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Indian Sign Language to Text/Speech Translation System

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ABSTRACT: This is an advanced idea, designed for the translating Indian sign Language into real-time text or speech which removes the gap between the deaf people and people who can't hear. Our application will recognize Indian sign language gestures and converting them into text or speech in multiple languages like Hindi, Telugu, Tamil. Here, it has a feature called as gesture recognition which identifies the gestures done by the people in front of camera and by using those gestures they will be converted to text. Using Computer Vision, Machine Learning, Gesture Recognition, Text translation, Speech Synthesis and real-time processing. First this interface will convert the gestures into the text format or speech format. Whereas Current systems are only focusing on other sign languages like ASL or Libras, but they have many limitations which are narrow language support and it has many struggles with the very complex gestures where it will also involve facial expressions. Now our model will concentrate on facial expressions by integrating comprehensive ISL gesture library and multi model input with glove-based sensors and some NLP translations. This system also contains customizable speech output in native multiple languages. This application will also utilize advanced computer vision frameworks like OpenCV and deep learning models such as CNNs for getting high accuracy while gesture recognizing. This will improve the quality of translation where as that customizable speech will give in multiple Indian languages.

KEYWORDS: Sign Language Translation, Machine Learning, Natural Language Processor, Gestures, Facial Expressions, Computer Vision, Open CV, Sign Translation, Text to Sign, Tkinter, TensorFlow, Media Pipe, CNN, LSTM.

I. INTRODUCTION

This System is to make the Communication possible for all the people. Mainly we know that Communication is a fundamental aspect of human interactions, this can make every individual to express their thoughts and emotions effectively. For people who can see but not speak or hear they can use this as medium to express their expressions and emotions by showing the signs which they wanted to express. Indian sign language (ISL) is the primary mode of communication for the deaf and dumb community in India. Unlike spoken languages which can be used from speech recognition and translation technologies whereas sign language still not at developed much compared to. This innovation solution creates communication between special ability people and rest of the society. Generally, if any dead or dumb wanted to express their feelings there should be a person who supports and understand their language which is more waste of time and money and even written text is not much suitable alternative so mostly people depend on sign language instead of written text. Therefore, there is much needed for developing AI model which could translate the Indian sign language.

One of the key challenges in ISL translation is differences in hand movements and hand gestures, many people show different gestures and hand movements for the same meaning, so we Used AI and NLP for facial expressions to match their hand gestures and facial expressions to understand their emotion and meaning. After understanding their emotional meaning, it will display a text of their emotion. And if the word is not in the global dictionary, it shows every individual letter and adds them to form a word and then a sentence. The deployment of such system can help the people in public spaces, we can think that the people who don't know how to study for them we even provide voice note of

that text. By also integrating into applications of mobile and laptops can remove the barriers between the communities by showing how AI can be used to give equal opportunities for all the individuals regardless their physical abilities.

II. LITERATURE SURVEY

There are several strategies that come out in existing studies to enhance the ability of the disable people's feelings for the society and we inherited some of the properties for these papers which are pre published some of them are

Advancements in Indian Sign Language Recognition Systems – 2023

From this we understood ISL grammar for better model development.

Indian Sign Language Recognition Using Mediapipe Holistic – 2023

Inspired about the ISL tools and more of them

A Comparative Analysis of Indian Sign Language Recognition Using Deep Learning Models -2023

Took the dataset from them which is very good one for ISL language.

Real-Time Indian Sign Language Recognition System -2018

Extracted grid-based feature from this project.

Indian Sign Language: A Linguistic Analysis of Its Grammar -2018

This contains the best performing deep learning model

Indian Sign Language Recognition – A Survey -2013

Checking and verifying CNN and LSTM for ISL gesture recognition. By this model we got to know how can we use gesture recognition and all with including their dataset.

A Review on Indian Sign Language Recognition – 2013

In this we learned to classify into different thing in ISL language.

Towards Performance Improvement in Indian Sign Language Recognition – 2020

This contains of high accuracy methods and this system give accuracy of 99.6% for sign language to text language or speech.

Indian Sign Language (ISL) Biometrics for Hearing and Speech Impaired Persons -2017

Used different ISL gesture recognition for finding all the patterns and methods in ISL language.

Vision-Based Hand Gesture Recognition Using Contour Analysis for ISL – 2014

Used contour analysis for hand gesture recognition, which explores vision-based approach in ISL recognition.

A Real-Time Indian Sign Language Recognition System Using Deep Learning – 2019

Used deep learning model to implement in real time with high accuracy.

Sign Language Recognition Using Kinect Sensor – 2015

Used sensors to evaluate the data based on sensors recognition for ISL language.

Hand Gesture Recognition for Indian Sign Language: A Hybrid Approach – 2017

Used hybrid method technology for recognition of ISL.

Deep Learning-Based Indian Sign Language Recognition System – 2021

Used Deep learning model for better outcomes in recognizing gestures and giving interlinked text and audio to it. This even gives more robust solution.

A Survey on Indian Sign Language Recognition Techniques – 2015

Shows all the ISL recognition methods and their limitations.

Real-Time Sign Language Recognition Using Machine Learning – 2017

Used Machine learning models to get the real time result for recognizing ISL gestures.

Indian Sign Language Recognition Using Convolutional Neural Networks – 2020

Used CNN to identify the hand gestures with high accuracy.

Real-Time Indian Sign Language Recognition. – 2018

Implemented grid-based feature extraction for the ISL language.

Sign Language Recognition Using Kinect -2012

Used Dept camera-based analysis for recognizing the gestures and used deep model for translating gestures to text and speech.

III. SYSTEM ARCHITECTURE

This System Consists of these Components:

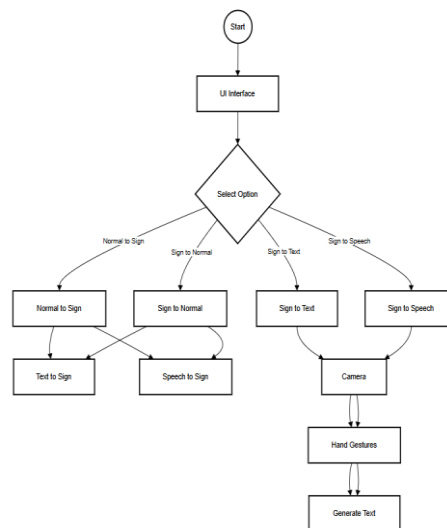


Fig 1. System Architecture diagram of Indian Sign Language System

This diagram shows the flow of the system which use deep learning and machine learning to detect the gestures and result the text and speech and vice versa.

1. Start

User will start here.

2. UI Interface

This is the visual interface which can be seen by naked eye.

3. Decision Point (Select option)

This contains of 2 options Signs to normal and normal to sign where they convert sign language to Indian language and also Indian language to Sign language.

4. Sign to Normal

When user select this option, his camera will be switched on and then user has to show the hand gestures of ISL language.

5. Normal to Sign

When user can speak and read but if he wants to convert that to sign language, he has to enter this option so there will be 2 options after this they are Text to sign or Voice Message to sign language.

Here if the system doesn't contain the words sign then it will generate sign for every single letter.

6. Sign to text

This converts Sign language to text form

7. Sign to Speech

In this step, gestures will be changed to Speech using NLP and deep learning.

IV. METHODOLOGY

This Python Program is a sign language translation application which provides two main functionalities:

1. Sign Translation – which converts images to text by recognizing the hand gestures.
2. Text to sign – This converts text and speech into the format of signed language using already existed data set which are images and animated GIFs.

For GUI we have used Tkinter and also OPENCV and PIL for processing the images which are already in pre-existing data set.

TensorFlow is used which is the Deep learning model used to recognize the sign and speech when the inputs are Live camera video and Voice inputs.

Importing Required Libraries:

```
import subprocess
import numpy as np
import cv2
import os
import PIL
from PIL import ImageTk, Image
import speech_recognition as sr
import pytsx3
from tkinter import *
import tkinter as tk
from tkinter import ttk
```

Loading Trained Model:

```
classifier = load_model('model.h5')
```

Defining the functions:

```
def give_char():
    test_image=image.load_img('tmp1.png', target_size=(64, 64))
    test_image = image.img_to_array(test_image)
    test_image = np.expand_dims(test_image, axis=0)
    result = classifier.predict(test_image)
    chars = "ABCDEFGHJKLMNOPQRSTUVWXYZ"
    indx = np.argmax(result[0])
    return chars[indx]
```

Handling Files for Signs:

```
op_dest = "filtered_data/"
alpha_dest = "alphabet/"
dirListing = os.listdir(op_dest)
editFiles = [item for item in dirListing if ".webp" in item]
```

```
file_map = {}
for i in editFiles:
    tmp = i.replace(".webp", "").split()
    file_map[i] = tmp
```

Function to Generate Sign Language GIF:

```
def func(a):
    all_frames = []
    words = a.split()
    for i in words:
        flag, sim = check_sim(i, file_map)
        if flag == -1:
            for j in i:
                im = PIL.Image.open(alpha_dest + str(j).lower() + "_small.gif")
```

```
for frame_cnt in range(im.n_frames):
    im.seek(frame_cnt)
    im.save("tmp.png")
    img = cv2.imread("tmp.png")
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    img = cv2.resize(img, (380, 260))
    im_arr = PIL.Image.fromarray(img)
    all_frames.append(im_arr)
else:
    im = PIL.Image.open(op_dest + sim)
    im.save('tmp.gif', 'gif', save_all=True)
    for frame_cnt in range(im.n_frames):
        im.seek(frame_cnt)
        im.save("tmp.png")
        img = cv2.imread("tmp.png")
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        img = cv2.resize(img, (380, 260))
        im_arr = PIL.Image.fromarray(img)
        all_frames.append(im_arr)
return all_frames
```

GUI Development with Tkinter:

Tk_Manage Class - Main Window Handler

```
class Tk_Manage(tk.Tk):
    def __init__(self, *args, **kwargs):
        tk.Tk.__init__(self, *args, **kwargs)
        container = tk.Frame(self)
        container.pack(side="top", fill="both", expand=True)
        self.frames = {}
        for F in (StartPage, VtoS):
            frame = F(container, self)
            self.frames[F] = frame
            frame.grid(row=0, column=0, sticky="nsew")
        self.show_frame(StartPage)

    def show_frame(self, cont):
        frame = self.frames[cont]
        frame.tkraise()
```

Home Page:

```
class StartPage(tk.Frame):
    def __init__(self, parent, controller):
        tk.Frame.__init__(self, parent)
        label = tk.Label(self, text="Sign Sense", font=("Helvetica", 24, "bold"))
        label.grid(row=0, column=0, columnspan=2)
        btn_voice_to_sign = ttk.Button(self, text="Text to Sign", command=lambda: controller.show_frame(VtoS))
        btn_voice_to_sign.grid(row=2, column=0, columnspan=2)
```

VtoS Class - Text to Sign Language Conversion:

```
class VtoS(tk.Frame):
    def __init__(self, parent, controller):
        tk.Frame.__init__(self, parent)
        self.inputtxt = tk.Text(self, height=1, width=30)
        self.inputtxt.pack()
        convert_button = tk.Button(self, text="Convert", command=self.take_input)
```

```
convert_button.pack()
speech_button = tk.Button(self, text="Use Voice", command=self.speech_to_text)
speech_button.pack()
self.gif_box = tk.Label(self)
self.gif_box.pack()
```

```
def speech_to_text(self):
    recognizer = r.Recognizer()
    with sr.Microphone() as source:
        audio = recognizer.listen(source)
        text = recognizer.recognize_google(audio)
        self.inputtxt.insert("1.0", text)
        self.take_input()
```

Sign Language Translator using MediaPipe, OpenCV, and TensorFlow:

This uses MediaPipe, OpenCV and TensorFlow for translating Sign language to Indian normal languages and also it identifies hand, face, and poses by using a already trained model and then displays real-time sign language Translations via Tkinter GUI.

V. RESULTS AND DISCUSSION

Model is tested on many real-world datasets and many live videos too, to check its performance all over with different people.

Based on these are results we have found Accuracy, false positive rates and overall reliability.

Overall Performance

Model/ Approach	Accuray (%)	Ranking
CNN -Based ISL Recognition	94.5%	1
LSTM-Based ISL Recognition	92.8%	2
Hybrid CNN- LSTM Model	91.2%	3
HMM-Based Gesture Recognition	88.7%	4
Kinect-Based Depth Recognition	85.6%	5

Table1 : Overall performance of the different models.

To also Evaluate the effectiveness of our model we also need to check serval ranking metrics scores.

Ranking Metrics:

Metrics	Percentage
Precision	94.31%
Recall	92.7%
F1-Score	93.5%
Latency	91.6%
Accuracy	94.5%

Table 2 : Ranking metrics for the model performance

VI. CONCLUSION

In conclusion that, this deep Learning model when compared with other models can have significant changes and the model has the highest Accuracy of 94.5% while using LSTM and other hybrid models also performs well but not in expected as CNN model.

Machine Learning techniques like HMM which results in very low accuracy which are not suitable for such kind of problems. Where as putting CNN and hybrid CNN-LSTM models are most suitable compared with Machine Learning models as they get higher accuracy and better performance. Even though it gets higher accuracy still real time processing remains a huge challenge and it's a crucial factor when it comes to Practical Applications. Using CNN - LSTM models which are more suitable. Even all the challenges are resolved we still remained with challenges like Dataset dependency, High computational cost and other minor issues

In future, we can still improve this with adding the analysis how sign language is being converted to Human speak able language so that even who doesn't know the sign language can learn and understand it.

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