GLip: A Global-Local Integrated Progressive Framework for Robust Visual Speech Recognition

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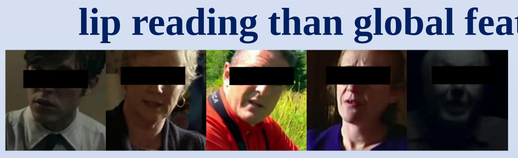
Motivation

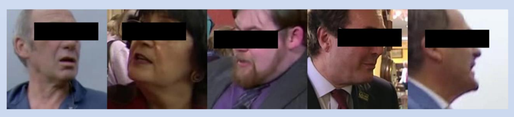
- **Existing Problems:** Current VSR methods struggle with real-world visual challenges (e.g., illumination variations, occlusions, blurring, and pose). Data collection and augmentation approaches are costly and lack generalization
- **Motivated by two key insights:**
  - Learning an initial coarse alignment between visual features across varying conditions and corresponding speech content facilitates the subsequent learning of precise visual-to-speech mappings in challenging environments;
  - Certain local regions often exhibit more discriminative cues for lip reading than global features under adverse conditions.



(a) Illumination

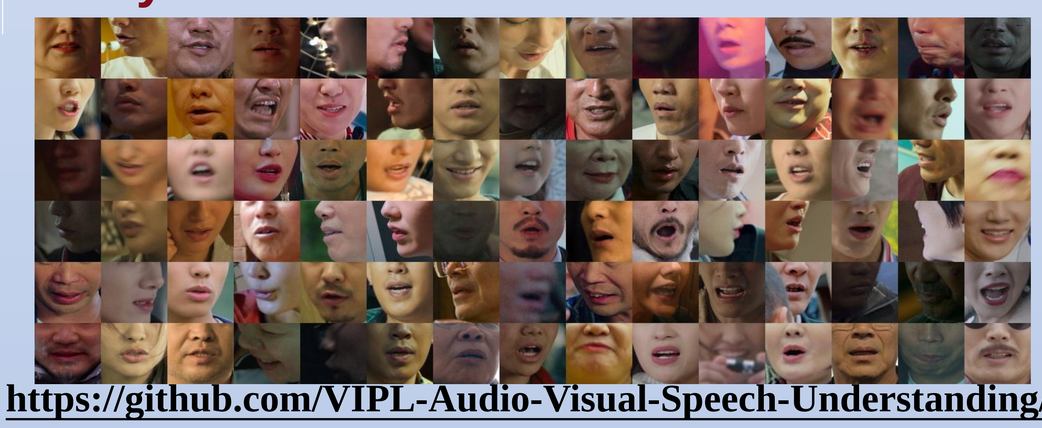
(b) Occlusions

(c) Motion blur



(d) Head poses

A Newly Introduced Dataset: CAS-VSR-MOV20



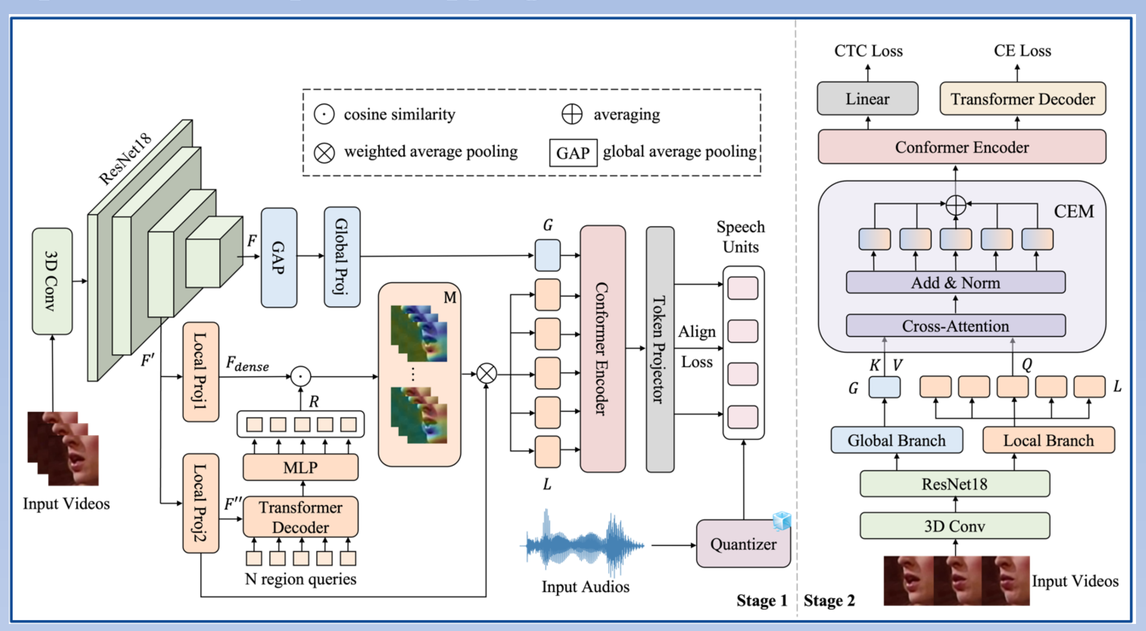
https://github.com/VIPL-Audio-Visual-Speech-Understanding/CAS-VSR-MOV20

Results on CAS-VSR-MOV20 datasets

Method	Setting	CER(%)	
		MOV20-Val	MOV20-Test
Baseline	From Scratch	93.05	91.73
GLip	From Scratch	88.04	87.78
GLip	Load Pre-trained Model	85.64	84.72

The Proposed GLip

- **GLip** is a novel two-stage framework for robust visual speech recognition:
  - **Stage 1:** Coarse global-local alignment establishes robust initial representations;
  - **Stage 2:** Context-aware refinement integrates multimodal cues for precise visual-speech mapping.



Workflow of the Glip

Comparison with Others

- **GLip** achieves state-of-the-art performance across various benchmarks

Comparison on LRS2 and LRS3 datasets

Method	Input Scale	Unlab hours	Lab hours	WER	
				LRS2	LRS3
MV-WAS [8]	224 × 224	–	223	70.4	–
TDNN [35]	112 × 112	–	223	48.9	–
CM-Seq2Seq [25]	96 × 96	–	223/438	39.1	46.9
CM-Aux [26]	96 × 96	–	223/438	32.9	37.9
LiRA [24]	96 × 96	438	223	38.8	–
RAVEn [13]	96 × 96	433	223/433	32.1	39.1
AutoAVSR [27]	96 × 96	–	438	–	36.3
ES^3 [36]	96 × 96	433	223/433	28.7	37.9
SyncVSR [3]	128 × 128	–	223/438	28.9	31.2
GLip (Ours)	96 × 96	223	223	**28.1**	–
GLip (Ours)	96 × 96	433	223/433	**27.4**	**30.1**

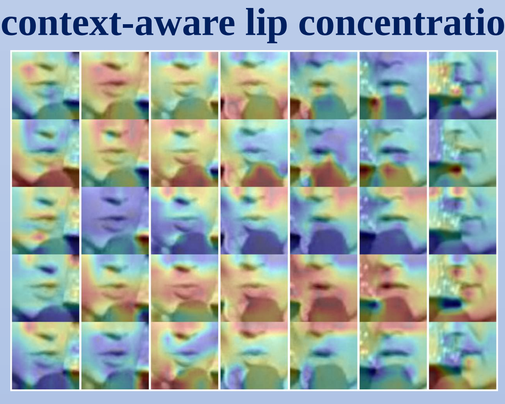
Ablation Study

- The progressive learning, the dual-path architecture, and the CEM module collectively boost performance

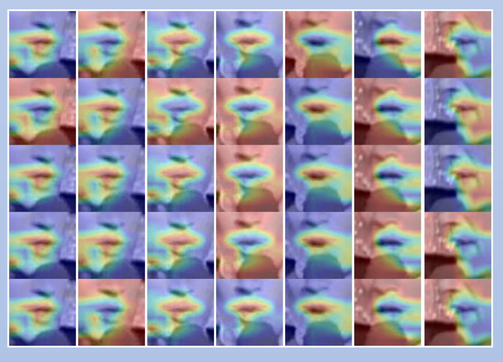
Method	Branches		Fusion	WER
	Stage1	Stage2		
Baseline	×	Global	×	30.01
Ours	Global	Global	×	28.45
	Global&Local	Global	×	28.24
	Global&Local	Local	×	28.30
	Global&Local	Global&Local	AVG	28.94
	Global&Local	Global&Local	CEM	**28.10**

Qualitative Results

- **GLip** evolves attention from a diffuse facial focus to precise, context-aware lip concentration



(a) Stage 1



(b) Stage 2

Under Diverse Visual Conditions

- **GLip** demonstrates superior robustness across various challenging visual conditions

Dataset	Method	Illumination			Occlusion		Blur			Pose		
		B	M	D	N	Y	C	M	B	S	M	L
LRS3	RAVEn[13]	48.82	37.97	41.79	38.52	41.77	32.84	40.61	52.34	37.42	42.77	44.04
	AutoAVSR[27]	37.05	34.25	37.50	34.01	40.99	30.21	35.03	47.25	33.22	39.28	37.61
	GLip (Ours)	**32.05**	**29.35**	**33.50**	**30.51**	**35.10**	**24.64**	**30.53**	**44.15**	**28.79**	**33.63**	**31.19**
LRS2	AutoAVSR[27]	30.44	28.33	34.70	29.48	38.68	30.16	29.64	32.89	29.51	29.42	49.16
	SyncVSR[3]	28.74	26.87	33.87	28.07	38.68	28.05	28.89	31.91	28.08	28.30	47.49
	GLip (Ours)	**28.40**	**26.82**	**31.69**	**27.58**	**36.84**	**27.98**	**27.96**	**30.92**	**27.46**	**28.04**	**44.13**

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