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VocaLiST: An Audio-Visual Synchronisation Model for Lips and Voices

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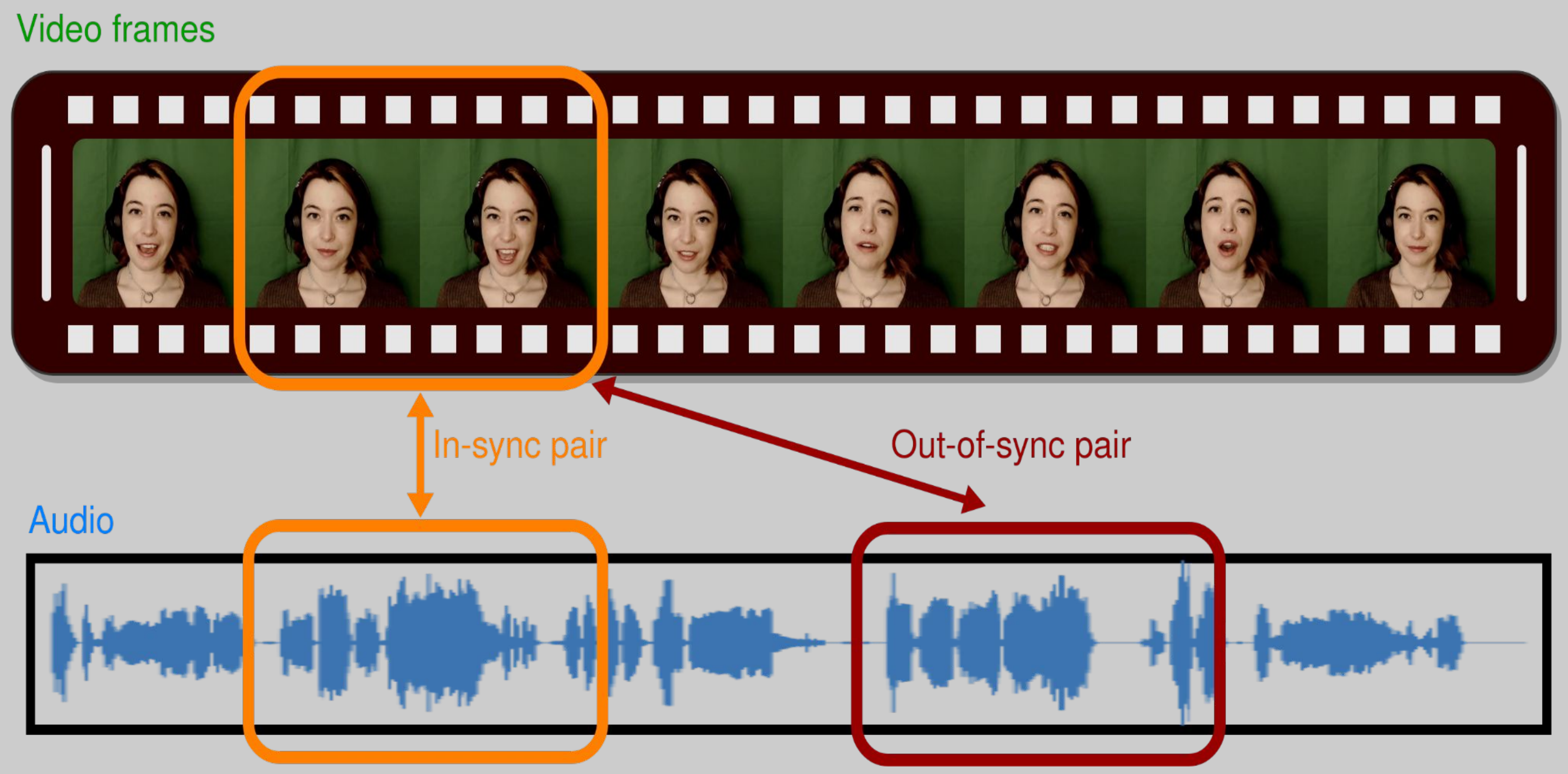
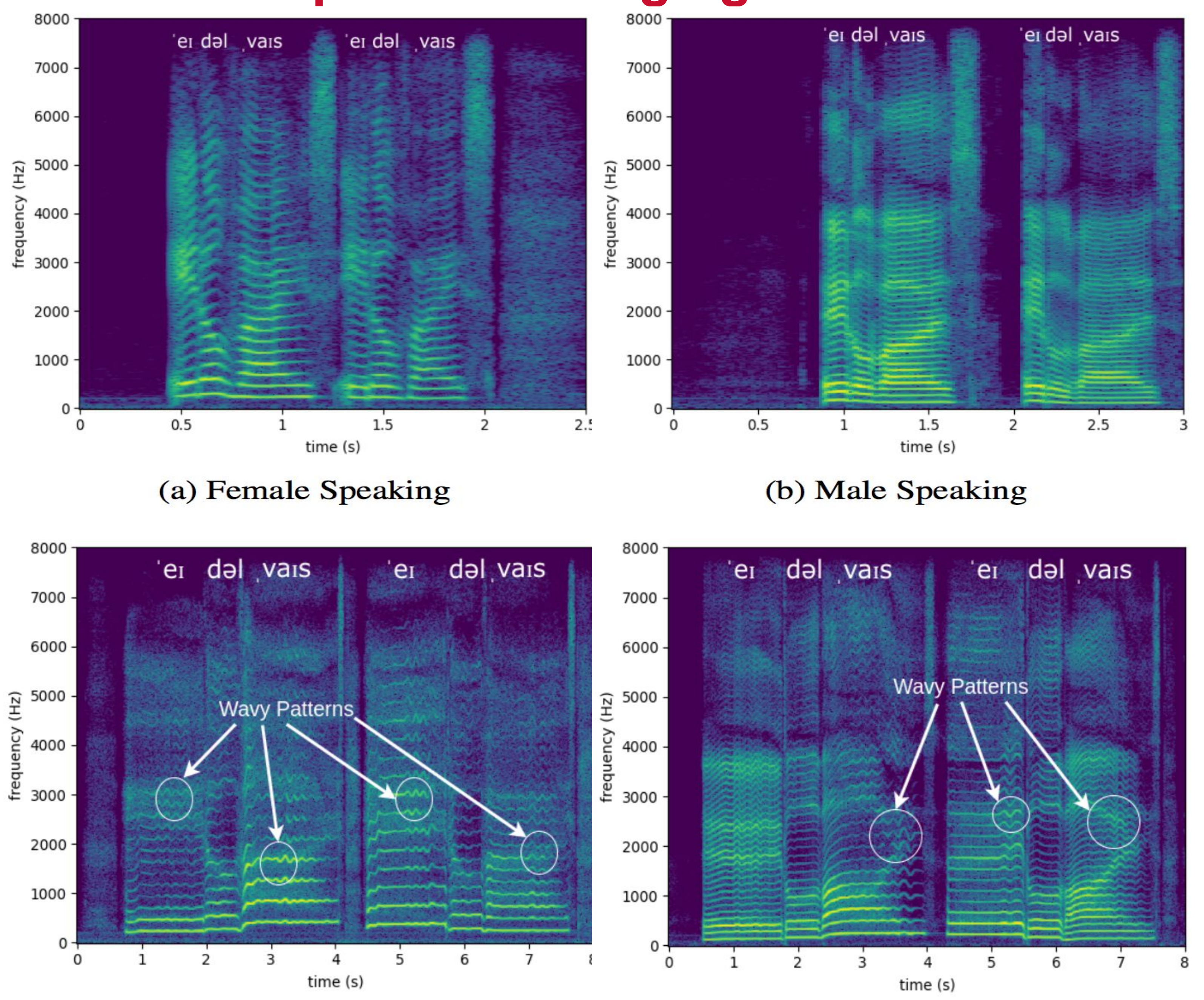
Abstract

We address the problem of lip-voice synchronisation in videos containing human face and voice. Our approach is based on determining if the lips motion and the voice in a video are synchronised or not, depending on their audio-visual correspondence score. We propose an audio-visual cross-modal transformer-based model that outperforms several baseline models in the audio-visual synchronisation task on the standard lip-reading speech benchmark dataset LRS2. While the existing methods focus mainly on the lip synchronisation in speech videos, we also consider the special case of singing voice. Singing voice is a more challenging use case for synchronisation due to sustained vowel sounds. We also investigate the relevance of lip synchronisation models trained on speech datasets in the context of singing voice. Finally, we use the visual features extracted by the pre-trained visual encoder of the lip synchronisation model in the singing voice separation task to outperform a baseline audio-visual model which was trained end-to-end.

Goal



Speech vs Singing Voice



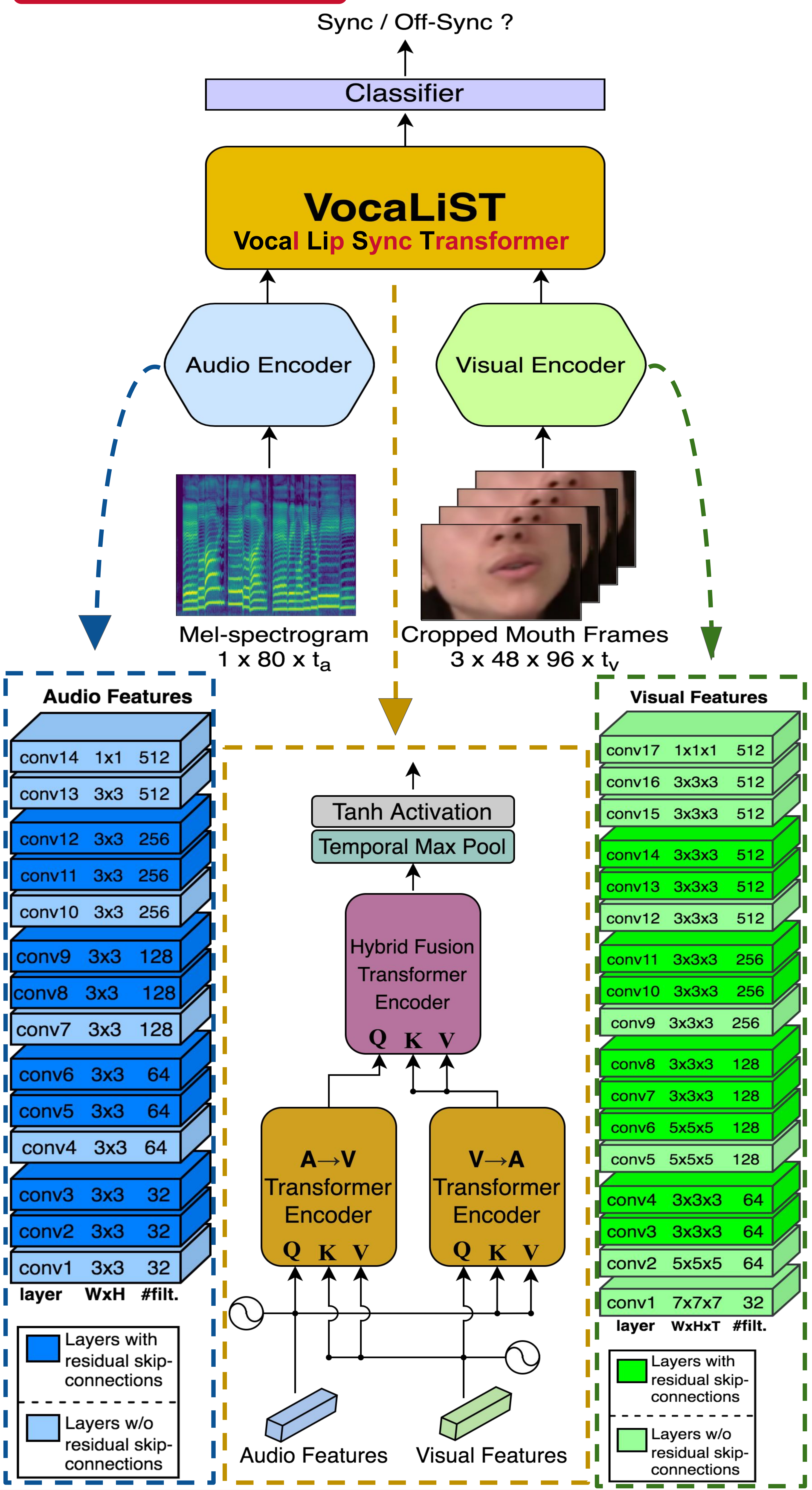
(a) Female Speaking

(b) Male Speaking

(c) Female Singing

(d) Male Singing

Model Architecture



Sync / Off-Sync ?

Classifier

VocaLiST

Vocal Lip Sync Transformer

Audio Encoder

Visual Encoder

Mel-spectrogram
1 x 80 x t_a

Cropped Mouth Frames
3 x 48 x 96 x t_v

Audio Features

layer	WxH	#filt.
conv14	1x1	512
conv13	3x3	512
conv12	3x3	256
conv11	3x3	256
conv10	3x3	256
conv9	3x3	128
conv8	3x3	128
conv7	3x3	128
conv6	3x3	64
conv5	3x3	64
conv4	3x3	64
conv3	3x3	32
conv2	3x3	32
conv1	3x3	32

🟦 Layers with residual skip-connections

□ Layers w/o residual skip-connections

Tanh Activation

Temporal Max Pool

Hybrid Fusion Transformer Encoder
Q K V

A→V Transformer Encoder
Q K V

V→A Transformer Encoder
Q K V

Audio Features

Visual Features

Visual Features

layer	WxHxT	#filt.
conv17	1x1x1	512
conv16	3x3x3	512
conv15	3x3x3	512
conv14	3x3x3	512
conv13	3x3x3	512
conv12	3x3x3	512
conv11	3x3x3	256
conv10	3x3x3	256
conv9	3x3x3	256
conv8	3x3x3	128
conv7	3x3x3	128
conv6	5x5x5	128
conv5	5x5x5	128
conv4	3x3x3	64
conv3	3x3x3	64
conv2	5x5x5	64
conv1	7x7x7	32

🟩 Layers with residual skip-connections

□ Layers w/o residual skip-connections

Results

Speech

Accuracy of lip synchronisation models in LRS2

Models	# params	Clip Length in frames (seconds)					
		5 (0.2s)	7 (0.28s)	9 (0.36s)	11 (0.44s)	13 (0.52s)	15 (0.6s)
SyncNet	13.6M	75.8	82.3	87.6	91.8	94.5	96.1
PM	13.6M	88.1	93.8	96.4	97.9	98.7	99.1
AVST	42.4M	92.0	95.5	97.7	98.8	99.3	99.6
VocaLiST	80.1M	**92.8**	**96.7**	**98.4**	**99.3**	**99.6**	**99.8**

SyncNet: J.S. Chung, A. Zisserman. Out of time: automated lip sync in the wild. ACCV, 2016.

PM: S.W. Chung, J.S. Chung, H.-G. Kang. Perfect match: Improved cross-modal embeddings for audio-visual sync. ICASSP, 2019.

AVST: Chen, W. Xie, T. Afouras, A. Nagrani, A. Vedaldi, and A. Zisserman. Audio-visual synchronisation in the wild. BMVC, 2021.

LRS2: T. Afouras, J.S. Chung, A. Senior, O. Vinyals, A. Zisserman. Deep audio-visual speech recognition. IEEE PAMI, 2018.

Singing Voice

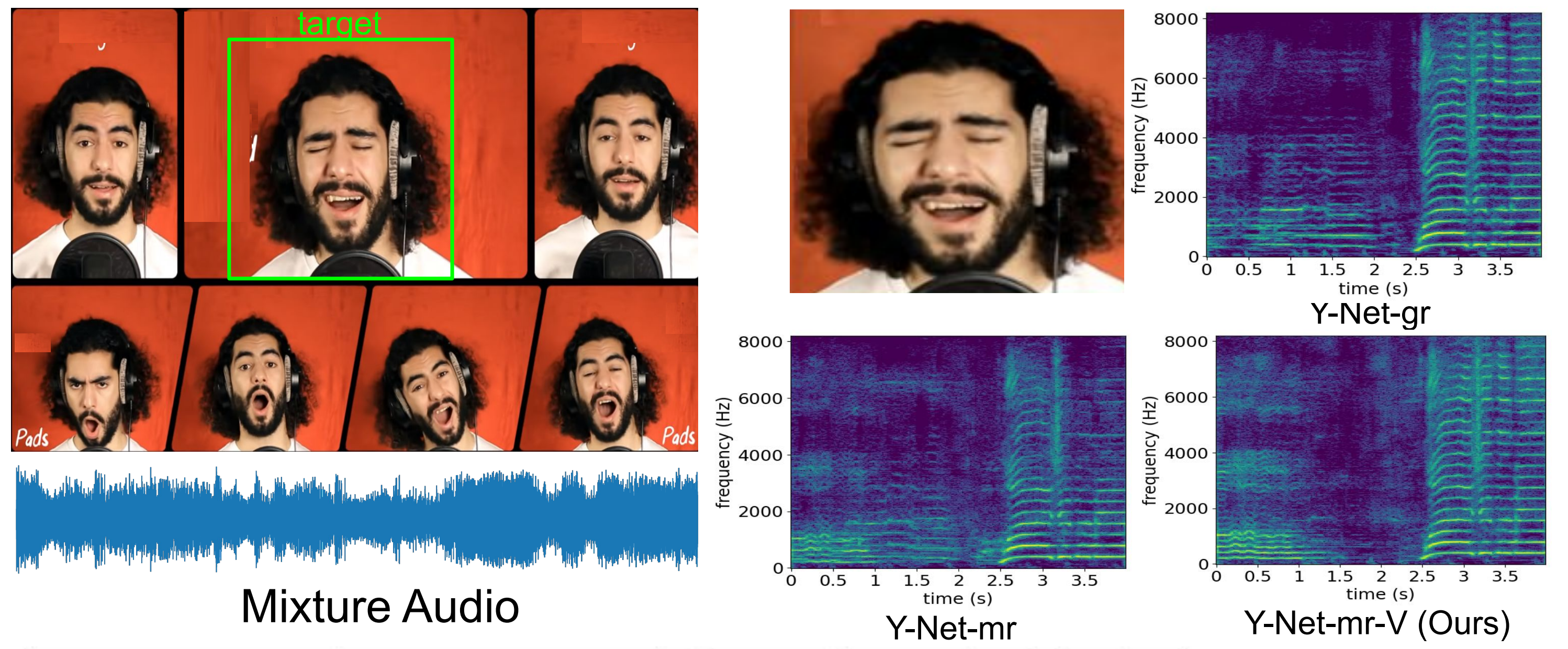
Accuracy of lip sync. in Acappella dataset

Models	Var	Trained on	Clip Length in frames (seconds)				
			5 (0.2s)	10 (0.4s)	15 (0.6s)	20 (0.8s)	25 (1s)
SyncNet*	N	Acappella	57.7	63.9	69.9	75.1	78.7
SyncNet*	Y	Acappella	57.7	65.9	—	—	73.6
VocaLiST	N	LRS2	56.7	65.1	72.2	77.2	81.2
VocaLiST	N	Acappella	58.8	65.4	71.6	76.5	80.5
VocaLiST	Y	Acappella	**58.8**	**66.4**	—	—	**85.2**

SyncNet*: K. Prajwal, R. Mukhopadhyay, V. P. Namboodiri, C. Jawahar. A lip sync expert is all you need for speech to lip generation in the wild. ACM Multimedia, 2020.

Acappella: J. F. Montesinos, V. S. Kadandale, G. Haro. A cappella: Audio-visual singing voice separation. BMVC, 2021.

Application: Singing Voice Separation



Mixture Audio

Y-Net-mr

Y-Net-mr-V (Ours)

Architecture	Method	Source Separation Metrics	
		SDR	SIR
Y-Net-mr	E2E	5.03	15.80
Y-Net-mr-V	E2E	1.14	11.72
Y-Net-mr-S*	PT - SyncNet*	5.44	16.17
Y-Net-mr-V	PT - VocaLiST	**6.32**	**17.08**

Y-Net: J. F. Montesinos, V. S. Kadandale, and G. Haro. A cappella: Audio-visual singing voice separation. In BMVC, 2021.

SCAN ME

Demos available!

Conclusion

- We propose **a new audio-visual transformer-based lip-voice synchronisation model** that detects synchronisation between the lips motion and the voice in a given voice video.
- The model produces **state-of-the-art results** both in **speech and singing voice.**
- Lip sync. in **singing voice is harder than speech** due to sustained vowels and it needs larger context windows.
- The model **learns powerful visual features** that are useful for singing voice separation.