

Salunke TP, Bharkad SD. 2017. “Power point control using hand gesture recognition based on hog feature extraction and K-NN classification”, International conference on computing methodologies and communication. Piscataway. IEEE. 1151-1155.

Ivan Laptev, Marcin Marszalek, Cordelia Schmid, and Benjamin Rozenfeld “Learning realistic human actions from movies”, International conference on Computer Vision and Pattern Recognition, 2008 CVPR 2008 IEEE Conference on, pages 1–8. IEEE, 2008.

Rafiqul ZK, Noor AI, “Hand gesture recognition: a literature review”, International Journal of Artificial Intelligence & Applications 3:161-174, 2012

Weiguo Z, Ananyaaet. al., Yun-Hui L, “Real-time implementation of vision-based unmarked static hand gesture recognition with neural networks based on FPGAs”, International conference on robotics and biomimetics ROBIO. Piscataway. IEEE. 1026-1031, 2017

ZhihanLv, Shengzhong Feng, Liangbing Feng, and Haibo Li “Extending touch-less interaction on vision based wearable device”. International conference on Virtual Reality (VR), 2015 IEEE, pages 231–232. IEEE, 2015.