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Survey on Real Time Hand Gestures Recognition Using Convolutional Neural Network

Venkata Naga Rani Bandaru[1]; A.M. Naveen[2]; S.M. Sharavanesh[3]

Assistant Professor[1]; Undergraduate student[2,3]

ranivenkata5@gmail.com[1]; naveen671998am@gmail.com[2]; saravaneshsaran@gmail.com[3]

ABSTRACT

Gesture Recognition is one of the most important part of research today. Many new algorithms are being developed recently in today's upcoming technologies. In the day to day life, mobile devices like phones or tablets are very common and being widely used among all people of world. These devices are connected with high speed networks and provide strong communications. These devices are often an enormous help for the people that aren't ready to communicate properly and even in emergency conditions. For a disabled one that isn't able to speak or an individual who speaks a special language, these devices are often a boon as understanding, translating and speaking systems for these people. This chapter discusses a transportable android based hand sign recognition system which may be employed by disabled people. This paper presents a comprehensive review on vision-based hand gesture recognition, with a stress on dynamic hand gestures. First, a quick introduction of the essential concepts and the classification of hand gesture recognition techniques are given. Then, variety of popular related technologies and interesting applications are reviewed. Finally, we give some discussion on the present challenges and open questions during this area and means an inventory of possible directions for future work.

Keywords: Python, NumPy, TensorFlow, Tflearn, Keras, Convolutional Neural Network, Training, Classification.

1. INTRODUCTION

Sign Language may be a well-structured code gesture, every gesture has meaning assigned thereto. Sign Language is that the only means of communication for deaf people. With the advancement of science and technology many techniques are developed not only to attenuate the matter of deaf people but also to implement it in several fields. Many research works associated with Sign languages are done as for instance the American, British, the Japanese, and so on. But only a few works have been wiped out Indian signing recognition till date. Finding an experienced and qualified interpreter whenever may be a very difficult task and also unaffordable. Moreover, people that aren't deaf, never attempt to learn the signing for interacting with the deaf people. This becomes a explanation for isolation of the deaf people. But if the pc are often programmed in such how that it can translate signing to text format, the difference between the traditional people and therefore the deaf community can be minimized.

We have proposed a system which is in a position to acknowledge the varied alphabets of Indian signing for Human-Computer interaction giving more accurate results a minimum of possible time. It will not only benefit the deaf and dumb people of India but also might be utilized in various applications within the technology field.

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2. LITERATURE SURVEY

The contributions of various scholars are studied for survey and analysing the merits and demerits in order to enhance the consequences for making the system work better.

In Paper [1], Abhishek B, Kanya Krishi, Meghana M, Mohammed Daaniyaal, Anupama H S have proposed a system on Hand Gesture Recognition using Machine Learning Algorithms. The main focus of this is to recognize the human gestures using mathematical algorithms for human computer interaction. Only a few modes of Human-Computer Interaction exist, they are: through keyboard, mouse, touch screens etc. Each of these devices has their own limitations when it comes to adapting more versatile hardware in computers. Gesture recognition is one among the essential techniques to create user-friendly interfaces. Usually gestures are often originated from any bodily motion or state, but commonly originate from the face or hand. Gesture recognition enables users to interact with the devices without physically touching them. This paper describes how hand gestures are trained to perform certain actions like switching pages, scrolling up or down in a page. The importance of gesture recognition lies in building efficient human-machine interaction. This paper describes how the implementation of the system is done based upon the images captured, and how they are interpreted as gestures by the computer to perform actions like switching the pages, scrolling up or down the page. The system is built using OpenCV and TensorFlow object detector.

In paper [2], Jay Prakash, Uma Kant Gautam have proposed a Hand Gesture Recognition using Computer Vision Based Approach, Hand Gesture Recognition, Human Computer Interface (HCI), Instrumented Glove, Non-Verbal language. Hand Gesture Recognition System works like this : first user gives input to the system by making hand gestures, then system scanned the gestures by using cam or sensor and deducts it into signal and passes the program, now its program responsibility to first accept the signal then examine what is the input given using gestures, then check if there is any corresponding data is saved into dataset then result will be obtained in the output device.

In paper [3], Amit Chaurasia and Harshul Shire have proposed a system SNCHAR: Sign language Character Recognition using Keras, TensorFlow, Scikit, and Pyttsx3. This project "SNCHAR: Sign language Character Recognition" system is a python-based application. It uses live video as input, and predicts the letters the user is gesturing in the live feed. It captures the gestures, and recognizes the area of hand gesture skin colour intensity object. It separates the gesture area from the rest of the frame, and feeds that part to their trained model. This pre-trained model, using the hand gesture as input predicts a value that represents an alphabet. This alphabet is displayed on the screen. User can hear the text predicted on the screen by pressing “P” on the keyboard. The predicted text can be erased if required by using “Z” from the keyboard. At one hand, the project is capable of capturing the live feed and converting the gestures into the corresponding alphabets. However, on the other hand, the efficiency and accuracy of the application is questionable in itself for real-time use. There needs to be set an optimal trade-off between the efficiency and accuracy. While the reduction of number of frames used to detect and recognize gestures and print characters will lead to increased speed, the accuracy will be compromised.

In Paper [4], D. Nagajyothi, M. Srilatha and V. Jyothi have proposed a Hand Gesture Method to Speech Conversion using Image Segmentation and Feature Extraction Algorithm. In this system, the detection of skin colour and region segmentation is performed during the segmentation stage. RGB colour space, cbr colour space, HS colour space, Normalized RGB & HSV are skin colour segmentation techniques. From these values the skin colour is detected. The RGB values lies in between a boundary for skin pixels and it varies for non-skin pixels. With this RGB ratio they can identify whether the skin pixel belong to the skin region or not. Skin region detection algorithm is applied for each gesture and it is applied to skin region to find the colour. This system not only recognizes gesture indications it develops speech system. From the results they have obtained accuracy up to 80%.

In paper [5], T. Chandraleka, Balasubramanian R, Balasubramanian S, Karthikeyan S and Jayaraj R have proposed a system on Hand Gesture Robot Car using ADXL 335. In this System, Arduino, Microcontroller, Transmitter, Receiver are used. The outer frame work was done using tyres and supporting board is fixed to it and the tyres are each other with steel road of suitable capacity and which the tyres are connected to the board using wires and also the motors are fixed to the tyres for rotation purpose. Radio signals are transmitted

using transmitter module Without any physical connection, the embedded system is used to interact with each other. After successful completion the working loads were improving the project. Even the mounting of ultrasonic sensor and other sensors for the complete information about the place where the car is being operated & make it useful for the society. The most important feature is to interact with the application from the distance object without any physical contact.

In paper [6], Sankara Gomathi.S, Amutha. S, Sridhar.G and Jayaprakasan.M have proposed a system Interpretation of Formal Semantics from Hand Gesture to Text using Proficient Contour Tracing Technique. In this system, Contour Tracing, Hand gesture, SVM, Feature Extraction, TOF, IoT are used. In this project, semantics are classified by support vector machine with trained datasets. The recognised hand gestures are displayed as text. Their main objective is to resolve the problem of facing interviewer for vocally impaired individuals. This helps them to build their confidence and eradicate their inferiority complex compared to other methods. In the interpretation of framework, conversion of sign to text, Image captured from camera is binaries, noise is expelled, boundaries of finger is detected and corresponding text is displayed as an output to the receiver(an individual who does not know the sign language).They have extended further the same concept to execute in shrewd cell phones too. The challenge in executing this thought in cell phone is actualizing the techniques utilized for picture handling and the accuracy was improved by the results carried.

In paper [7], Abdul Khader, Muhammad Thouseef, Akbar Ali and Ahamad Irfan have proposed a system on Efficient Gesture based Language Recognition using SVM and Lloyd's Algorithm. In this work, they have actualized a presumable exact strategy to perceive static gestures or image frames from a live camera or video data. As Hand Gesture Recognition is identified with two noteworthy fields of image processing and AI (machine learning). APIs that can be utilized to implement different strategies and methods in these fields. They explored the different methodologies and the strategies utilized for hand gesture recognition. They found the dataset and the strategies to be utilized as referenced in the Experimentation area as per our suppositions, they picked two procedures for each stage with the exception of the recognition phase and dependent on the outcome they got, they picked one out of them or a combination of both. They found out about OpenCV and the various function it gives. Regarding Machine Learning, in spite of the fact that they utilized Lloyd's Algorithm and Support Vector Machine, and an API to actualize the TensorFlow utilizing python.

In paper [8], Rajesh George Rajan and M Judith Leo have proposed a Comprehensive Analysis on Sign Language Recognition System. The human-machine interaction is developed through the gesture recognition system. In the previous years, most of the researchers had done their research in static hand gesture recognition. Some works have been reported for recognition of dynamic hand gesture. Also, facial expressions aren't included in most generally used systems. Developing systems which are capable of recognizing both hand and facial gestures may be a key challenge during this area. In this paper they have discussed different sign language recognition approaches using different acquisition methods. By using the different data acquisition methods like sensor-based gloves, Kinect, leap motion controller etc. and these devices having good recognition rate, but the computation complexity and cost is too high and having difficulty to maintain in the public places. So, in order to avoid the severe problem, the camera-based approaches is more beneficial. With the help of web camera, they have acquired the input data easily and processed. To achieve better results and high accuracy, future investigation in the areas of segmentation techniques, feature extraction methods and classification methods are required to achieve the final objective of human computer interface in the area of sign language recognition for deaf and dumb people.

In paper [9], S. Shivashankara and S. Srinath have proposed a system on American Sign Language Recognition System using Bounding Box and Palm FEATURES Extraction Techniques. Bounding Box Technique, Canny Edge Detector, CIE Colour Model are used. This research paper exhibits an inventive framework, to achieve the transliteration of 24 static alphabets (Letter J and Z not included as they involve hand movement) of American Sign Language into English text and achieved an average recognition rate of 98.21% which is the best in recent (papers published in year 2017, and 2018) existing traditional work carried out. This paper also summarizes the system architecture, state of art, data collection for the proposed work, proposed system design, and the detailed results evaluation by showing comparative graphical depiction of the proposed technique with the existing techniques average recognition rate and also depicts the average gesture recognition rate chart by considering various factors like background complexity, background colour, location, time, distance, angle, mobile camera resolution, and illumination. This paper also highlights on face detection and edge detection technique, and also the various hand / palm features extraction techniques.

In paper [10], Shreyas Rajan, Rahul Nagarajan, Akash Kumar Sahoo, M. Gowtham Sethupati have proposed a system on Interpretation and Translation of American Sign Language for Hearing Impaired Individuals using Image Processing. This project mainly focuses on the development of software that can convert American Sign Language to Communicative English Language and vice-versa. This is accomplished via Image-Processing. The latter is a system that does a few activities on a picture, to acquire an improved picture or to extricate some valuable data from it. Image processing in this project is done by using MATLAB, software by MathWorks. The latter is programmed in a way that it captures the live image of the hand gesture. The captured gestures are put under the spotlight by being distinctively coloured in contrast with the black background. The contrasted hand gesture will be delivered in the database as a binary equivalent of the location of each pixel and the interpreter would now link the binary value to its equivalent translation delivered in the database. This database shall be integrated into the mainframe image processing interface. The Image Processing toolbox, which is an inbuilt toolkit provided by MATLAB is used in the development of the software and Histogramic equivalents of the images are brought to the database and the extracted image is converted to a histogram using the 'imhist()' function and would be compared with the same. The concluding phase of the project i.e. translation of speech to sign language is designed by matching the letter equivalent to the hand gesture in the database and displaying the result as images. The software uses a webcam to capture the hand gesture made by the user. This venture plans to facilitate the way toward learning gesture-based communication and supports hearing-impaired people to converse without trouble. This paper deals with the day-to-day problems of communication amongst the Hearing-impaired individuals and thus a solution has been proposed regarding the same. There are two major drawbacks to this system. The letter 'J' and 'Z' has some motion as a part of its gesture and hence the system will not be able to input these letters. The system's dataset is fixed and limited to alphabets and numbers only. Furthermore, Artificial Neural Network algorithms can be applied in the future for the image comparison module.

In paper [11], S. Chandrasekhar and N.N. Mhala have proposed a system on High-speed Integration of Kinect V2 Data for Identification of Hand Gesture in Real time Movements. Hand gesture recognition is extremely critical for human-PC connection. This manuscript presents a narrative constant strategy for human-hand gesture recognition. There a framework for the discovery of quick gesture movement by utilizing a direct indicator of hand developments utilizing information combination technique. In their system, the hand area is removed from the foundation with the foundation subtraction strategy. At long last, the framework has been approved by methods for the Kinect v2 application actualized. The time requirement is recognized and the recognition is quick contrasted with other ongoing minutes. The timing analysis is compared, and the average time using data fusion method is 63ms. By using fast integration of data, the average time is 45ms. The time taken for recognition of hand gesture is been improved. The experimental results are performed using MATLAB tool. In many real time applications, recognition of hand gestures is one of the most important factors and is difficult to identify and accurate results need to be obtained. In this paper, Kinect V2 images are considered to perform the experimentation. An information combination-based hand gesture recognition shown by intertwining profundity data and skeleton information. In view of the exact division, the following Kinect V2, the model can accomplish constant execution, which is quicker than the best in class hand gesture recognition techniques. In view of the exploratory outcomes, the proposed model is precise and proficient and enhanced in time of recognition.

In paper [12], E. Padmalatha, S. Sailekya, R. Ravinder Reddy, Ch. Anil Krishna and K. Divyarsha have proposed a system on Sign Language Recognition. There are many recognized sign language standards that have been defined such as ASL (American Sign Language), IPSL (Indo Pakistan Sign Language), etc., which define what sign means what. ASL is the most widely used sign language by the deaf and dumb community.The deaf and dumb use sign language to communicate among themselves with the knowledge of the standard sign language. But they can't communicate with the remainder of the planet as most of the people are unaware of the existence and therefore the usage of the signing. This method aims to remove this communication barrier between the disabled and the rest of the world by recognizing and translating the hand gestures and convert it into speech. The CNN model fetched 99.4% accuracy while training and testing with the dataset. The problem of hand segmentation has been resolved with the usage of a colored hand glove and gave better results. After working with different combinations of the number of convolution layers and pooling layers, 3 convolution layers along with 2 pooling layers fetched the highest accuracy. The disadvantage of training the new gestures is currently taking 80 minutes, hence the process of user adding a new gesture and training the model will be improved in the further stages of development. As the hand

segmentation is dependent on the colour of the hand, if the objects in the background match the skin colour, it could distort the binarized threshold image. Due to similar gestures that exist in ASL, the final accuracy of classification depends on the environment and image processing techniques.

In paper [13], L. Latha and M. Kaviya have proposed a system on A Real Time System for Two Ways Communication of Hearing and Speech Impaired People. The gestures shown by the impaired people will be captured and the corresponding voice output is produced together way and therefore the before the voice input by normal people is taken and the periodic gesture are going to be showed them as another. This system uses RASPBERRY PI kit because the hardware, where a Pi camera, LCD display, Speaker and Microphone are going to be attached alongside it. First the image acquisition is carried where it captures the input image and then image pre-processing is done to extract the foreground image from the background, then feature extraction is carried out to extract the necessary details. The extracted image is matched with the dataset and therefore the corresponding voice output is generated for that gesture. Likewise, a microphone is employed to capture the speech input of the traditional people, then it's pre-processed to get rid of the additional noise within the speech signal and have extraction is administered to spot the required details and eventually extracted voice is matched with the dataset and therefore the corresponding hand gestured image are going to be displayed in LCD display. By using this method, the communication gap between the impaired and normal people gets reduced. Their proposed system mainly aims to overcome the communication gap between the disabled and the normal people. This system is straightforward and implement and shows the accuracy of about 70%. The input is been tested for multiple times by considering various criteria. This system works for gesture to speech conversion and speech to gesture conversion, so it's a two-way communication. The drawback of this system is, speed of the system is a bit slower. There is a need for research to increase the speed of the system by concentrating on the feature extraction part.

In paper [14], Suthagar S., K. S. Tamilselvan, P. Balakumar, B. Rajalakshmi and C. Roshini have proposed a system on Translation of Sign Language for Deaf and Dumb People. Their project objective is to analyse and translate the sign language that is hand gestures into text and voice. For this process, Realtime Image made by deafmute people is captured and it is given as input to the pre-processor. Then, feature extraction process by using algorithm and classification by using SVM (support Vector Machine) can be done. After the text of corresponding sign has been produced. The obtained output is converted into voice with use of MATLAB. Thus, hand gestures made by deaf-mute people has been analysed and translated into text and voice for better communication. In this proposed model an attempt has been made to design a system which can recognize the sign language of alphabets and number. 11 different features from image has been extracted to make a feature vector database. SVM and neural network is used for classifying the different sign-language word and hence for recognition. Accuracy of the proposed method for sign language of different language are tested and found to be more than 95 % for most of the sign word.

In paper [15], V. Padmanabhan, M. Sornalatha have proposed a system for dumb people Hand gesture recognition and voice conversion system. In this system, Gesture, Flex sensor, accelerometer, microcontroller, TTS are used. This project aims to lower the communication gap between the mute community and additionally the quality world. The projected methodology interprets language into speech. The system overcomes the required time difficulties of dumb people and improves their manner. Compared with existing system the projected arrangement is compact and is feasible to hold to any places. This system converts the language in associate passing voice that's well explicable by blind and ancient people. The language interprets into some text kind displayed on the alphanumeric display screen, to facilitate the deaf people likewise. In world applications, this technique is useful for deaf and dumb folks those cannot communicate with ancient person. The foremost characteristic of this project is that the gesture recognizer could also be a standalone system, that's applied in common- place of living. It's in addition useful for speech impaired and paralysed patient means those do not speak properly and in addition used for Intelligent Home Applications and industrial applications.

Table 1: Comparison on Various Methods Used in Hand Gestures

S. No	Paper	Technique	Result	Issues
1	Hand Gesture Recognition using Machine Learning Algorithms	Gesture Recognition, Human Computer Interaction, User-friendly Interface.	Each of these devices has their own limitations when it comes to adapting more versatile hardware in computers.	They are interpreted as gestures by the computer to perform actions like switching the pages, scrolling up or down the page. The system is built using OpenCV and TensorFlow object detector.
2	Hand Gesture Recognition	Computer Vision Based Approach, Hand Gesture Recognition, Human Computer Interface (HCI), Instrumented Glove, Non-Verbal language	Hand Gesture Recognition System works like this: first user give input to the system by making hand gestures, then system scanned the gestures by using cam or sensor and deducts it into signal and passes the program, now its program responsibility to first accept the signal	Examine what is the input given using gestures, then check if there is any corresponding data is saved into dataset then they will get their result.
3	SNCHAR: Sign language Character Recognition	Keras, TensorFlow, Scikit, and Pyttsx3	Different images were tested and found that the new technique of TensorFlow was found to show some results.	Moreover, there were difficulties to attain a 57% accuracy.
4	Hand Gesture Method to Speech Conversion using Image Segmentation and Feature Extraction Algorithm	HSV colour model, Pattern Recognition, Tracking and Segmentation.	The RGB values lies in between a boundary for skin pixels and it varies for non-skin pixels. With this RGB ratio they can identify whether the skin pixel belong to the skin region or not. Skin region detection algorithm is applied for each gesture and it is applied to skin region to find the colour.	The issue is the system was not able to achieve the proper image capturing and colour detection problems.

5	Hand Gesture Robot Car using ADXL 335	Arduino, Microcontroller, Transmitter, Receiver	The outer frame work is done using tyres and supporting board is fixed to it and the tyres each other with steel road of suitable capacity and which the tyres are connected to the board using wires and also the motors are fixed to the tyres for rotation purpose.	The system provides results are improper for outputs.
6	Interpretation of Formal Semantics from Hand Gesture to Text using Proficient Contour Tracing Technique	Contour Tracing, Hand gesture, SVM, Feature Extraction, TOF, IoT	semantics are classified by support vector machine with trained datasets. The recognised hand gestures are displayed as text.	The main issue is extraction algorithm is reduced to 60% - 80%.
7	Efficient Gesture based Language Recognition using SVM and Lloyd's Algorithm	SVM, Gesturing, Lloyd's algorithm, audio output, TensorFlow, CNN	Explored the different methodologies and the strategies utilized for hand gesture recognition. They found the dataset and the strategies to be utilized as referenced in the Experimentation area as per our suppositions, they picked two procedures for each stage with the exception of the recognition phase and dependent on the outcome.	Experiment results show that the system recognizes static hand gestures at recognition rates of 60% of dynamic gestures using our collected dataset. This can greatly enhance the usability of SVM.
8	A Comprehensive Analysis on Sign Language Recognition System	Vision based Acquisition, Leap motion acquisition, Segmentation	Hand Gesture Recognition System works as the system by making hand gestures, then system scanned the gestures by using cam or sensor and deducts it into signal and passes the program, now its program responsibility to first accept the signal.	Improper results for the modules created in the system.

9	An American Sign Language Recognition System using Bounding Box and Palm FEATURES Extraction Techniques	Bounding Box Technique, Canny Edge Detector, CIE Colour Model.	Each of these devices has their own limitations when the colour model affects the whole project for the outcome.	Edge detection doesn't work properly for the image processed.
10	Interpretation and Translation of American Sign Language for Hearing Impaired Individuals using Image Processing	Feature Extraction, Edge Detection, Segmentation	Their system translates the detected gesture into actions such as opening websites and launchingapplications like VLC Player and PowerPoint. The dynamic gesture is used to shuffle through the slides in presentation. Our results show that an intuitive HCI can be achieved with minimum hardware requirements.	System that did not utilize any markers, hence making it more user friendly and low cost. In this gesture recognition system, they have aimed to provide gestures, covering almost all aspects of HCI such as system functionalities, launching of applications and opening some popular websites.
11	High-speed Integration of Kinect V2 Data for Identification of Hand Gesture in Real time Movements	Gesture Recognition, Human Computer Interaction, Kinect V2 system	The time requirement is recognized and the recognition is quick contrasted with other ongoing minutes. The timing analysis is compared, and the average time using data fusion method is 63ms	Outcome of the module is inappropriate.
12	Sign Language Recognition	SVM, CNN, HSV colour model	A dataset containing all the gestures are present. Each gesture folder consists of 2400 images which is used for training and testing the model. There are 47 gestures but more can be added by the users.	As the hand segmentation is dependent on the colour of the hand, if the objects in the background match the skin colour, it could distort the binarized threshold image. Due to similar gestures that exist in ASL, the final accuracy of classification depends on the environment and image processing techniques.

13	A Real Time System for Two Ways Communication of Hearing and Speech Impaired People	Feature extraction, pre-processing, matching	The input is been tested for multiple times by considering various criteria. This system works for gesture to speech conversion and speech to gesture conversion, so it's a two-way communication. Since this system is developed using hardware, the disabled persons can easily carry it along with them	The issue is feature extraction was not properly obtained.
14	Translation of Sign Language for Deaf and Dumb People	SVM, MATLAB, Hand detection, Segmentation and Hand Tracking	An attempt has been made to design a system which can recognize the sign language of alphabets and number. 11 different features from image has been extracted to make a feature vector database. SVM and neural network is used for classifying the different sign-language word and hence for recognition.	The result obtained for the system is not appropriate and could recognise the images properly.
15	Hand Gesture Recognition and Voice conversion system for dumb people	Gesture, Flex Sensor, TTS, Microcontroller	The language interprets into some text kind displayed on the digital display screen, to facilitate the deaf people.	The main issue is recognition algorithm is reduced to 60% - 80%.

3. CONCLUSION AND FUTURE WORK

In this project, we present a hand tracking and segmentation algorithm that is both accurate and computationally efficient. The importance of gesture recognition lies in building efficient human-machine interaction. This paper describes how the implementation of the system is completed based upon the pictures captured, and the way they're interpreted as gestures by the pc to perform actions like switching the pages, scrolling up or down the page. They were able to create a robust gesture recognition system that did not utilize any markers, hence making it more user friendly and low cost. In this gesture recognition system, we have aimed to provide gestures, covering almost all aspects of HCI such as system functionalities, launching of applications and opening some popular websites. In future we would like to improve the accuracy further and add more gestures to implement more functions. Finally, we target to extend our domain scenarios and apply our tracking mechanism into a variety of hardware including digital TV and mobile devices. We also aim to extend this mechanism to a range of users including disabled users.

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