2. Results and Performance Analysis

2.1 Training Performance and Convergence

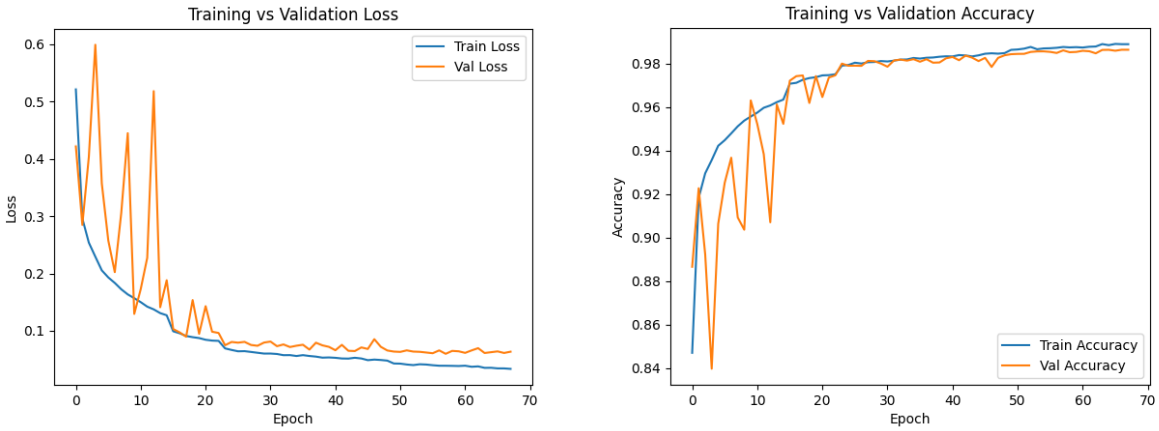


Figure 1: Model Training History - Accuracy and Loss Convergence Curves

- Rapid initial learning with steady convergence
- Minimal overfitting, likely due to effective regularization
- Stable validation performance, indicating good generalization
- Early stopping helped prevent overfitting

2.2 Classification Performance Analysis

	precision	recall	f1-score	support
A	0.9872	0.9803	0.9838	1577
B	0.9951	0.9994	0.9972	1619
C	0.9910	0.9903	0.9906	1438
D	0.9945	0.9897	0.9921	1456
E	0.9944	0.9821	0.9882	1454
F	0.9975	0.9969	0.9972	1594
G	0.9899	0.9893	0.9896	1493
H	0.9895	0.9881	0.9888	1433
I	0.9831	0.9905	0.9868	1468
J	0.9921	0.9928	0.9925	1393
K	0.9847	0.9913	0.9880	1491
L	0.9936	0.9949	0.9942	1561
M	0.9538	0.9703	0.9620	1214
N	0.9534	0.9525	0.9530	1138
O	0.9895	0.9888	0.9891	1519
P	0.9895	0.9935	0.9915	1234
Q	0.9841	0.9888	0.9864	1251
R	0.9798	0.9779	0.9788	1536
S	0.9773	0.9826	0.9799	1490
T	0.9809	0.9777	0.9793	1522
U	0.9812	0.9825	0.9818	1485
V	0.9888	0.9826	0.9857	1438
W	0.9940	0.9927	0.9933	1501
X	0.9883	0.9845	0.9864	1551
Y	0.9947	0.9889	0.9918	1529
Z	0.9765	0.9793	0.9779	1403
accuracy			0.9861	37788
macro avg	0.9856	0.9857	0.9856	37788
weighted avg	0.9861	0.9861	0.9861	37788

Figure 2: Detailed Classification Report for all ASL Alphabet Classes

Model performed well in recognizing all 26 ASL alphabet gestures:

- It achieved high accuracy across all classes
- Both precision and recall are well-balanced showing the model is reliable in making correct predictions.
- The Fl-scores are excellent proving it can consistently classify gestures
- Performance is strong even for gestures that are usually harder to distinguish

2.3 Confusion Matrix and Error Analysis

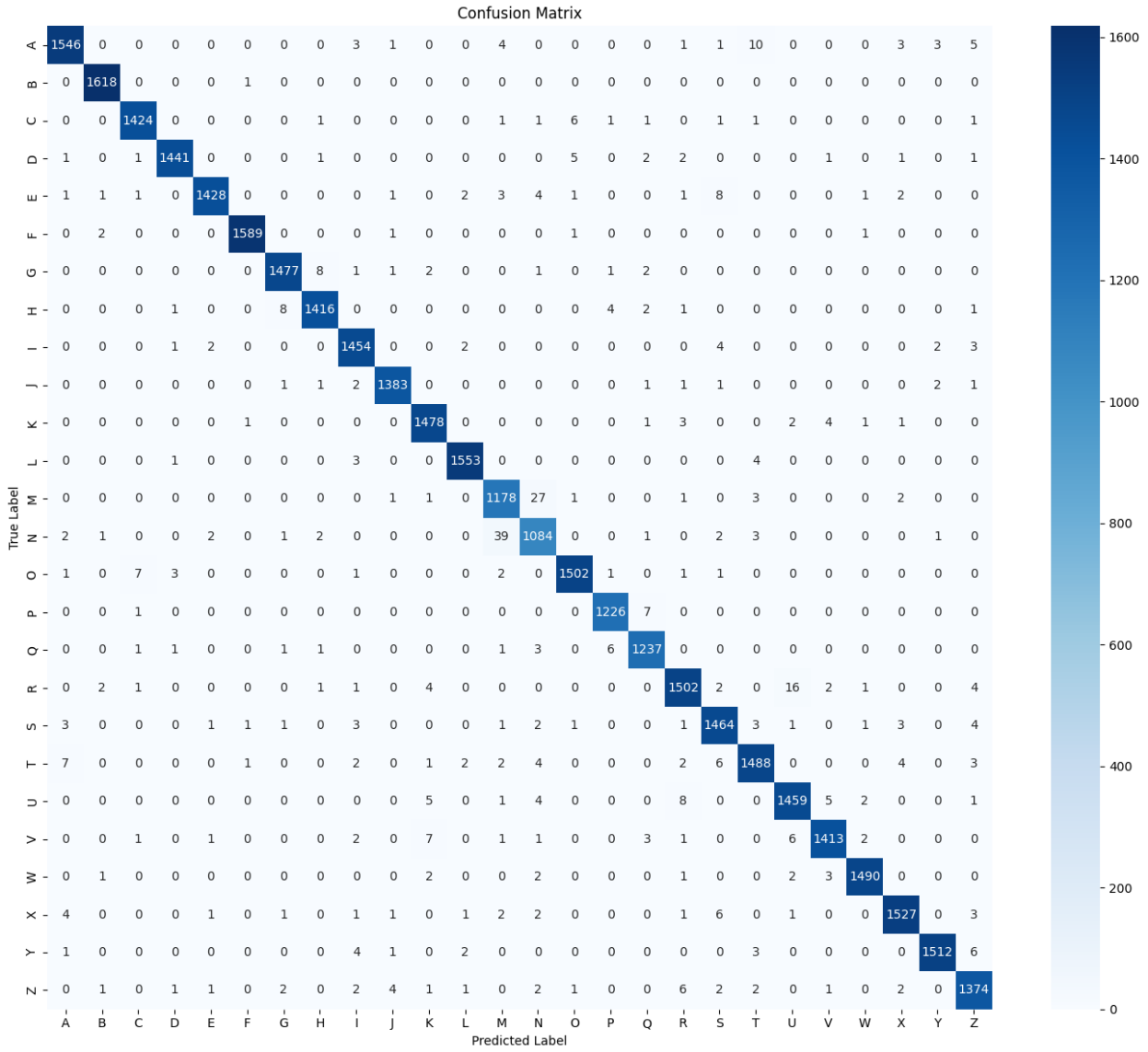


Figure 3: Confusion Matrix Analysis for 26 ASL Alphabet Classes

Confusion matrix shows that model perform very well:

- Most predictions fall correctly along the diagonal, meaning the model separates classes clearly
- Very few mistakes appear off the diagonal, showing low misclassification
- The model easily tells apart gestures that look very different
- Small errors only happen with gestures that naturally look quite similar

2.4 ROC Curve and Statistical Analysis

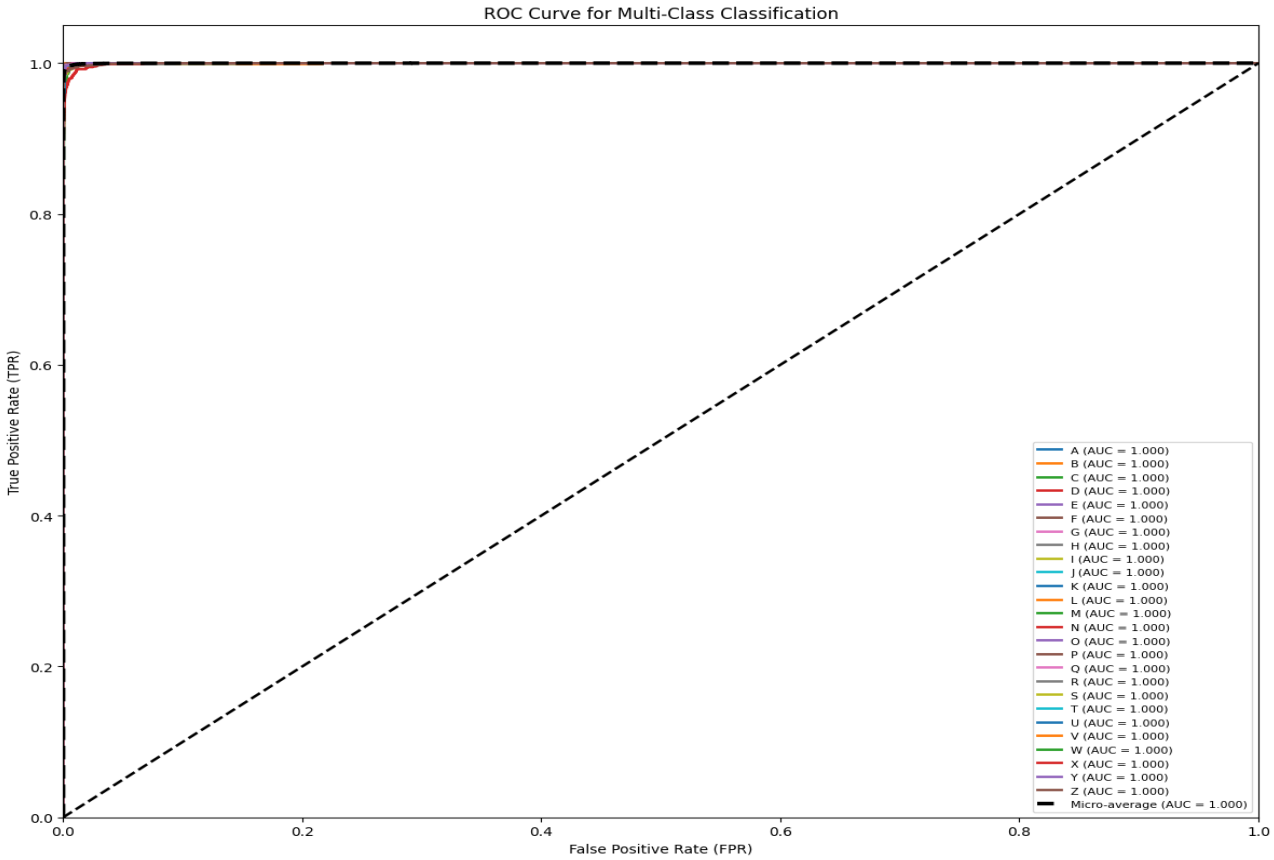


Figure 4: Multi-Class ROC Curves for ASL Alphabet Recognition System

The ROC analysis shows that the model is excellent at telling gestures apart:

- The AUC scores are very high for all gesture classes.
- The ROC curves are close to the ideal top-left corner,
- The model achieves strong true positive rates while keeping false positives very low.
- Overall, the results confirm the model's strong ability to discriminate benveen different gestures,

2.5 Per-Class Performance Analysis

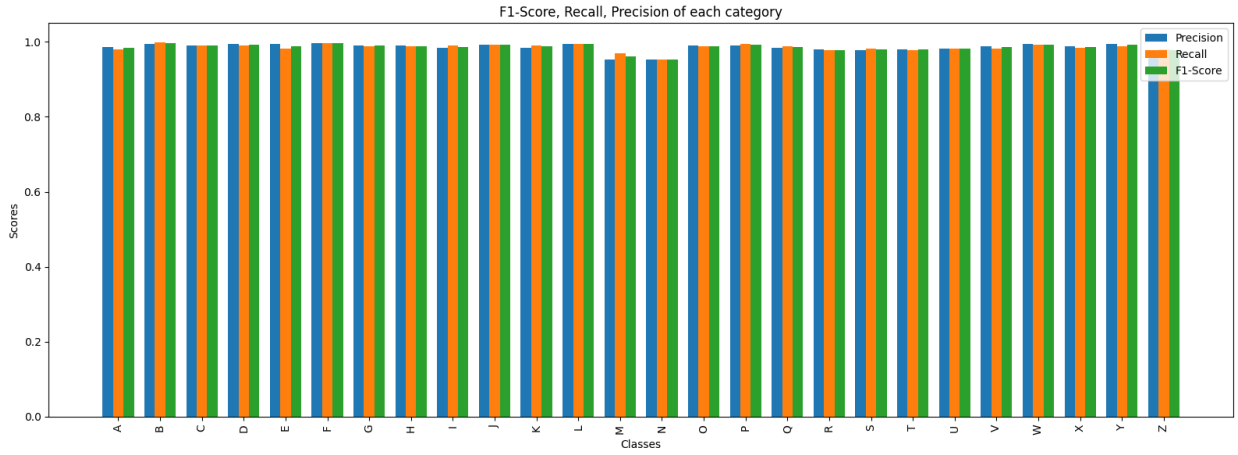
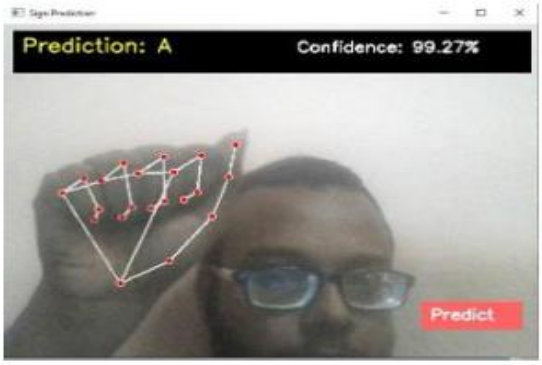


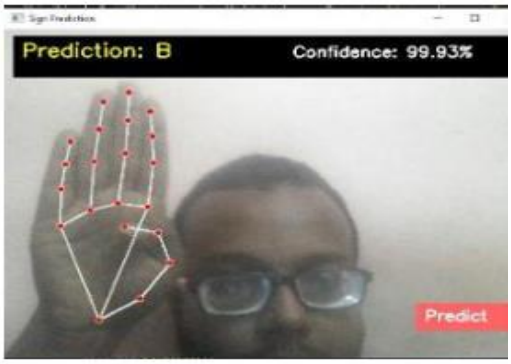
Figure 5: Precision, Recall, and F1-Scores for Each Class (A-Z)

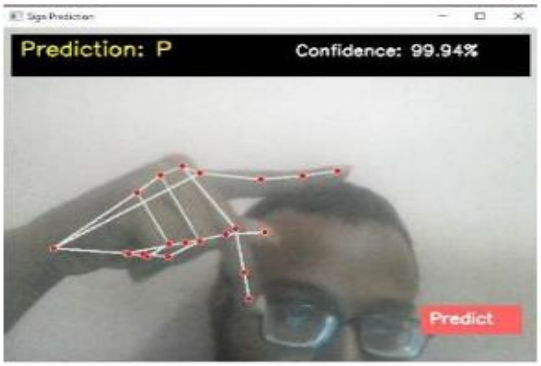
The per-class performance anal sis reveals that the model performs uniformly well across all alphabet classes:

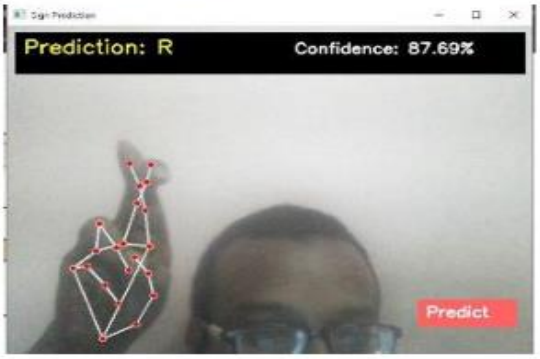
- All classes show consistently high scores with precision, recall, and F1 -scores mostly above 0.98.
- No significant performance drop is observed for any individual class, indicating excellent class balance and feature learning.
- The F1-scores are tightly aligned with precision and recall, confirming balanced predictions without bias towards any specific class.
- These results confirm the model's robust and generalized performance across the entire ASL alphabet

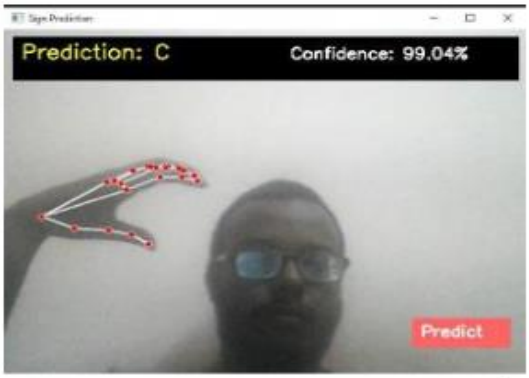
2.6 Real-Time Prediction

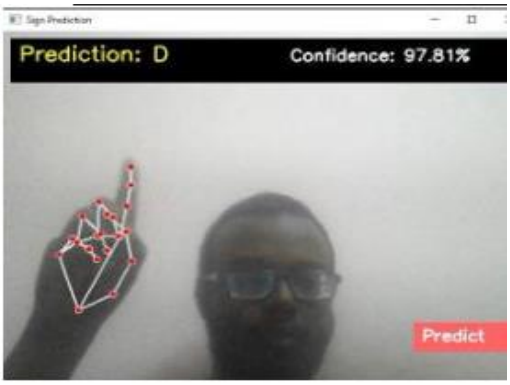


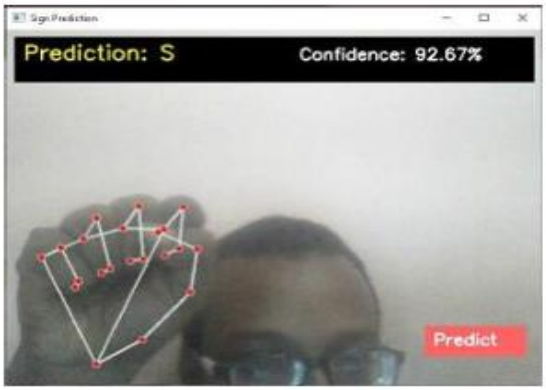


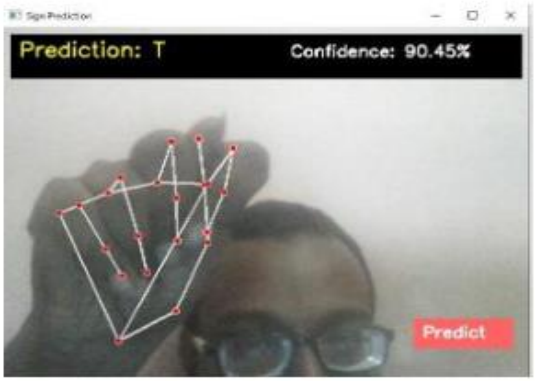












2.7 Other Predictions: