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HAND GESTURE RECOGNITION AND VOICE CONVERSION FOR DEAF AND DUMB

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Abstract

To communicate with individuals who are primarily deaf and dumb, sign language is a language that uses hand gestures and movements. In order to process the image and anticipate the hand gestures, this paper suggests a system that uses a Convolution Neural Network (CNN), a Deep Learning algorithm. This study demonstrates how 26 alphabets and 0–9 digit hand movements in Sign Language can be recognized in sign language. The suggested system includes modules for feature extraction and preprocessing, model training and testing, and sign to text conversion. To improve recognition accuracy, we are using various CNN architectures and pre-processing methods like skin masking, greyscale, thresholding, and Canny edge detection algorithms and tried on our dataset.

Keywords

Hand gestures, Convolution Neural Networks, Sign language, Model training, CNN architectures.

Introduction

Deaf people are those whose hearing aids are entirely or partially broken. The deaf utilize lipreading or signing to communicate with others who have good hearing aids.

Language is a sign language used largely by deaf people that consists of hand gestures, other body motions, face expressions, and body postures. In order to communicate with someone who does not speak the same language, people will occasionally create their own sign languages, such as British and American Sign Hand Movements. People with normal hearing are sometimes unable to communicate with deaf people because they are unaware of sign language.

Communication is the act of communicating thoughts or messages orally or written down. One of the most effective ways we may express our thoughts to others is through hand gestures. There are static and dynamic gestures. When speaking, static gestures involve hand shape and dynamic gestures involve hand movements.

The most fundamental and organic form of communication for those with hearing loss is sign language. These physically handicapped individuals are neglected by society and kept alone. Understanding sign language is necessary to bridge the communication gap between hearing-impaired people and the general public. As a means of overcoming this communication barrier, our goal is to create an effective method. An option for a silenced person to communicate with a non-signer without the need of an interpreter can be provided by a working sign language interpreter. This project will concentrate on using an Android app to identify Sign Language. The goal is to encourage algorithms that are suitable enough to run on a mobile device. Ten Sign Language hand motions were used in the system's development. There were roughly 250–300 images each letter and 200 images per number in the dataset. The simple assignment was to preprocess the photographs that were acquired for this project.

The following preprocessing procedures were used to obtain the raw images for this paper: 1. Grey scaling Masking the skin Threshold 3. Detection of Canny Edges.

In order to train and evaluate the Convolution Neural Network model, photos that had undergone post-processing were fed into the model. The most effective CNN architecture for the recognition of hand motions was determined through testing of various CNN designs on our dataset.

Literature survey

Hand gesture recognition is a growing area of research that has numerous applications in various fields, including robotics, human-computer interaction, sign language recognition, and virtual reality. Here is a literature survey on hand gesture recognition that includes some of the recent research papers:

[1] Mitra and T. Acharya, "Gesture recognition: A survey," IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), vol. 37, no. 3, pp. 311-324, May 2007.This paper provides an overview of the state-of-the-art in hand gesture recognition. It describes the different types of gestures, sensors used for capturing hand gestures, feature extraction techniques, and classification methods.

[2] H. Wu, W. Hu, Z. Zhang, and T. Tan, "Real-time hand gesture recognition using a depth camera for natural HCI," IEEE Transactions on Multimedia, vol. 15, no. 6, pp. 1270-1280, Oct. 2013.This paper proposes a real-time hand gesture recognition system using a depth camera. The system can recognize multiple gestures simultaneously and achieves high recognition accuracy.

[3] J. Zhang, W. Chen, and S. Wang, "A survey of recent advances in hand gesture recognition," Frontiers of Computer Science, vol. 11, no. 5, pp. 815-827, Oct. 2017.This paper provides a comprehensive survey of recent advances in hand gesture recognition. It covers different sensors, feature extraction techniques, and classification methods, as well as applications in different fields.

[4] S. Liu, X. Zhang, and X. Guo, "A survey of hand gesture recognition using depth data," IEEE Transactions on Human Machine Systems, vol. 46, no. 1, pp. 30-39, Feb. 2016.This paper surveys hand gesture recognition methods that use depth data, which is obtained from depth cameras or time-of-flight sensors. It discusses the advantages of depth data over RGB data and presents some recent works in this area.

[5] F. Alt and A. Bulling, "Eye-free interaction with in-air hand gestures: A survey," ACM Computing Surveys, vol. 48, no. 2, pp. 1-42, Nov. 2015.This paper surveys the research on in-air hand gesture recognition, which enables eye-free interaction with digital devices. It covers different sensors, gesture recognition algorithms, and interaction techniques.

[6] M. Polikar, "A survey on transfer learning," IEEE Transactions on Neural Networks and Learning Systems, vol. 22, no. 5, pp. 768-781, May 2011.This paper surveys transfer learning techniques, which can improve the performance of hand gesture recognition systems by transferring knowledge learned from one task to another. It covers different transfer learning methods and their applications in hand gesture recognition.

One of the main problems in hand gesture recognition is the ability to accurately detect and recognize a wide range of gestures in real-world settings. This requires the development of robust and accurate methods that can handle variations in lighting, hand orientation, camera angle, and background clutter, while also being able to recognize complex gestures used in sign language and other applications. Another challenge is the resource-intensive nature of many existing methods, which can make it difficult to implement hand gesture recognition on low-power devices such as mobile phones and wearable devices. Finally, there is a need for standardized datasets and evaluation metrics to enable fair comparisons between different methods and to facilitate further research in this field.

Existing methodology

Hand gesture recognition is an important area of computer vision and human-computer interaction, which has many applications in fields like virtual reality, robotics, sign language recognition, and video game control. There are several methods that are currently used for hand gesture recognition, including

1.Template matching: This method involves comparing the image of a hand gesture with a set of pre-defined templates to find the best match. The templates are typically created using a set of sample images of the hand gesture, which are then used to build a database of templates.

2.Neural networks: Neural networks are machine learning algorithms that are designed to recognize patterns in data. They are commonly used for hand gesture recognition because they can learn from a large dataset of hand gesture images, and can be trained to recognize even subtle differences between different gestures.

3.Hidden Markov Models (HMMs): HMMs are statistical models that are commonly used for speech recognition, but can also be used for hand gesture recognition. HMMs model the probability distribution of the hand gesture sequence, and use this to recognize new gestures based on their probability distribution.

4.Depth-based methods: Depth-based methods use 3D data to recognize hand gestures, typically obtained from sensors such as Microsoft Kinect. These methods can

provide more accurate recognition of hand gestures, as they are less affected by variations in lighting conditions and background clutter.

Overall, hand gesture recognition is a challenging problem, as it requires accurate detection of the hand and fingers, as well as recognition of the gesture itself. Each of the methods listed above has its own strengths and weaknesses, and the choice of method will depend on the specific requirements of the application.

Although there are many methods that have been developed for hand gesture recognition, there are also some drawbacks and limitations associated with these methods. Some of the common drawbacks of existing methods in hand gesture recognition include

1.Limitedaccuracy
2.Limitedrangeofgestures
3.Sensitivitytobackgroundclutter
4.Resource-intensive
5.Limited robustness to variability

Overall, while existing methods in hand gesture recognition have made significant progress, there are still several challenges that need to be addressed in order to improve the accuracy, reliability, and practicality of these methods. Researchers are actively working on developing new methods and techniques that can address these limitations and overcome the challenges of hand gesture recognition.

Proposed method

Convolutional Neural Networks (CNNs) have emerged as a popular method for hand gesture recognition due to their ability to learn complex features from images and their ability to handle variations in lighting, hand orientation, and camera angle.

CNN-based approaches typically involve training a neural network to learn a mapping between input images of hand gestures and corresponding output labels. This involves feeding a large dataset of labeled hand gesture images into the network and adjusting the weights of the network through backpropagation to minimize the error between the predicted and true labels.

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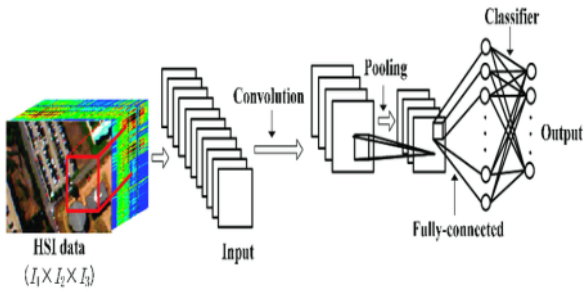

Fig: CNN model

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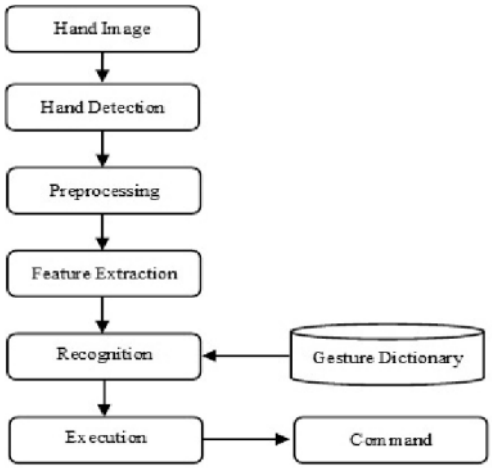

Fig: Flow graph of hand gesture detection in CNN model

Implementation

The implementation of CNN in hand gesture recognition involves several steps:

1. Data collection.
2. Data processing.
3. Model training.
4. Model evaluation.
5. Testing the model.
6. Model development.

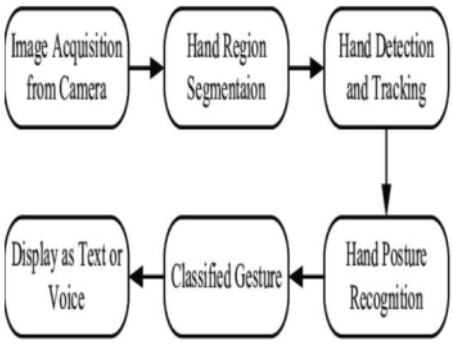

Fig: Block diagram.

1. Data collection:

A dataset of hand gestures is collected by taking pictures of different hand gestures with a camera.

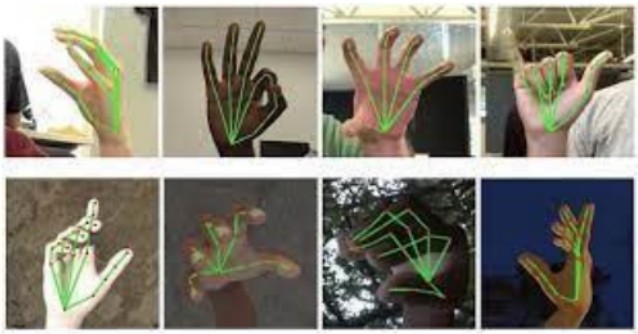

Fig: Data collection of hand gestures.

2. Data processing:

The collected data is preprocessed by resizing the images, normalizing the pixel values, and splitting the dataset into training, validation, and testing sets.

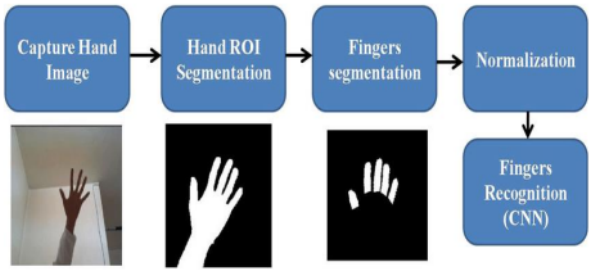

Fig: Data processing of hand gestures.

3. Model training:

The CNN model is defined, compiled, and fitted to the training data using a software tool like Keras.

4. Model evaluation:

The performance of the model is evaluated on the validation and testing sets using metrics like accuracy, precision, recall, and F1 score.

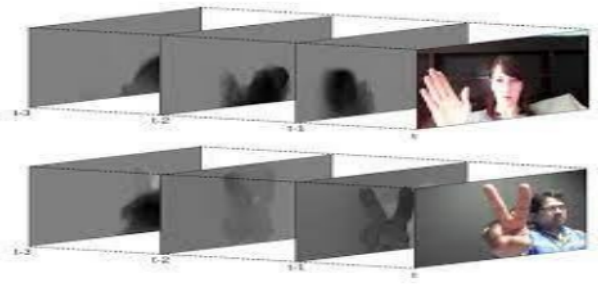

Fig: Model evaluation.

5.Testing the model:

The model is tested on new data by capturing live video, preprocessing the frames, and feeding them to the model to make predictions.

6.Model development:

The final step is to deploy the model to a device or platform of your choice, integrating the model into the application and providing a user interface for users to interact with it.

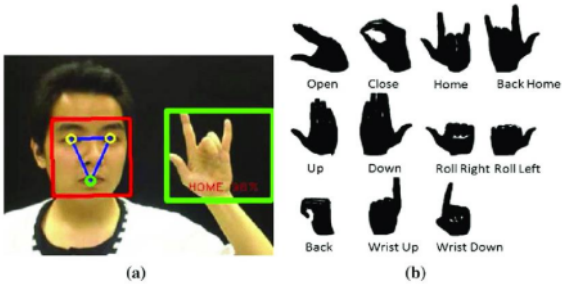

Fig: Model development.

Overall, the implementation of CNN in hand gesture recognition is a complex process, but it can be achieved with the right tools and techniques.

Results

Hand gesture recognition using convolutional neural networks (CNN) in OpenCV has shown promising results. With the help of deep learning techniques, CNN models can learn the features of hand gestures from input images and accurately classify them into different categories. This technology has a wide range of applications, including sign language recognition, virtual reality, and human-computer interaction. The use of CNNs in hand gesture recognition has greatly improved the accuracy and efficiency of the process, making it a valuable tool in various industries.

Conclusion

In conclusion, hand gesture recognition using convolutional neural networks (CNN) in OpenCV is a powerful technology that has demonstrated high accuracy and efficiency in recognizing different hand gestures from input images. With its wide range of applications, including sign language

recognition, virtual reality, and human-computer interaction, CNN-based hand gesture recognition has become an important area of research and development. While there are still some challenges that need to be addressed, such as lighting and pose variations, the use of CNN models in hand gesture recognition has significantly improved the accuracy and reliability of the process. Overall, CNN-based hand gesture recognition in OpenCV has shown great potential and is expected to have a significant impact on various industries in the future.

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