Signify: Hand Sign Recognition System

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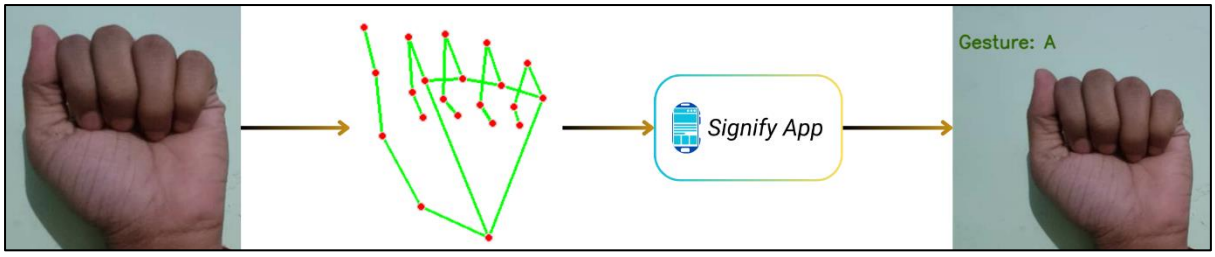


Step 1: Prototype Selection

Abstract:

The motivation behind developing Signify was to address the communication challenges faced by individuals who rely on sign language, especially in situations where others may not understand it. By creating a tool that translates hand signs into text in real-time, Signify aims to bridge the gap between sign language users and non-sign language speakers, promoting inclusivity and accessibility.

This report outlines the use of MediaPipe for hand pose estimation and keypoint distance calculation, along with classification algorithms to accurately recognize and convert hand gestures into text. By doing so, Signify seeks to improve communication experiences and provide an alternative method for text input. The report also includes insights into the app's functionalities and potential future developments to enhance its capabilities further.

1. Problem Statement:

Communication is a fundamental human right, yet millions of people with hearing or speech impairments face challenges due to the lack of understanding of sign language by others. This creates significant barriers in social, educational, and professional settings. Current solutions, like interpreters and text-based tools, are often unavailable or inadequate for dynamic conversations. Additionally, existing sign language recognition technologies suffer from inaccuracies and require specialized hardware. Developing a reliable and accessible hand sign recognition application is crucial to bridging this communication gap and promoting inclusivity for individuals with hearing or speech impairments.

2. Market/Customer/Business Need Assessment

Understanding market trends and customer needs is crucial for positioning Signify in the growing field of hand sign recognition technology. The market for these tools is expanding rapidly, driven by demand in healthcare, education, and customer service sectors for inclusive communication solutions. Customers require reliable, real-time recognition technologies that are easy to use and integrate into existing workflows without needing specialized hardware. Signify aims to meet these needs by offering a tool that enhances communication accessibility and inclusivity, leveraging high-quality datasets to ensure accuracy and effectiveness across diverse user groups.

3.Target Specifications and Characterization

Signify is designed to meet the following specifications:

- **Real-Time Processing:** The application should convert hand signs into text without delay, enabling smooth and immediate communication.
- **High Accuracy:** It must accurately recognize a diverse range of hand signs, accommodating various hand shapes, sizes, and skin tones.
- **User-Friendly Interface:** The app should be easy to navigate and use, requiring minimal training or technical expertise.
- **Seamless Integration:** It should integrate with existing systems and devices, functioning without specialized hardware.
- **Scalability:** The application should support future updates and expansions, including additional sign languages or tailored functionalities.

These features are aimed at improving communication and accessibility for users across different sectors.

4. External Search (Information Sources/References):

Some relevant online resources and links that could help with my Hand Sign Recognition System:

- **Mediapipe Documentation (**Mediapipe Documentation): Provides guidance on keypoint detection for hand sign recognition.
- **Machine Learning & Gesture Recognition (**IEEE Xplore): Offers academic papers for insights into gesture recognition and machine learning.
- **Computer Vision (**OpenCV Documentation): OpenCV documentation for tasks related to computer vision in the app.
- **Scikit-learn Documentation (**Scikit-learn Documentation**)**: Resource for implementing and refining classification algorithms.

Dataset for Code Implementation:

I am using the following Dataset for my code implementation. This csv file, contains hand gesture data captured for various signs. Each row in the file includes:

- **Distance Measurements:** Calculated distances between pairs of 21 hand landmarks, forming feature vectors for gesture recognition.
- **Gesture Label:** Indicates the corresponding hand sign (e.g., A to Z).

The file is structured with columns for each distance measurement followed by a final column for the gesture label. This dataset is used to train and evaluate models for hand sign recognition.

Dataset Overview:

```
# importing libraries
import numpy as np
import pandas as pd

# loading dataset
df = pd.read_csv('/kaggle/input/hand-sign-dataset/sign_data.csv')
df.head()
```

	Distance_0	Distance_1	Distance_2	Distance_3	Distance_4	Distance_5	Distance_6	Distance_7	Distance_8	Distance_9	...
0	0.076694	0.161632	0.228380	0.285946	0.200716	0.260093	0.267756	0.250494	0.197406	0.266744	...
1	0.089151	0.188643	0.260381	0.315467	0.216081	0.269505	0.214803	0.168108	0.199608	0.251859	...
2	0.084058	0.186973	0.262486	0.317055	0.218029	0.268898	0.207260	0.159519	0.202275	0.254334	...
3	0.086785	0.191843	0.270346	0.323954	0.225063	0.285468	0.220374	0.172865	0.212522	0.270331	...
4	0.089493	0.197114	0.277567	0.340391	0.233693	0.284127	0.213904	0.165717	0.218010	0.268056	...

```
# Dataset Information
print(f"Shape of Dataset - {df.shape}")
print(f"\nNull Data - {sum(df.isnull().sum())}")
print(f"\nDusplicate Data - {df.duplicated().sum()}")
print("\nDataset Information:")
df.info()
```

```
Shape of Dataset - (2700, 211)

Null Data - 0

Dusplicate Data - 0

Dataset Information:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2700 entries, 0 to 2699
Columns: 211 entries, Distance_0 to Sign
dtypes: float64(210), object(1)
memory usage: 4.3+ MB
```

5. Business Opportunity

Signify specializes in real-time translation of hand sign gestures into text or spoken language, primarily targeting deaf or hard-of-hearing individuals and institutions. The company's business model is designed to deliver value through unique features while ensuring sustainable revenue from multiple streams:

1. **Freemium Model:** Users start with a 7-day free trial of basic services, then can subscribe for premium features like customizable gestures and advanced integrations.

2. **Institutional Subscriptions:** Tailored pricing for schools, workplaces, and community centres, with discounts for bulk purchases, promoting accessibility.

3. **API Sales:** Revenue from API access allows third-party integration, priced by usage and API calls, extending the technology's reach and fostering innovation.

Signify's business model emphasizes delivering accessible and efficient communication solutions for the deaf and hard-of-hearing community. Through subscription models, institutional partnerships, and API sales, Signify aims for sustainable growth while upholding its commitment to inclusivity and technological innovation. These revenue streams collectively support Signify's mission of enhancing communication through innovative technology solutions.

6. Concept Development

Concept generation for Signify, began with identifying the need for a solution that facilitates real-time conversion of hand sign gestures into text. This involved:

1. **Identifying User Needs:** Recognizing the communication challenges of the deaf and hard-of-hearing community and the need for real-time gesture recognition.

2. **Brainstorming:** Generating ideas for effective hand gesture capture, focusing on accuracy, speed, and usability.

3. **Filtering and Selection:** Evaluating concepts based on feasibility, impact, and alignment with accessibility goals.

This structured approach ensured Signify was tailored to meet user needs and enhance communication through technology.

7. Concept Development

Concept development for Signify involves refining the initial idea into a comprehensive product/service designed to meet the needs of its target users. This includes:

- **Defining Features:** Determining the essential functionalities such as real-time hand sign gesture recognition, conversion to text, and user-friendly interface.

- **Technical Implementation:** Detailing the technical aspects such as creating a custom dataset using Mediapipe for accurate gesture analysis and employing the KNN classification algorithm for real-time processing.

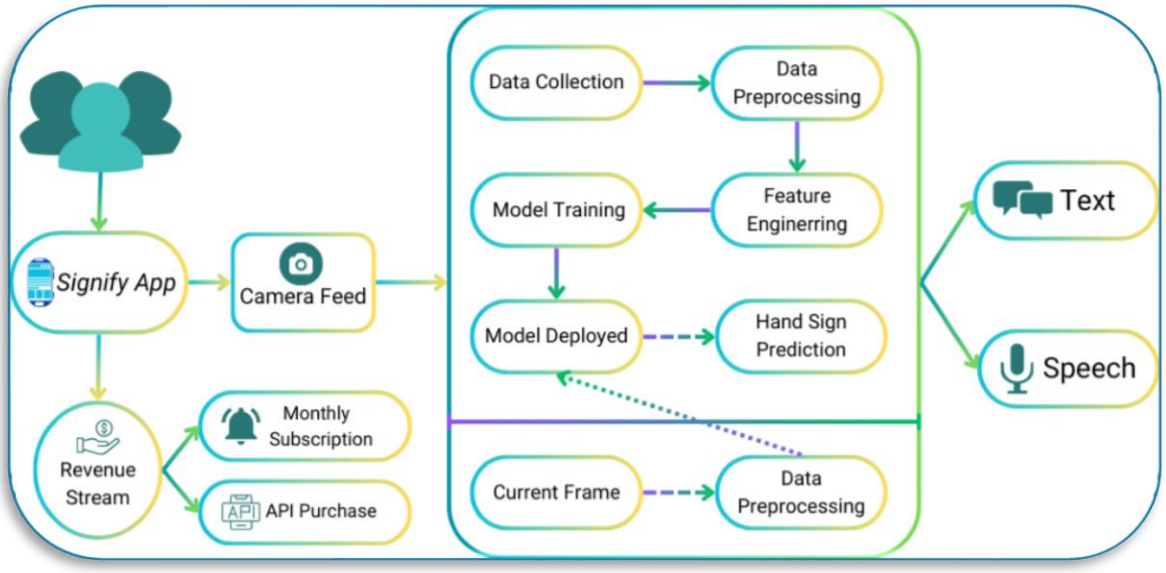
- **User Experience:** Focusing on enhancing user experience through intuitive design, seamless integration, and accessibility features tailored to the deaf and hard-of-hearing community.

- **Business Model:** Establishing a sustainable business model that offers a 7-day free trial followed by subscription options and API sales, ensuring scalability and profitability while supporting ongoing development and user support.

Concept development for Signify aims to deliver a robust and user-centric solution that addresses communication barriers effectively, promoting inclusivity and accessibility through innovative technology.

8. Final Product Prototype

The Signify Hand Sign Recognition System is designed to enhance communication for individuals with hearing or speech impairments by converting hand gestures into real-time text and speech. This solution supports inclusive communication in social, educational, and professional settings. The system utilizes user data, sign language resources, and performance metrics to train advanced machine learning models, ensuring accurate and responsive gesture recognition that improves with user feedback. Key components include a camera feed for capturing gestures, a gesture recognition engine, and an output module, all integrated into a user-friendly application.



Hand Sign Recognition System: Feasibility, Viability, and Monetization

1. Feasibility: The Hand Sign Recognition System can be developed and deployed within a short-term timeline of 2-3 years. It can be offered as a Software as a Service (SaaS) solution, making it accessible for individuals, educational institutions, and businesses to integrate into their environments.

3. Viability: As the need for accessible communication solutions continues to grow globally, the Hand Sign Recognition System is viable for long-term survival. It caters to the ongoing and expanding demand for inclusivity and accessibility, ensuring its relevance for the next 20-30 years. Continuous improvements will be necessary to keep up with emerging technologies and user needs.

3. Monetization: The Hand Sign Recognition System is directly monetizable. Upon completion, it can be launched as a service that users can subscribe to, or organizations can integrate via API sales. This direct approach to monetization ensures a sustainable revenue model, making it a viable business proposition.

Step 2: Prototype Development

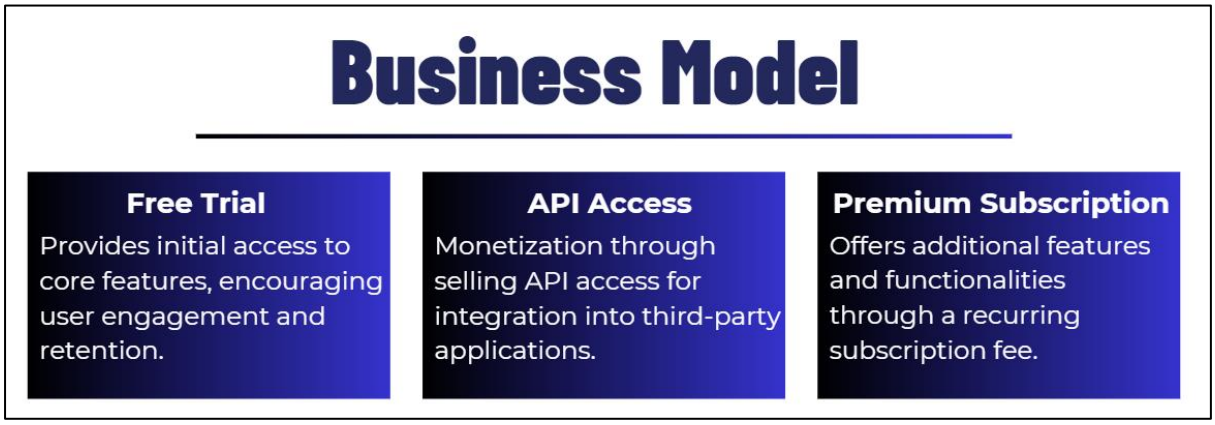
GitHub Repository: Hand Sign Recognition System

This repository provides access to the code and resources used for real-time hand sign gesture recognition and prediction using machine learning models. It serves as a practical demonstration of the system's capabilities and can be used as a reference for further development and testing.

Step 3: Business Modeling

For Signify, a subscription-based model is advantageous. Initially, users will have access to basic features for free, which helps in attracting and retaining customers. After the initial free trial, users will be charged a subscription fee to continue using the service with additional features.

In this model, customers pay a fixed amount at regular intervals to access the product or service. The primary challenge is user conversion: transforming free trial users into paying subscribers.



Step 4: Financial Modeling

To calculate the total profit for the Hand Sign Recognition System, we will use a simple financial equation:

$$Y = m * x(t) - c$$

Where:

Y: Total profit

x(t): Number of users over time

c: Total production and maintenance cost

m: Price of the product (API or subscription fee)

1. API Sales Model:

API Fee (m): Rs 5000 (one-time fee)

Initial Users: 200

Growth Rate: 18.8% per year

Time Frame: 5 years

Production and Maintenance Cost (c): Rs 100,000

$$x(t) = 200 * (1 + 0.188)^5 \approx 474\ users$$

$$Y = 5000 * 474 - 100000 = Rs\ 2{,}270{,}000$$

2. Subscription Model:

Subscription Fee (m): Rs 500 per month (Rs 6000 annually)

Initial Subscribers: 500

Growth Rate: 18.8% per year

Time Frame: 5 years

Production and Maintenance Cost (c): Rs 200,000

$$x(t) = 500 \times (1 + 0.188)^5 \approx 1184\ users$$

$$Y = 6000 \times 1184 - 200{,}000 = Rs\ 6{,}904{,}000$$

Total Combined Profit from both API & Subscription:

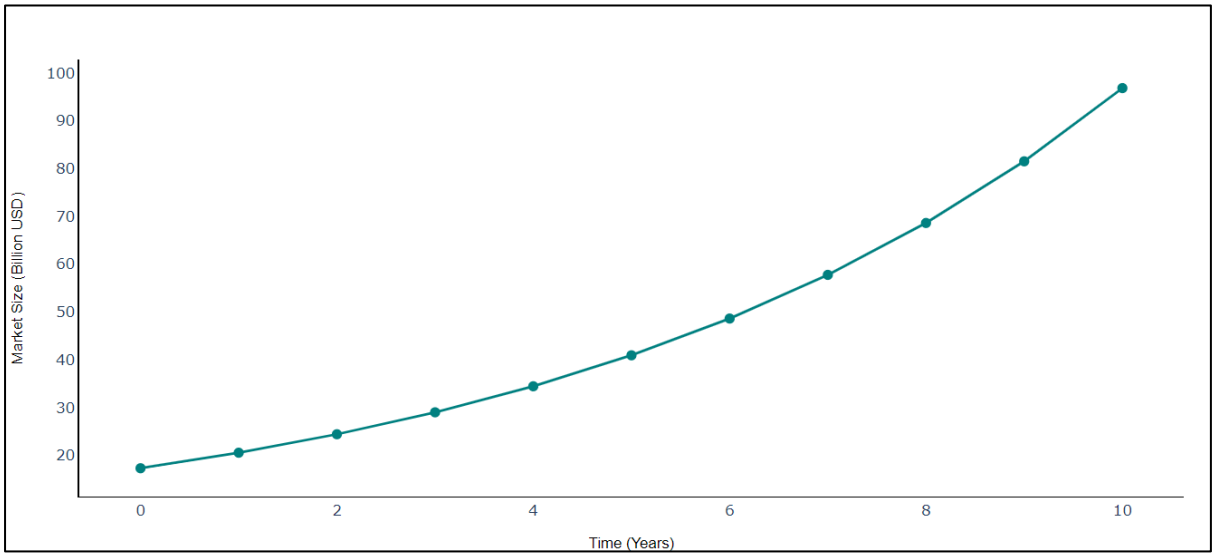
$$Y = Y(API) + Y(Subscription)$$

$$Y = 2270000 + 6904000$$

$$Y = Rs\ 9{,}174{,}000$$

These calculations demonstrate that the Hand Sign Recognition System can achieve substantial profitability through both API sales and a subscription-based model, ensuring sustainable growth and supporting the system's expansion and maintenance over time.

Market Size Forecast Over Time:



Conclusion: The Signify project is poised to make a meaningful impact by improving communication for the deaf and hard-of-hearing community. Its feasibility, long-term viability, and direct monetization strategies position it for success in the evolving market. With a comprehensive business model and solid financial projections, Signify is well-equipped to achieve its mission and contribute to greater inclusivity and accessibility.