Sign Language Translation using Temporal Classification

Problem Statement:

Communication is a fundamental human need, yet for hearing-impaired individuals, interacting with non-signers can be a daily struggle—whether during job interviews, at hospitals, or in routine conversations. Current solutions, like camera-based translators, often require fixed setups or cumbersome devices, limiting their real-world practicality. This project aims to bridge this gap by creating a **wearable sensor-based sign language recognition system** that converts gestures into text in real time, making communication smooth and natural.

Approach:

Data: Collected from wearable sensors capturing sign language gestures; ~2000 gesture samples, each with 36 sensor features (e.g., finger bend, hand orientation, acceleration).

Task:

- **Classification:** Recognize which gesture is being performed.
- **Regression:** Optional—predict intensity or speed of gesture for dynamic analysis.

Models Implemented:

- **Classification:** Logistic Regression, Random Forest, Support Vector Machine (SVM), LSTM for sequential gesture data.
- **Regression:** Gesture intensity/speed regression using linear regression or Random Forest Regressor.

Validation Strategy: User-based cross-validation — data from each participant was left out once for testing while training on the remaining participants, ensuring model generalization across different users.

Implementation:

Tools: Python, pandas, scikit-learn, NumPy.

Preprocessing:

- Label encoding for gestures.
- Feature scaling to normalize sensor readings.

Model Training:

- Classification models: Logistic Regression, Support Vector Machine (SVM), and LSTM for sequential gesture data.
- Regression models trained for predicting gesture intensity or speed.

Evaluation:

- **Classification:** Accuracy in predicting gestures.
- **Regression:** Mean Squared Error (MSE) for intensity/speed prediction.
- **User Generalization:** Tested via user-based cross-validation to ensure robust performance across different participants.

Results:

MODEL	DATASET	METRIC	PERFORMANCE
SVM	HIGH QUALITY	ACCURACY	0.702
	LOW QUALITY	ACCURACY	0.554
LOGISTIC REGRESSION	HIGH QUALITY	ACCURACY	0.930
	LOW QUALITY	ACCURACY	0.825
LSTM	HIGH QUALITY	ACCURACY	0.862
	LOW QUALITY	ACCURACY	0.756
SPM	HIGH QUALITY	ACCURACY	0.26
	LOW QUALITY	ACCURACY	0.35

Conclusion:

This project shows that wearable sensors can effectively translate sign language gestures into text, making communication easier for hearing-impaired individuals. The models performed well across different users, proving that the system is practical, portable, and inclusive for everyday interactions.