Review Article

Gestures Controlled Home Automation using Deep Learning: A Review

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Abstract

This paper presents the review of the studies carried out on the application using computer vision for hand gesture recognition. Hand gestures can be used to operate the electronic devices. Therefore, it is very much essential to review on the scientific studies whose aim is to develop a technique to achieve more precise and faster sign language recognition system for plain and cluttered backgrounds with different humans to help speech and hearing impaired in their life, robot control, human–computer interaction (HCI), home automation and medical fields. The objective of this paper is to give an overall literature review of the work done related to identify the current technology and methodology used in hand gesture recognition as well as home automation system. This paper mainly describes various images or vision based sign language recognition system comprising pre-processing, feature extraction and classification. The system conversion of sign language to text. The recognized text can be sent to the control model. The gesture based automation communicates directly with control model to control home appliances.

Keywords: Gesture Recognition, Image Classification, Deep Learning, Home Appliances

1. Introduction

Now a day, the scope for hand gestures has been increased for interaction with consumer electronics and mobile devices. The objective of the home automation system is to create a system that can manage home appliances using any one of the two assigned methods:

1. Gesture-based   2. Web-based.

Disabled or old aged people who can't walk require an effortless way of accessing things around them, which must be served systematically and efficiently. This idea integrates automation with technology. Traditional home automation systems are not suitable for aging populations or disable persons. It's for those who cannot perform basic activities efficiently. Home automation systems are used to control home appliances through remote control. Web-based automation and gesture-based automation provides a comfort to those people who are physically unable for efficiently performing the day-to-day tasks.

Home automation or domestics is building automation for a home, called a smart home or smart house. A home automation system will control lighting, climate, entertainment systems, and appliances.

It may also include home security such as access control and alarm systems. When connected with the Internet, Home devices are an important constituent of the Internet of Things. Hand Gesture Recognition System is a branch of Human Computer Interaction in which Human hand gestures are recognized by the computer system and then perform a pre-defined task as per the application for controlling software as well as hardware. As we know, the vision-based technology of hand gesture recognition is an important part of human-computer interaction (HCI). In the last decades, keyboard and mouse play a significant role in human computer interaction. However, owing to the rapid development of hardware and software, new types of HCI methods have been required. In particular, technologies such as speech recognition and gesture recognition receive great attention in the field of HCI. Being able to interact with the system naturally is becoming ever more important in many fields of Human Computer Interaction.

Hand gestures offer an inspiring field of research because they can facilitate communication and provide a natural means of interaction that can be used across a variety of applications. Previously, hand gesture recognition was achieved with wearable sensors attached directly to the hand with gloves. These sensors detected a physical response according to hand movements or finger bending. The data collected were then processed using a computer connected to the glove with wire. This system of glove-based sensor could be

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made portable by using a sensor attached to a microcontroller. Home automation not only refers to reduce human efforts, but also energy efficiency and time saving. We would develop an authentication to the system for an authorized person to access home appliances. The device with low cost and scalable to less modification to the core is much important

1.1 Motivation

It's still a challenge to make interaction between humans, computers, and various tools as natural as possible. Our goal is to make human-computer connection feel as natural as human-to-human interaction. Human existence is made easier by gestures, which are also of tremendous assistance to physically challenged and elderly individuals.

1.2 Need

One of our system's main key goals is to make life easier for persons with disabilities and the elderly. In these coronas situation, it also promotes safety. It enables the use of contactless equipment in public spaces, assuring the safety of those who use it. Light sensors and smart thermostats can also be used to achieve efficient energy usage. Along with these benefits, the primary purpose of home automation is to give users both comfort and peace of mind.

1.3 Applications

- Our system is aimed at providing an environment that ensures the automation of specific tasks that is controlling the electrical appliances using gestures for the Disabled People (Deaf, Dumb, and Blind) and normal people.
- Normal people use sign language to communicate in daily life that consists of gestures instead of sound. So our system provides ease of accessing appliances using gestures.
- This project can be used in offices and industries.
- Home automation overcomes situations where normal cabling is difficult or financially impractical.
- It can be used in areas where short-distance communication is required.
- Managing all of your home devices from one place.

2. Literature Review

Following is the literature review of some papers giving more information about their contribution in Home automation appliances using deep learning.

Some researchers doing their work in hand gesture analysis.

Jayashree Katti, et al. (2021) covered a review to make human life easier and more straight forward. Hand gestures can be used to operate electronics. This will also be useful in the current Covid-19 pandemic situation, where social distance is essential and contact-free appliances provide an added benefit in public spaces. Hand gestures are the most ubiquitous and important ways of communication in modern society. They can assist in the development of secure and comfortable user interfaces for a variety of applications. Color and depth cameras have been used in several computer vision algorithms for hand gesture identification, but effective classification of movements from different people remains a challenge.

Akanksha Kulkarni, et al. (2021) had describes the CNN model in his paper to define gesture and control devices using particular gestures. Gesture recognition technology will be easy, powerful and secure in this covid-19 pandemic situation.

Abdullah Mujahid, et al. (2021) study was aimed to noticed on gestures can help people with certain disabilities in communicating with other people. This paper proposes a lightweight model based on YOLO (You Only Look Once) v3 and DarkNet-53 convolutional neural networks for gesture recognition without additional preprocessing, image filtering, and enhancement of images. The proposed model achieved high accuracy even in a complex environment, and it successfully detected gestures even in low-resolution picture mode.The proposed model was evaluated on a labeled dataset of hand gestures in both Pascal VOC and YOLO format. We achieved better results by extracting features from the hand and recognized hand gestures of our proposed YOLOv3 based model with accuracy, precision, recall, and an F-1 score of 97.68, 94.88, 98.66, and 96.70%, respectively. Further, we compared our model with Single Shot Detector (SSD) and Visual Geometry Group (VGG16), which achieved an accuracy between 82 and85%. The trained model can be used for real-time detection, both for static hand images and dynamic gestures recorded on a video.

Uma N M, et al. (2021) has proposed his work on a new approach that recognizes the hand gesture based on Indian Sign Language and convert them into text and speech output. This system uses the vision-based technique where the hand gestures and facial expressions are captured using web-camera and the various technologies. The captured images are processed with image processing, and classified with neural network, Open CV to recognize the hand gesture and facial expressions and convert it into text and speech using microcontroller based hardware (raspberry pi).

Ninad Kheratkar, et al. (2020) have a discuss a Home Automation model is designed to provide ease of control of home appliances, using an android application. The elderly and physically challenged people can perform their day-to-day activities efficiently. In previous methods, accelerometers are used to monitor the activity, which are accurate but are not flexible and portable. The proposed system detects the gestures given as input by the user and controls the home appliance. The client interface is responsible for capturing the input gesture from the user, using an android application and uploading it on the raspberry pi

server. Raspberry pi acts as an important preprocessor. Backend Processing involves image preprocessing, training the CNN model, and prediction of image class category of input gesture image. Based on this predicted class of image, the respectively assigned action takes place at the home interface.

Dr. Yeresime Suresh, et al. (2020) focused on the human beings communicate with each other using words of different spoken languages, but what will happen if a person is deaf/dumb and not able to hear or speak. The deaf/dumb people need to communicate using a certain sign language. As sign language is not understandable by everyone, a translator is needed to make up communication between normal and deaf/dumb people. Practically, translators are not available all the time hence a beneficial impact on the social lives of these hearing/speech disabled people can be brought by a system that recognizes hand gestures and performs the task same as translators. The propound system "Mudrakshara" is an ASL interpreter developed using concepts of machine learning like neural network methodologies and image processing techniques. It identifies hand gestures in the images obtained from video that is captured by a web 'cam recorder and gives the meaning of signs made by hearing/speech disabled people thus making communication complete. In this article, an approach is proposed to convert video of hand gestures made by deaf/dumb people into
text and audio format.

S.Gnanapriya, et al. (2020) had shown that Hand gesture is the prominent medium of communication for speech and hearing-impaired community to express their feelings to normal people at public places and the normal community finds it difficult to interpret the communicated content. This problem can be resolved by developing a real time hand gesture recognition system that converts word level sign vocabulary to text. Convolution Neural network is used for the real time processing of hand sign gestures as feature extraction and classification is automatically handled by CNN. Feature map is obtained by convolving filter over the image. The ReLU activation function removes the nonlinearity from the image and gives the extracted feature map. The dimensionality of the feature map is reduced by max pooling layer and labelled. This labelling helps in classification of gesture. The 90 percent of self collected dataset is used for training and 10 percent is used for testing. During testing phase, the trained CNN directly classify the hand gesture and display the annotation corresponding to the hand gesture. The proposed system architecture achieves maximum validation accuracy of 99.78% and 100% by varying number of filters, and training accuracy of 99.56%, 99.46% and 99.42% by changing the optimizers.

Suthagar S, et al. (2020) had discussed the deaf-mute people can communicate with normal people with help of sign languages. His project objective is to analyse and translate the sign language that is hand gestures into text and voice. For this process, Real Time Image made by deaf-mute people is captured and it is given as input to the pre-processor. Then, feature extraction process by using otsu's algorithm and classification by using SVM(support Vector Machine) can be done. After the text for corresponding sign has been produced. The obtained text is converted into voice with use of MATLAB function. Thus hand gestures made by deaf-mute people has been analysed and translated into text and voice for better communication.

Sachin Devangan, et al. (2020) provided detailed study on various methods through which we can achieve computer vision-based hand gesture recognition natively on smartphones. If smartphones can support hand gesture recognition it can provide a new way to interact with mobile devices and overcome the hurdles of voice and touch-based user interface improving the user experience at the same time also supports other gesture-based applications. The techniques we study are mainly vision-based since camera module is present on most of the smartphones and it does not require other additional sensors or other hardware. We have compared the various methods available based on algorithms used and corresponding accuracy.

Sushmita Nooka, et al. (2020) It was concluded that; home automation model using the android application is designed for providing ease of control of home appliances to the people, especially elderly or those who are physically unable for efficiently performing the day-to-day activities. As technology is rising more advancements are made in making the life of these people easier by providing methods easy to monitor and manage. The previous methods have seen the use of accelerometers, which are fixed on the hand as they are considered to be the best tool for carrying out such practices. These models are accurate but not flexible and portable. Our system is based on remote control home automation where-in our remote is an android application. In our system, the smartphone camera is used to give gestures as input to the gesture recognition model to filter and predict the gesture. Web-based automation communicates directly with raspberry pi to control home appliances. The proposed method, allows users to flexibly and portably control multiple household appliances with simple gestures.

Surendra Kumar Keshari, et al. (2019) the authors proposed system is to develop a translation tool which can reduce the communication gap by converting the real-time gesture-based signs to text and finally to speech. This paper will first at discuss the design to recognize the hand gesture as it is one of the fastest way to communicate. And further the discussion will be about recognizing the digit and perform operations in addition to recognizing the English alphabets to form words. The paper reviewed the current study status of application aiming to recognize the hand gestures, symbols and movements to convert it into numbers and

alphabets, and further into words and then sentences. According to the research the application will work as a medium in between an aphonic person and a normal person or vice versa. This paper shows the status of the application, customized hand gestures, the methods, analyzing the strength and week points and lists all the challenging problems in current research of hand gestures used for aphonic people school etc.

Prof. Anand Mannikeri1, et al. (2019) proposed a system that Hand Gesture Recognition System is a branch of Human Computer Interaction in which Human hand gestures are recognized by the computer system and then perform pre-defined task as per the application for controlling software as well as hardware. The main goal of gesture recognition research is creation of a system that can identify specific human hand gestures and use them to convey information or for device control as well as document control. Owing to the rapid development of hardware and software, new types of HCI methods have been required. In particular, technologies such as speech recognition and gesture recognition receive great attention in the field of HCI. Being able to interact with the system naturally is becoming ever more important in many fields of Human Computer Interaction. Both non-vision and vision based approaches have been used to achieve hand gesture recognition. A home automation system will control lighting, climate, entertainment systems, and appliances. In this paper we proposed the hand gestures can be used to automate home applications and also control documents in the system. The model is trained using training images to improve the accuracy of the model.

Sangjoon Lee, et al. (2018) study was conducted on a method to recognize gestures using machine learning, which uses gesture data collected from a gyroscope sensor in a smartphone. We implemented and tested to verify our method, and as a result, we found that the method showed an acceptable rate of recognition for home automation.

Arathi P. N, et al. (2017) investigated the work MATLAB based algorithm is used. This proposed work uses this tool for the recognition and processing of the hand gesture. The algorithm used for this proposed work is the object detection algorithm. At first the image is captured by the camera and it is processed by the MATLAB, if the preloaded gesture is matched with the existing gesture the data will be sent to the microcontroller, then the home appliances are controlled. There are other applications which could be controlled by a gesture such as media players, robots and virtual objects. The hardware module consists of camera, PIC microcontroller, fan, light, power supply, LED, GSM module. This hardware module is communicated with simulation software using a USB to serial converter bus which comes along with driver software.

Abhijit M, et al. (2017) gave general study, which was carried out in the controlling the home appliances and electronic gadgets through an infrared remote control is now in general. But the same controlling tasks can be done more easily. The primary motive of proposing the new system of hand gesture remote control is to remove the need to look into the handheld remote and to search for a specific key for specific function. An accelerometer, gyroscope and magnetometer is used to recognize the hand gestures in 3 perpendicular directions and transmitted through wireless protocol using radio frequency. The data is received by the hub section which controls the home appliances according to the decisions made. This project proposes a simple and easy way of controlling the home appliances.
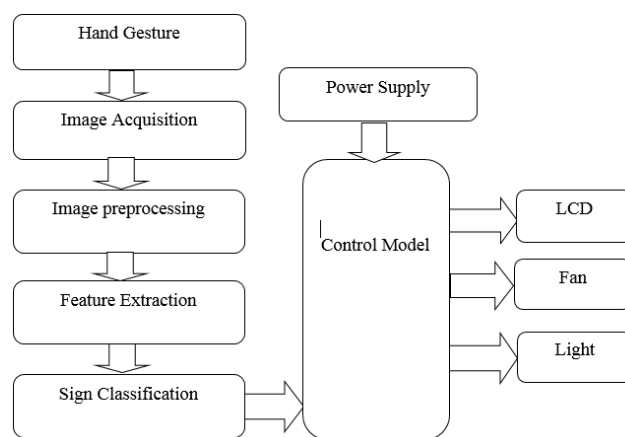
3. Methodology

Figure 3.1 Model of the block diagram of the proposed system

The Figure 3.1 shows the model of the block diagram of the proposed system as a gesture- based home automation system using deep learning algorithm method. It represents the various steps involved in the gesture recognition process along with the hardware components required for the controlling of the home appliances. In this the simulation tool for the processing of gesture images is interfaced with the hardware using USB to serial converter.

4. Result and Discussion

From above literature review, it is observed that hand gesture recognition systems are used for controlling home applinces.

The above literature review showed that ways to recognize hand gestures using various deep learning algorithms have been investigated. Also, it is showed that hand gestures can be recognized using three approaches such as vision based, instruments-glove based & colored-marker based.

The objectives most of the work carried by various authors was to minimize the communication gap between the normal world & the deafmute people in the area like controlling the home applinces.

An hand gesture investigation will be needed to minimize the communication gap between the normal

world & the deafmute people problems in order to improve work efficiency in the home automation, vehical systems & industry as well.

So there is a necessity to consider the application of hand gestures at the time of controlling home automation systems.

4. Conclusion

The paper presented a literature review concerning the studies on hand gestures at the time of controlling home automation systems. Review found that sign language can be recognized using different methods based on vision & data glove. In VBA feature extraction makes use of different algoritjms like YOLO, CNN, PCA etc.

From the above literature review, it is observed that various classification stages such as SVM, ANN & CNN classifiers uses for imporving the accuracy.

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