Application Of Convolution Neural Network To Recognize Hand Gestures

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ABSTRACT

Hand Gesture Recognition has many applications such in Human Computer Interaction applications. It can be used for communication as sign language among specially enabled people of the society as well as different computer applications can be created to operate various devices like phones, games etc. It is the responsibility of researchers to think in this direction and provide solutions so that this communication with devices by recognizing hand gestures can become effective and easier. In modern technical society, hand gestures-based computer applications are developed which motivates researchers to work on different techniques to recognize hand gestures. This work is also an attempt in this direction where Convolution Neural Network (CNN) is applied to recognize hand gestures. For this, an application is developed which is working on Kaggle data set of hand gesture images.

Key words: Hand, Gesture, Convolution Neural Network, Sign Language, Open CV

1. INTRODUCTION

Hand Gestures are a kind of non-verbal interaction technique to communicate with machines. Its applications can be seen in many computerized games, smart homes, robots, smart phones etc. In addition to provide communication with machines, hand gesture recognition is also useful for specially challenged people of society as this is the only mean of communication with them. As per World Health organization (WHO), approximately 5% of the population is specially challenged. Communication mode for them is different from normal people and with this reason in this automated world also they are not getting benefitted. So, for providing communication between user and computer and to help specially challenged people there is opportunity to work on some interactive techniques like hand gesture recognition. Hand Gesture Recognition (HGR) is an interactive technique that

converts hand gestures into text or voice (Pisharady & Saerbeck,2015). This work focused on converting hand gestures into text.

The main motive behind building this work is to provide natural interaction among user and machines where important decisions can be taken based on meaningful information obtained from hand gestures. The main challenge in this work is to interpret the hand gestures correctly and efficiently for which multiple deep learning techniques are available. In this present work an application is developed for Hand Gesture Recognition (HGR) and Convolutional Neural Network (CNN) is applied. Complete task is divided into three main stages where firstly frame extraction is done from hand gesture video. In second step noise removal is done. Third part of this work is about applying CNN classifier. For completing this task, three different models are proposed with three different filter values to compare the results. Comparison between three models is done based on training accuracy, validation loss and validation accuracy. Result shows that as we increased the number of filters, training accuracy and validation accuracy is increased, and validation loss is decreased.

The main contribution of this paper will be that communication will be easier with deaf and dumb people and it can be applied to develop several computer-based applications and machines which can work effectively by recognizing hand gestures to provide automation.

This paper is dived into following parts: section 2 describes review of related work in area of hand gesture recognition, section 3 focuses on research methodology for describing all the necessary steps to be followed to provide results, results are given in section 4 and in section 5 conclusion and future scope of this work is provided.

2. RELATED WORK

In 2012, a deep review is done on depth-based hand gesture recognition methods. This review includes total 37 papers related to Kinet and OpenNI libraries [2]. In 2012, a depth sensor approach was used to recognize hand gestures and performance of model is evaluated on 12 dynamic American Sign Language (ASL) gestures [3]. Another HGR system was proposed by researchers using Kinect and 84% to 99% of accuracy was achieved for single-hand gestures while 90-100% of accuracy was achieved for both hand gestures [4]. In 2013, a survey of last 10 years (2003-2013) was done on different HGR system and based on that's characteristics for a robust and efficient HGR system are described [5]. In 2014, CNN approach was used to work on HGR where Gaussian Mixture model (GMM) was used to train the skin model and it was used to filter non-skin colors of images. From this model 95.96% of accuracy was achieved by researchers [6]. A multi-sensor system was designed for successfully recognizing car driver hand gesture CNN was used for classification in this work(Molchanov, Gupta, Kim, & Pull, 2015). For dynamic hand gesture recognition work is also done in 2016 where a novel feature vector is proposed for satisfactory solutions.89.5% and 95% accuracy as achieved for different datasets (Lu, Tong, & Chu, 2016) . A review was done to understand use of 3D depth sensors to recognize hand gestures where four different aspects like 3D hand modelling, static hand gesture recognition hand trajectory gesture recognition and continuous hand gesture recognition were reviewed (Cheng, Yang, & Liu, 2016). Later that in 2017, hand gestures recognition was done for HCI where

gestures were translated into actions to open different computer application. Accuracy was calculated for plain as well as non-plain background also (Hariaa, Archanasri, Asokkumar, Poddar, & Nayak, 2017). A new deep learning-based technique was proposed which was giving commands to computer using six static and eight dynamic hand gestures. Accuracy level of this work was 93.09% (Hussain, Saxena, Han, Khan, & Shin, 2017). Deep learning approach was also used in 2018 for introducing 3D hand gesture recognition model where CNN approach was applied and 91.28% and84.35% accuracy was achieved for 4 gestures and 28 gestures respectively (Devineau, 2018). To improve the accuracy level further work is being done using deep learning approach for segmenting the hand gestures based on skin color model where CamShift algorithm was used for real time hand gesture tracking and 98.3% accuracy was achieved (Sun, Ji, Zhang, Yang, & Ji, 2018). Work was also done to recognize statis hand gestures using CNN approach where focus was given to remove noise from hand region (Pinto, Borges, Almeida, & Paula, 2019). A review was also done to understand applications, techniques and challenges related to hand gesture recognition. Study shows that the most popular tool for this work was surface electromyography sensors with wearable hand gesture devices and most popular approach was Artificial Neural Network (Yasen & Jusoh, 2018).

3. RESEARCH METHODOLOGY

Firstly, image frames are extracted from hand gesture videos and pre-processing is done to remove noise from images. For this purpose, Gaussian filter is used. This process is performed by the convolution of Gaussian kernel with each point in the input array and then added to provide the output array. After removing noise CNN was applied for image classification. This popular image classifier takes an input and classifies it into one of the possible categories that it was trained to identify. Finally, results are obtained and analyzed for a dataset (https://www.kaggle.com/datasets/aryarishabh/hand-gesture-recognition-dataset). Complete methodology can be understood from Fig 1.

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┌─────────────┐
│ Hand Image  │
└─────────────┘
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       ▼
┌─────────────┐
│Hand Detection│
└─────────────┘
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       ▼
┌─────────────┐
│Preprocessing│
└─────────────┘
       │
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┌──────────────────┐
│Feature Extraction│
└──────────────────┘
       │
       ▼
┌─────────────┐
│ Recognition │
└─────────────┘
Gesture Dictionary
       │
       ▼
┌──────────────────┐     ┌─────────┐
│Command Execution │────▶│ Command │
└──────────────────┘     └─────────┘
```
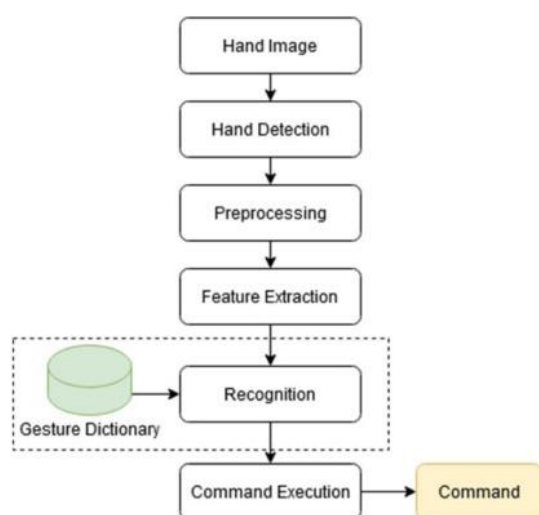
Fig. 1. Proposed Research Methodology

4. RESULTS

The GUI for this application has been developed using Python. Main Window of this application is shown in Fig 2. Hand gestures recognized using this application are shown in Fig 3. From these images it is observed that the developed system was giving satisfactory results.
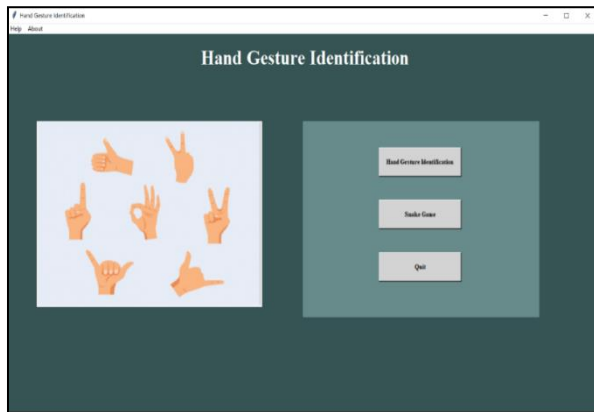

Fig 2. Main Window of Hand Gesture Recognition Application

Fig 3. Results obtained form proposed method

5. CONCLUSION AND FUTURE SCOPE

This research work is about recognition of hand gestures for which an application is developed. Convolution Neural Network is used for this purpose. The motive behind this work was to recognize the hand gestures efficiently and correctly so that this feature can be useful for specially challenges people to understand the sign language and to make conversation easy with them. In addition to that this work can also be used in various Human Computer Interaction (HCI) applications which can be used in various machines like smart phones, computerized games etc. In future this work can be used to develop an HCI application as well as results can be obtained for different data sets also.

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