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Hand Sign Recognition using Machine Learning

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Abstract - Hand sign recognition is an emerging and impactful application in the field of human-computer interaction (HCI) and assistive technologies, particularly for communication with and among hearing- and speech-impaired individuals. This project aims to develop an efficient and accurate system capable of recognizing hand gestures representing specific signs or alphabets using various computer vision and machine learning techniques. The proposed system processes hand signs captured through a live camera or image input and classifies them using robust algorithms to interpret the meaning of each gesture.

The system incorporates a combination of image processing techniques and machine learning models. Initially, the hand region is isolated from the background using methods such as colour segmentation or background subtraction.

Key Words: Hand Sign Recognition, Assistive Technology, Machine Learning, Image Processing,CNN.

1. INTRODUCTION

In an increasingly digital world, enabling intuitive and accessible communication between humans and machines has become a critical area of technological development. One such avenue is hand sign recognition, a subset of gesture recognition, which interprets the visual language of hand movements into meaningful digital signals.

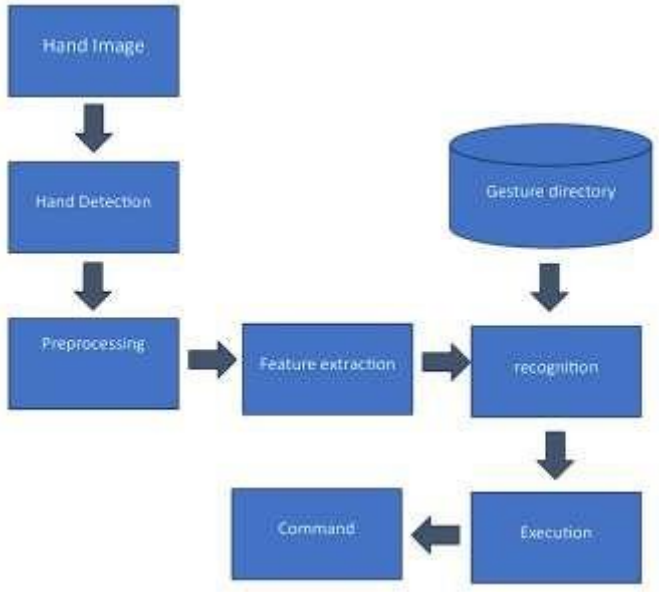
2. Body of Paper

This hand sign recognition system integrates image processing and machine learning techniques to enable real-time gesture classification for assistive communication. Using tools like OpenCV, MediaPipe, and TensorFlow, the system captures hand gestures via live camera input, isolates the hand region through color segmentation or background subtraction, and enhances image quality using grayscale conversion and morphological operations. Features are extracted using methods like HOG or MediaPipe landmarks and classified using SVM, KNN, or CNN models. The system supports dynamic and static gesture recognition and can be deployed on mobile or desktop platforms, making it a practical solution for inclusive human-computer interaction.

Table -1:

AUTHOR	ALGORITHM/TECHNIQUES	METHODOLOGY	REMARKS	MERIT
Sasikala Dhamodaran Pratyush pranjal Phukan Mayank singh	(Opencv)Detects hand using contours and convex hull; identifies finger gaps for gesture classification.	Capture image, preprocess, find contours, compute convexity defects, classify based on geometry.	Works well in controlled environments; sensitive to lighting, background, and hand orientation.	Fast,requires no training, ideal for simple, static hand gestures in real-time systems.
Laveen chandwani Jaydeep Khilari Kunal Gurjar Pravin Maragale	(Mediapipe)Uses machine learning to detect 26 hand landmarks from real-time RGB image input.	Detect palm, estimate hand pose, extract landmarks, classify gestures using landmark patterns.	Highly accurate, robust to lighting and background changes, but needs decent processing power.	Real-time, high-precision landmark tracking; easy integration with gesture classification models.
Shanmugan Saravanan Lakshmanan S A Dhanasekaran Parasuraman P.Mahalakshmi	(cnn) Learns spatial features from hand images using layered convolution and pooling operations.	Train CNN model on labeled hand sign images; classify based on learned visual patterns.	High accuracy ;needs large dataset and training time; performs well on complex gestures	Automatically extracts features; scalable and robust for both static and dynamic gestures.

Existing Block Diagram



Proposed Block Diagram

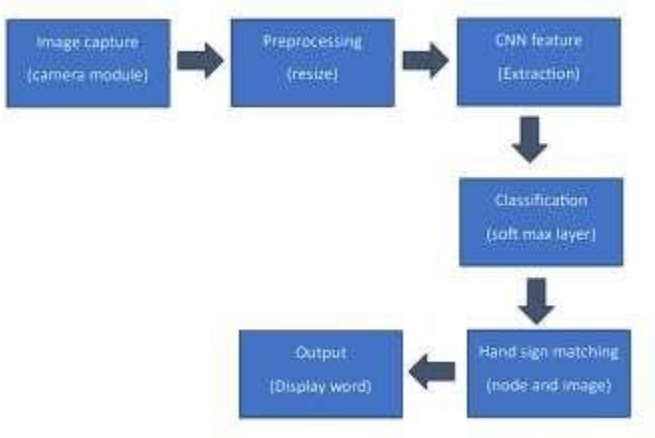


Fig -1: Figure

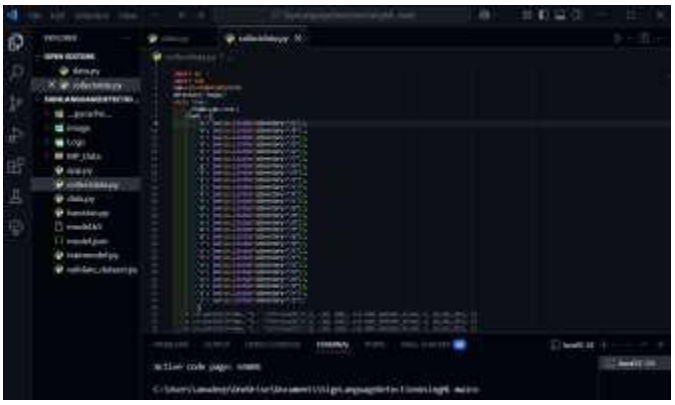
Hand sign recognition involves the identification and interpretation of hand gestures using computer vision and machine learning techniques. It plays a vital role in enabling communication for individuals with speech and hearing impairments by converting visual gestures into digital signals. Accurate recognition requires preprocessing, feature extraction, and classification of hand images, with applications in assistive technology, human-computer interaction, and smart environments.

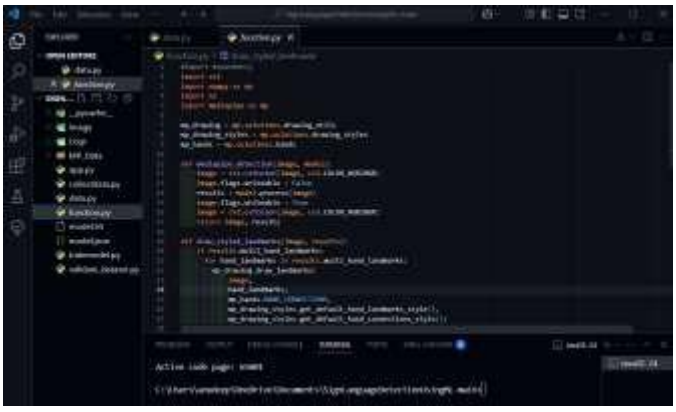
Here are common methods of hand sign recognition techniques:

1. **Image Processing & Feature Extraction** — Using cameras to capture hand images and extracting features like edges, contours, or fingertips for recognition.
2. **Machine Learning Approaches** — Applying classifiers such as Support Vector Machines (SVM), k-Nearest Neighbors (k-NN), or Random Forest on extracted hand features.
3. **Deep Learning Methods** — Utilizing Convolutional Neural Networks (CNNs) or Recurrent Neural Networks (RNNs) to automatically learn features from raw image or video data.
4. **Glove-based Sensors** — Using data gloves with sensors (flex sensors, accelerometers) to directly capture finger positions and gestures.
5. **Leap Motion & Depth Cameras** — Employing specialized hardware like Leap Motion or Microsoft Kinect to capture 3D hand motion and gestures.
6. **Optical Flow and Motion Tracking** — Tracking hand movement across frames to recognize dynamic gestures.
7. **Hidden Markov Models (HMMs)** — Modeling temporal sequences of hand gestures, useful for continuous sign language recognition.
8. **Template Matching** — Comparing hand images against predefined templates for recognition.

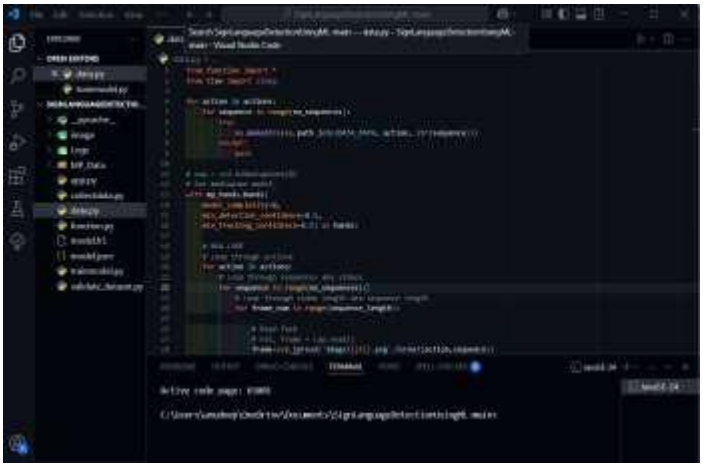
3. SYSTEM ARCHITECTURE

1. Create an image folder first with all the 26 alphabets folders in it. Run the code below and Collect all the images in the image folder you have created above . and create a function.py file and write down the code in the second image and save it .

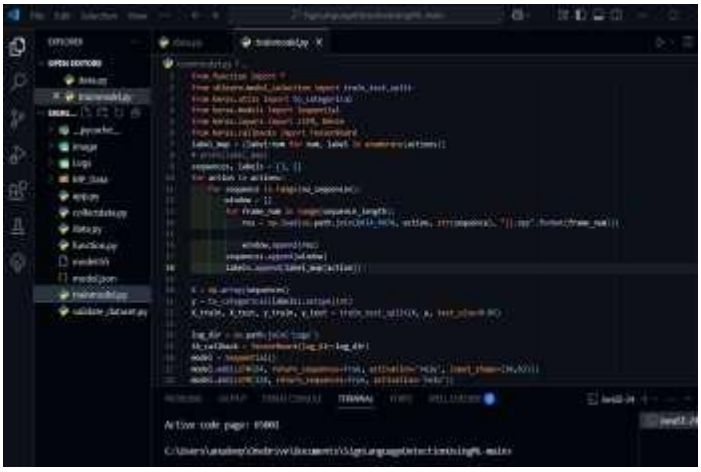




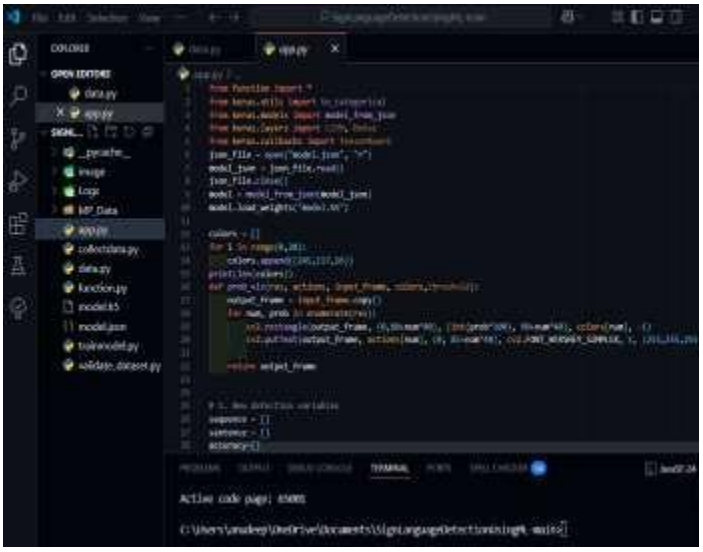
2. Run the code below to create an Mp_data folder where all of the nodes (.npy) are stored.



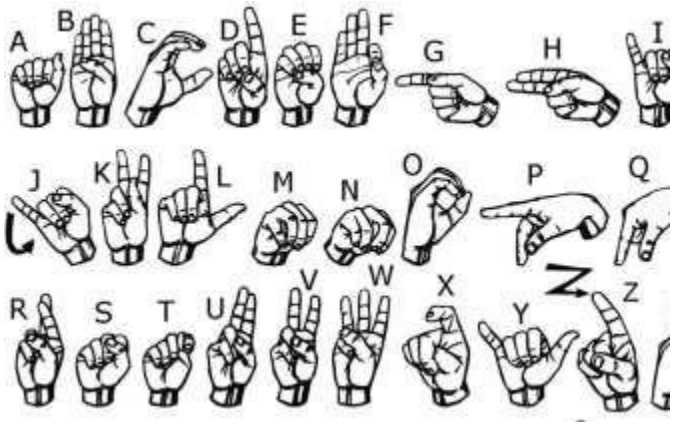
3. Now train the model using train_model code provided below (tensor flow software) so that it can detect the hand sign.



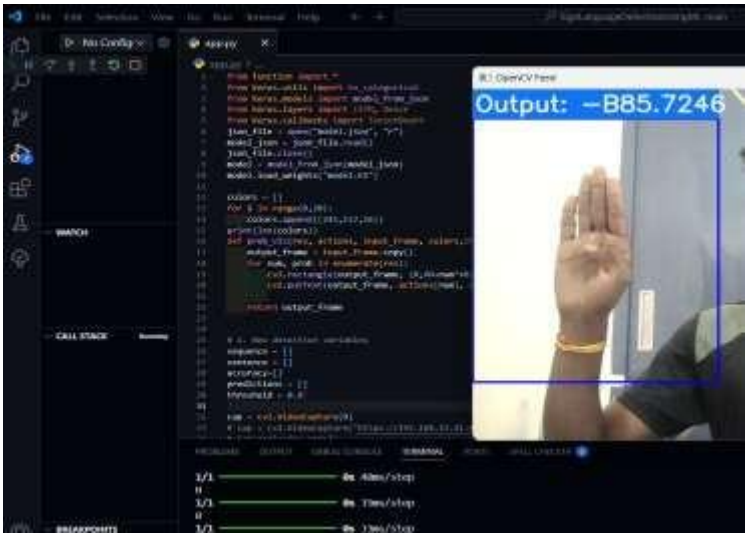
Result

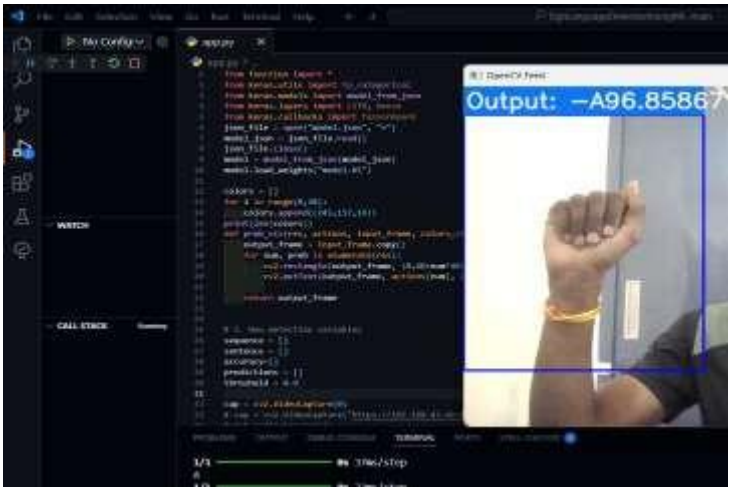


Run the above code, show the hand signs as shown in the image below and observe the live output.



The output is shown below with the accuracy of the hand sign.





4. CONCLUSION

In this project, we proposed a novel ResUnet architecture to extract more features efficiently on brain tumor segmentation data. The model architecture can be improved by adding more frameworks with multiple residual blocks at both the contraction and the expansion paths. Therefore, our future work is to look into more detailed features and also identify the grade of tumor based on the segmented tumor shape.

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BIOGRAPHIES

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