HySTA-NET : A HYBRID SPATIO-TEMPORAL ATTENTION NETWORK FOR RECOGNITION OF EMERGENCY SIGNS IN INDIAN SIGN LANGUAGE

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Abstract

Effective communication is essential, enabling individuals who rely on sign language to express their thoughts and emotions seamlessly. Hybrid Spatio-Temporal Attention Network (HySTA-Net) is a novel deep learning framework for real-time recognition of emergency Indian Sign Language (ISL) gestures. By integrating CNN-based spatial feature extraction (using a modified VGG16), LSTM-based temporal modeling, and multi-head attention for enhanced feature representation, the system achieves high accuracy in classifying critical emergency signs. Tested on both public and custom video datasets, HySTA-Net demonstrates strong generalization, making it a promising tool for improving emergency communication for the deaf and hard-of-hearing community.

Objective

Develop a real-time ISL emergency gesture recognition system using deep learning to ensure accurate communication and enhance safety for the deaf and speech-impaired community.

Dataset

A publicly available dataset of 8 dynamic emergency ISL signs was used for training, while a custom dataset of 8 signs ,50 videos per sign from 7 signers was created for evaluation.

Accident

Call

Doctor

Help

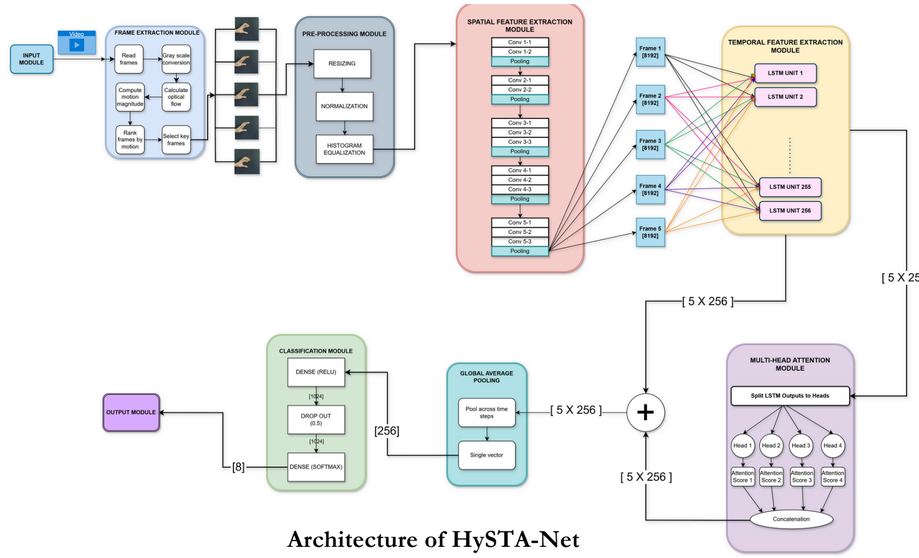
Hot

Lose

Pain

Thief

Methodology

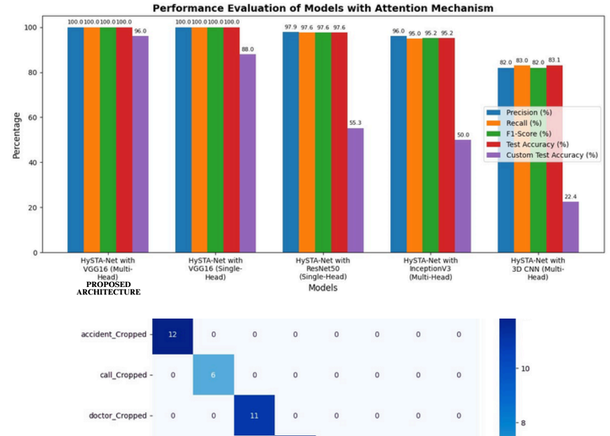


Architecture of HySTA-Net

- **Video Acquisition & Frame Extraction:** Capture raw videos and extract key frames using an optical flow-based method.
- **Pre-Processing:** Standardize frames via resizing (150×150), normalization, and histogram equalization.
- **Spatial Feature Extraction:** Use a modified VGG16 (wrapped in a Time Distributed layer) to derive spatial features from each frame.
- **Temporal Modeling:** Process sequential spatial features with a 256-unit LSTM to capture dynamic gesture evolution.
- **Attention & Residual Connection:** Apply multi-head attention (4 heads) and add a residual connection to refine temporal features.
- **Global Pooling & Classification:** Aggregate features via global average pooling and classify using dense layers with ReLU, dropout (0.5), and softmax activation.

Result and Analysis

Comparative evaluation shows that the proposed model HySTA-Net using VGG16 achieves 100% test accuracy and 96% custom test accuracy—outperforming state-of-the-art and other custom developed models. Graphs and a confusion matrix confirm that attention-enhanced models yield superior results, ensuring robust emergency ISL recognition. Confusion matrix analysis shows strong diagonal dominance, indicating minimal misclassifications across 8 emergency gestures



The results validate the technical approach and promises significant social impact by enabling timely communication for the deaf, hard-of-hearing, and speech-impaired communities in critical situations.

Conclusion

HySTA-Net effectively recognizes emergency ISL gestures by combining spatial and temporal deep learning techniques, addressing the crucial need for accessible communication in emergencies for the deaf and hard-of-hearing community.

References

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