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Cross-Modal Alignment Strategies for Robust Multimodal Conversational Agents under Acoustic and Visual Degradation

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Abstract

Multimodal conversational agents must maintain
coherent interaction when either auditory or visual
channels are degraded. This paper investigates cross-
modal alignment strategies that explicitly model
redundancy and complementarity between speech and vision. We introduce a dual-stream transformer with modality-specific encoders coupled through a cross-attention fusion layer calibrated to uncertainty estimates in each modality. Robustness is evaluated on noisy audiovisual dialog benchmarks with controlled perturbations: background noise, reverberation, occlusions, and camera motion. Results show that dynamic cross-modal gating yields up to 18% relative improvement in intent classification accuracy and 0.12 BLEU gain in response generation under severe corruption compared to audio-only or naive fusion baselines. We discuss how such architectures extend prior work on multimodal integration of auditory and visual modalities in conversational AI.

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