Students Innovative Project Report

Tamil Isolated Sign Language Recognition

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Submitted by

Ms.A.Abiramashree(*Department of Computer Science and Engineering*)
Ms.V.K.Tamizhini(*Department of Computer Science and Engineering*)
Ms.M.Swathi(*Department of Computer Science and Engineering*)

Guided by

Dr.R.Arockia xavier annie
Assistant Professor(SRGR),Department of Computer Science and Engineering)

Department of Computer Science and Engineering
College of Engineering ,Guindy
Anna University

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BONAFIDE CERTIFICATE

Certified that this project report TAMIL ISOLATED SIGN LANGUAGE RECOGNITION is the *bonafide* work of **ABIRAMASHREE(2020103053),TAMIZHINI VK (2020103580)**,**SWATHI M(2020103053)** who carried out the project work under my supervision, for the fulfilment of the requirements for the award of the degree of Bachelor of Engineering in Computer Science and Engineering. Certified further that to the best of my knowledge, the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or an award was conferred on an earlier occasion on these or any other candidates.

Dr. S. Valli

HEAD OF THE DEPARTMENT

Professor

Department of Computer Science and Engineering

College of Engineering Guindy
12, Sardar Patel Rd, Guindy
Chennai, Tamil Nadu - 600025

Dr. R. Arockia Xavier Annie

SUPERVISOR

Assistant Professor

Department of Computer Science and Engineering

College of Engineering Guindy
12, Sardar Patel Rd, Guindy
Chennai, Tamil Nadu - 600025

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We would like to express our hearty thanks to our friends and family, who not only provided support, but also contributed to the project by providing video recordings that we incorporated into the datasets used – this project would have not been possible without them.

Abiramashree A **Tamizhini VK** **Swathi M**

INTRODUCTION:

Sign language recognition refers to the ability of a computer system to interpret and understand the hand gestures and body movements used in sign language. Sign language is used by people with hearing disabilities to communicate and express themselves, and sign language recognition technology can help bridge the communication gap between them and hearing individuals. The development of sign language recognition technology is an important step towards making communication more inclusive and accessible for the deaf and hard-of-hearing people. It has the potential to revolutionize the way in which people with hearing disabilities interact with technology and the world around them.

Tamil sign language (TSL) is a visual language used by the deaf people in the Indian state of Tamil Nadu and some parts of Sri Lanka. It is a unique and distinct language with its own grammar, syntax, and vocabulary.

However, like many sign languages, TSL is not widely known or understood outside of the deaf community. There is still a need for more awareness and education about TSL to promote better communication and inclusion for the deaf and hard-of-hearing community in Tamil Nadu and Sri Lanka.

OBJECTIVE:

The objective of Tamil Sign Language recognition is to develop technology that can recognize and interpret sign language gestures used by individuals who are deaf or hard of hearing and who use Tamil Sign Language as their primary mode of communication. The goal is to create systems and software that can accurately and efficiently recognize the various hand gestures, facial expressions, and body movements used in Tamil Sign Language, and translate them into spoken or written language.

Tamil Sign Language recognition has several potential benefits, including making communication more accessible for deaf or hard of hearing individuals, allowing them to more easily interact with technology, and improving their ability to participate in various aspects of daily life. It can also help to bridge the communication gap between deaf or hard of hearing individuals and those who do not understand sign language.

SCOPE:

The scope of Tamil Sign Language recognition applications is broad and can encompass various fields, including communication, education, accessibility, entertainment, healthcare etc…It can be used to create accessible environments for deaf or hard of hearing individuals by integrating the technology into public spaces such as airports, hospitals, and other public buildings. This recognition can be used in healthcare settings to facilitate communication between healthcare

providers and deaf or hard of hearing patients. Overall, the scope of Tamil Sign Language recognition applications is vast and has the potential to improve the quality of life and accessibility for deaf or hard of hearing individuals in many different areas of their lives.

LITERATURE SURVEY:

PAPER	AUTHOR	MODEL	RESULT
American Sign Language Posture Understanding with Deep Neural Networks,IEEE,2018,July	Jalal et al	Capsule based neural network	Adaptive pooling and the proposed model gave accuracy of 99%
Real-Time American Sign Language Recognition Using Skin Segmentation and Image Category Classification with Convolutional Neural Network and Deep Learning,IEEE,2018,October	Shahriar et al	CNN	Acquired 94.7%
Classification of Sign Language Characters by Applying a Deep Convolutional Neural Network	Hasan et al	Deep convolution neural network	Successful identification of sign linguistics alphabets with accuracy of 97.2%

HARDWARE AND SOFTWARE TECHNOLOGIES USED:

- Raspberry pi 4 model B
- Raspbian OS
- Media pipe
- OpenCV
- Web Camera
- CV zone

RASPBERRY PI 4 MODEL B:

The Raspberry Pi 4 Model B is a powerful single-board computer that is designed to offer a low-cost computing solution for a wide range of applications. The Raspberry Pi 4 Model B delivers significantly better performance compared to its predecessor. The faster processor, combined with more RAM, enables the device to handle more demanding applications and multitasking. The improved connectivity options also make it easier to connect to other devices and networks.

Specifications: The Raspberry Pi 4 Model B is powered by a Broadcom BCM2711 quad-core Cortex-A72 (ARM v8) 64-bit SoC with a clock speed of 1.5GHz. It is available in three different RAM configurations: 2GB, 4GB, and 8GB. The device features dual-band 802.11ac wireless networking, Gigabit Ethernet, Bluetooth 5.0, two USB 3.0 ports, two USB 2.0 ports, and two micro-HDMI ports that can support resolutions up to 4K.We all have seen sign language recognition system for different languages like American Sign Language(ASL),Indian Sign Language(ISL) that has been used for many years. In our project we created a model to recognize tamil signs. We implemented our working model in raspberry pi by developing a web application.

RASPBIAN OS:

Raspbian OS is a reliable, lightweight, and user-friendly operating system that is designed specifically for Raspberry Pi computers. Its Debian-based architecture and support for GPIO pins make it an ideal choice for a wide range of projects, from basic computing tasks to complex hardware interfacing. With its pre-installed applications including the Chromium web browser, LibreOffice productivity suite, and the Thonny Python IDE,easy software installation, and regular updates, Raspbian OS is a solid choice for anyone looking to use their Raspberry Pi for a variety of tasks.

OPEN CV:

OpenCV (Open Source Computer Vision Library) is a popular open-source computer vision and machine learning library. important aspect of OpenCV is its support for real-time video processing. The library provides tools for video capture, processing, and output.The most important aspect of OpenCV is its support for real-time video processing. The library provides tools for video capture, processing, and output. It also includes tools for object detection and tracking in real-time video streams.

WEB CAMERA:

We use web camera to create the dataset for our model and for real time detection. CV Zone provides a pre-trained hand detection model that can be loaded using the Hand Detector class. This model uses deep learning techniques to detect and localize the hand in an input image or video frame.

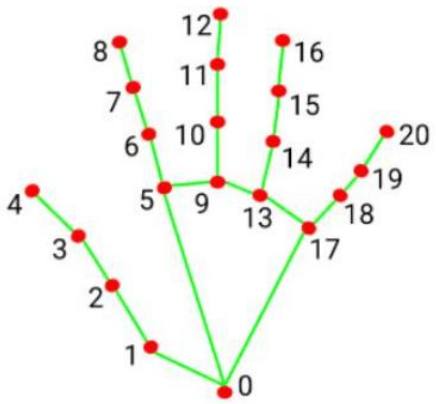
MEDIA PIPE:

MediaPipe is an open-source cross-platform framework developed by Google that provides developers with pre-built machine learning models and a set of APIs to build real-time

multimedia processing applications. The framework is designed to work with different types of media, including audio, video, and 3D graphics.

MediaPipe Hand Landmarks is built on top of TensorFlow and utilizes deep neural networks to detect and track hand landmarks. It can run on various devices, including desktop computers, mobile phones, and even Raspberry Pi. MediaPipe Hand Landmarks can detect and track hands in real-time, making it suitable for applications that require fast and accurate hand tracking, such as virtual reality and augmented reality.

Hand Land Marks



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

CVZONE:

CVZone is an open-source computer vision and machine learning library. The library is built on top of the popular computer vision library OpenCV and provides developers with a set of pre-built models and tools for building computer vision applications. One of the key features of CVZone is its ability to detect and track objects in real-time using deep learning techniques. CVZone also includes a set of tools for building custom models and training them on new datasets. The library provides developers with an easy-to-use interface for training models and includes support for popular deep learning frameworks such as TensorFlow and PyTorch.

Import the required libraries - First, we need to import the CVZone library and other required libraries like OpenCV and NumPy.

Load the pre-trained hand detection model - CVZone provides a pre-trained hand detection model that can be loaded using the HandDetector class. This model uses deep learning techniques to detect and localize the hand in an input image or video frame.

Capture image - Next, we need to capture image frames from the camera.

Process the images - For each image frame, we need to detect the hand using the pre-trained hand detection model. Once the hand is detected, you can extract the hand region using the findHand() method of the HandDetector class.

Recognize hand gestures - Once we have the hand region, you can use a hand gesture recognition algorithm to recognize the hand gesture. CVZone provides a pre-built hand gesture recognition model that can be loaded using the HandGesture class. This model uses machine learning techniques to recognize hand gestures based on the position of the fingers and the orientation of the hand.

Display the results - Finally, we can display the results of the hand gesture recognition system on the screen or save them to a file.

DESIGN METHODOLGY:

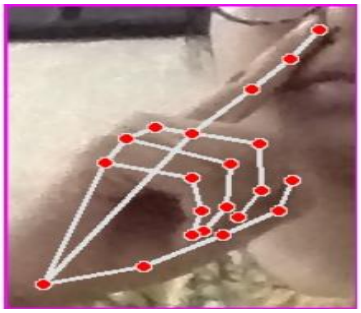
The motive of our project is to develop a model to recognize Tamil signs that helps deaf and hard of hearing people .Then the model is deployed as a web application that can be accessed via localhost. It involves dataset creation ,feature extraction, model development, hand gesture recognition, deployment.

DATASET CREATION:

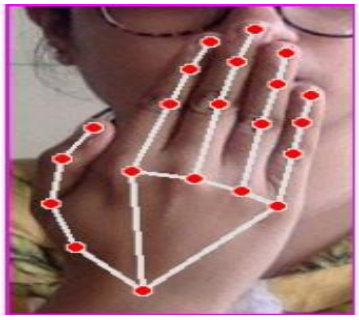
There is no dataset available for Tamil sign language. So we created the dataset for 7 words Amma, Sorry, Thanks, Water, Good, Anna, Akka with 700 images for each sign. We used web camera to capture images for the dataset.

SAMPLE DATSET IMAGES:

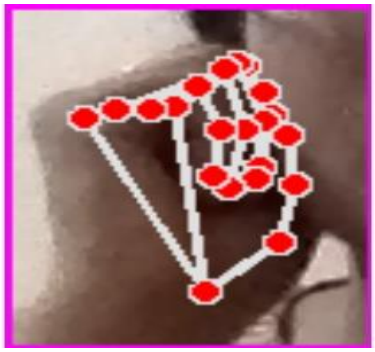
Amma



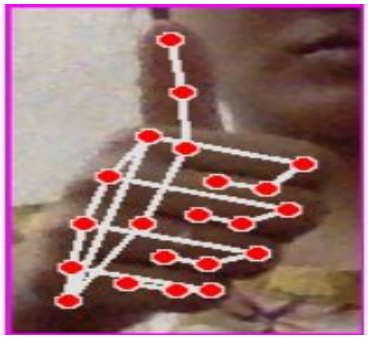
Thanks



Sorry



Correct



FEATURE EXTRACTION:

We imported Media Pipe and OpenCV libraries to work with hand tracking and gesture recognition. After loading the hand tracking model, we use OpenCV to capture the images from the camera. For each frame of the image, we pass the image to the hand tracking model to detect and localize the hand landmarks. Once the hand landmarks are detected, you can extract the hand gestures by analyzing the relative positions and movements of the landmarks. We displayed the hand landmarks and gestures on the image using OpenCV.

MODEL DEVELOPMENT:

Based on a variant of a Convolutional Neural Network (CNN) called a MobileNet architecture, which is designed to be computationally efficient and fast. The MobileNet architecture uses depthwise separable convolutional layers to reduce the number of computations required to process the input data, which makes it ideal for running on mobile devices and low-power hardware.

The hand gesture detection model in Mediapipe also uses a technique called Spatial Temporal Graph Convolutional Networks (ST-GCN), which is used to model the spatial and temporal relationships between different parts of the hand. Mediapipe Hand Gesture Detection uses a combination of MobileNet and ST-GCN algorithms to detect hand gestures in real-time. The MobileNet architecture is used to extract features from the input image, while the ST-GCN algorithm is used to model the spatial and temporal relationships between different parts of the hand.

```
Epoch 995/2000
4/4 [==============================] - 0s 111ms/step - loss: 0.2870 - categorical_accuracy: 0.9298
Epoch 996/2000
4/4 [==============================] - 1s 124ms/step - loss: 0.2888 - categorical_accuracy: 0.9035
Epoch 997/2000
4/4 [==============================] - 0s 111ms/step - loss: 0.2841 - categorical_accuracy: 0.9211
Epoch 998/2000
4/4 [==============================] - 0s 119ms/step - loss: 0.2819 - categorical_accuracy: 0.9298
Epoch 999/2000
4/4 [==============================] - 0s 124ms/step - loss: 0.2676 - categorical_accuracy: 0.9123
Epoch 1000/2000
4/4 [==============================] - 1s 125ms/step - loss: 0.3037 - categorical_accuracy: 0.9298
```

HAND GESTURE RECOGNITON:

After developing the model, we tested our model by implementing real time hand gesture recognition. On running our code, the camera will start streaming and be ready to capture the input from the user. Based on the sign showed in the feed, it will recognize the gesture and show the output on the screen.

DEPLOYMENT:

We created a web application that showcase a live demo of our working model of tamil sign language recognition. The web application can be accessed via localhost. We did a live stream of sign language in raspberry pi computer.

WEB APPLICATION:

We created a Python Flask web application that uses computer vision to recognize isolated sign language gestures in Tamil language. The application uses OpenCV for image processing and the CVZone library for hand detection and gesture classification.

Prerequisites

To run the application, you will need:

Python 3.6 or later

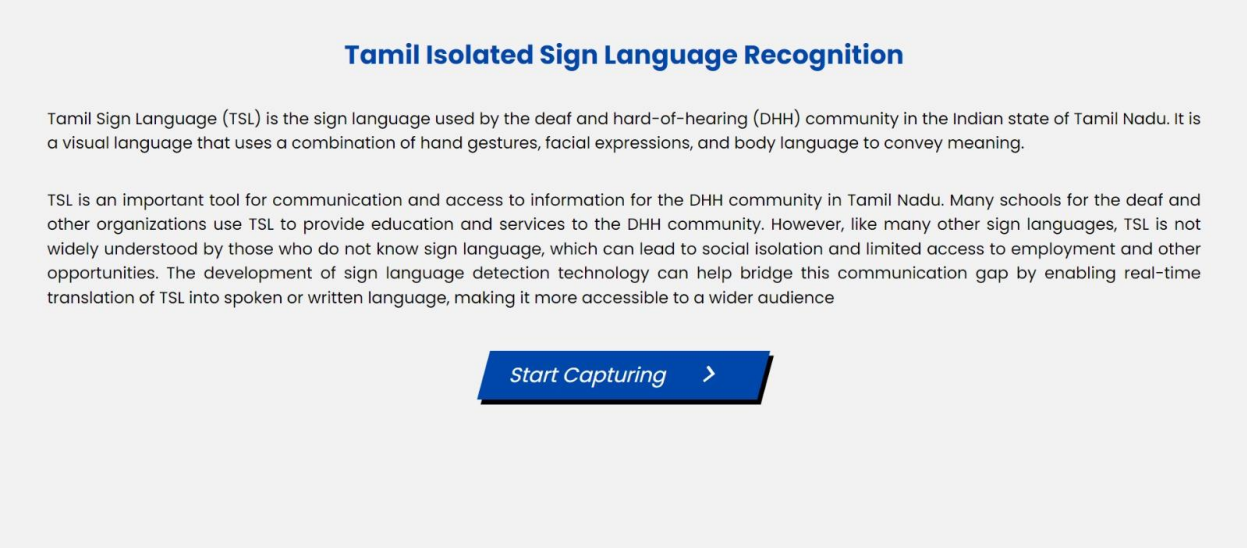
Flask (pip install flask)

OpenCV (pip install opencv-python)

CV Zone (pip install cvzone)

Usage

To start the application, run python app.py in the terminal and then go to http://localhost:5000 in your web browser. Once you are on the main page, click the "Start Capturing" button to start the video stream and see the real-time recognition of sign language gestures.To recognize a gesture, you need to perform it in front of a camera. The application will detect your hand and crop the image to the region of interest. Then, it will resize the cropped image to a fixed size (300x300 pixels) and feed it to a pre-trained deep learning model that will classify the gesture.



RESULTS AND CONCLUSION:

The signs Amma, Sorry, Thanks, Water, Good, Anna, Akka are recognized by our model and it is converted to a web application for the benefits of the deaf and hard-hearing people.

METRICS AND EVALUATION:

- **True Positives (TP):** Number of classifications where the actual label is positive and class is correctly predicted by the model to be positive.
- **False Positive (FP):** Number of classifications where the actual label is negative and class is incorrectly predicted by the model to be positive.
- **True Negatives (TN):** Number of classifications where the actual label is negative and class is correctly predicted by the model to be negative.
- **False Negative (FN):** Number of classifications where the actual label is positive and class is incorrectly predicted to be negative.

  Accuracy is the fraction of predictions the model has correctly classified. Formally, accuracy can be defined as follows:

$$Accuracy = \frac{Number\ of\ correct\ predictions}{Total\ number\ of\ predictions} = \frac{TP + TN}{TP + TN + FP + FN}$$

The accuracy for our model is 93%

Correct detection under good lighting:

Wrong detection under bad lighting

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C. Chansri, J. Srinonchat, E. G. Lim and K. L. Man, "Low Cost Hand Gesture Control in Complex Environment Using Raspberry Pi," 2019 International SoC Design Conference (ISOCC), Jeju, Korea (South), 2019, pp. 186-187, doi: 10.1109/ISOCC47750.2019.9027669.