Multi-task Learning for Detecting and Segmenting Manipulated Facial Images and Videos

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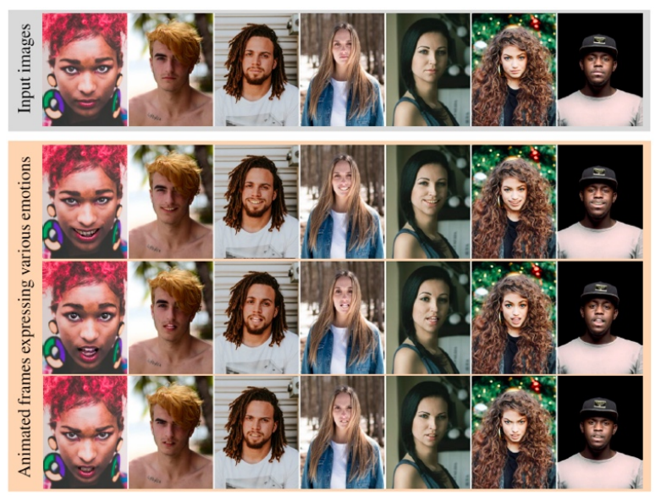
Generating of Fake Videos Impersonating a Person Using Deep Learning

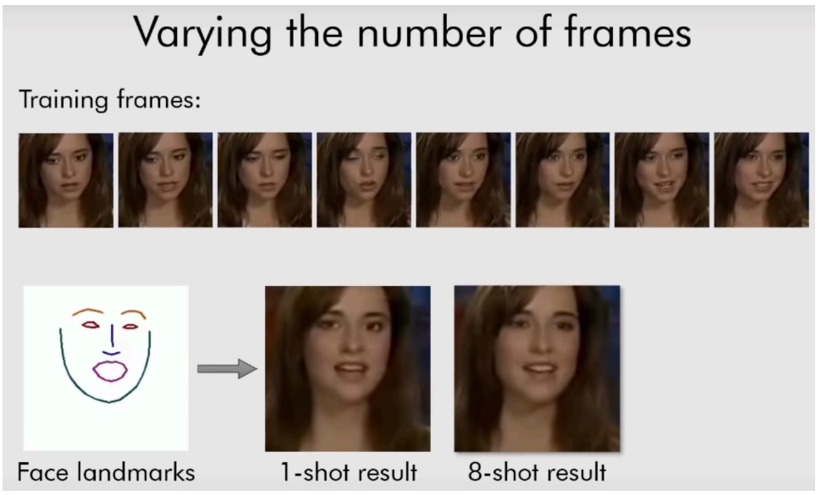
Real-time Facial Reenactment
Live capture using a commodity webcam

Face2Face: Real-time facial reenactment
(Thies et al. 2016)

Deepfakes
Video face swapping
(2017)

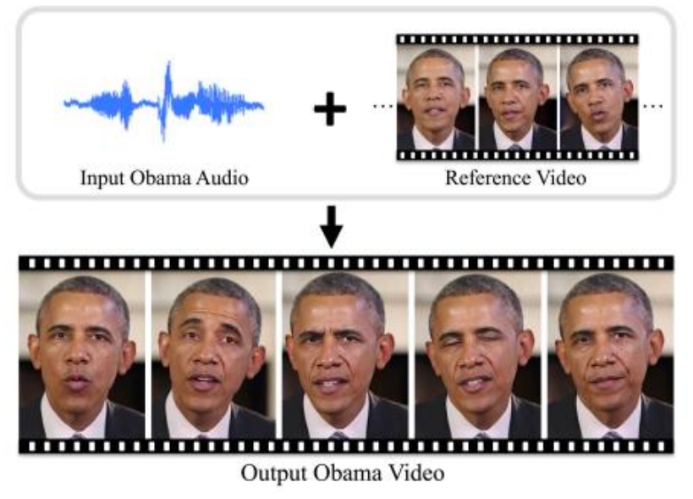


Bringing portraits to life
(Averbuch-Elor et al. 2017)

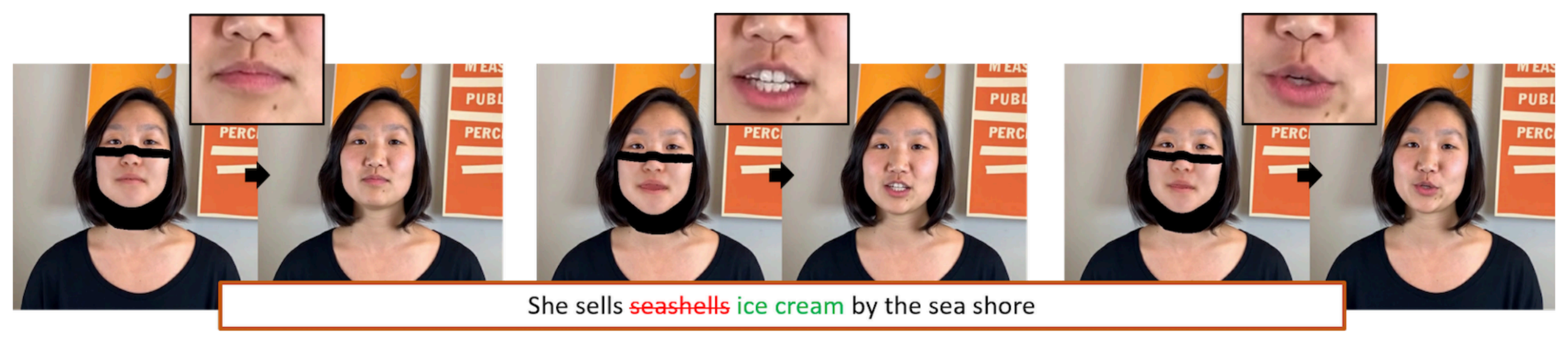


Realistic Neural Talking Head Models
(Zakharov et al. 2019)

Speech2Vid
(Chung et al. 2017)

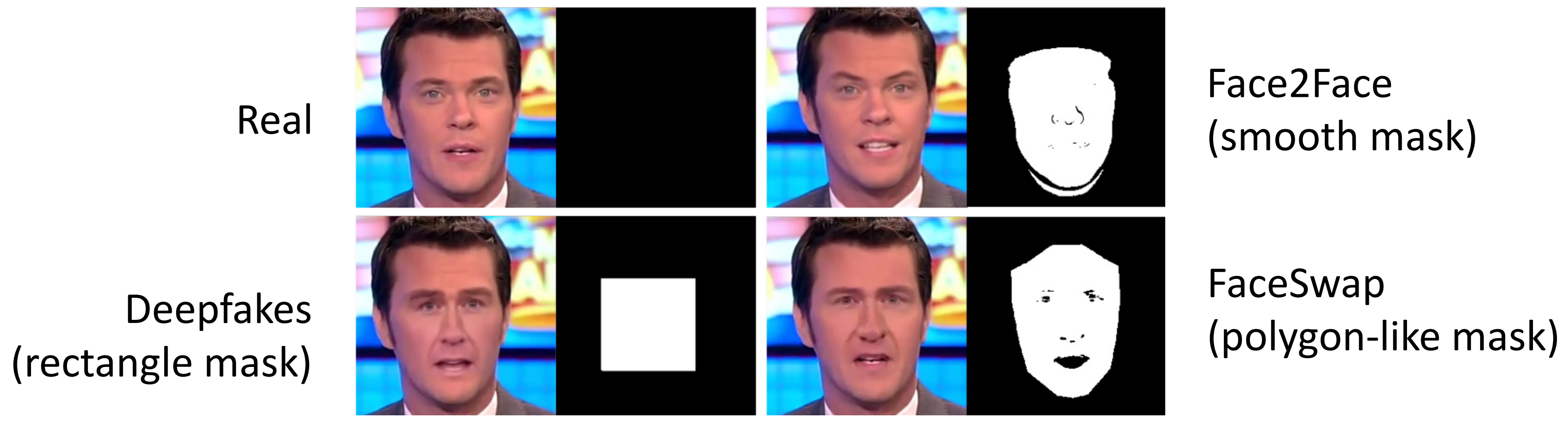


Synthesizing Obama: Learning lip sync from audio
(Suwajanakorn et al. 2017)



Text-based Editing of Talking-head Video
(Fried et al. 2019)

Overview



Example of a natural image and three corresponding manipulations: Deepfakes, Face2Face, and FaceSwap.
→ Based on segmentation result, we can infer the manipulated method.

Aim: Solving **3 problems simultaneously**:

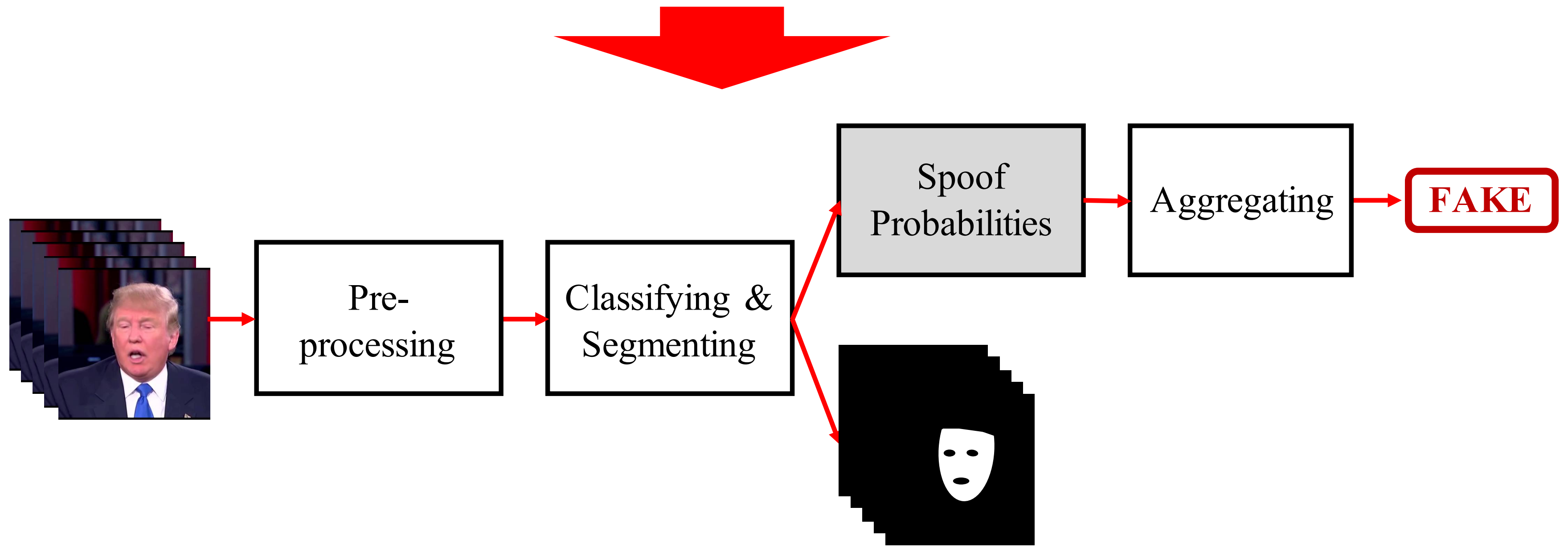
1. Identifying manipulated images/videos (PAD → classification).
2. Specifying manipulated regions (tampering detection → segmentation).
3. Detecting unseen attacks (transferability/cross-database detection).

Solution:

- Combining classification (real or fake), segmentation (tampering detection), and image reconstruction in a single network → multi-task learning.

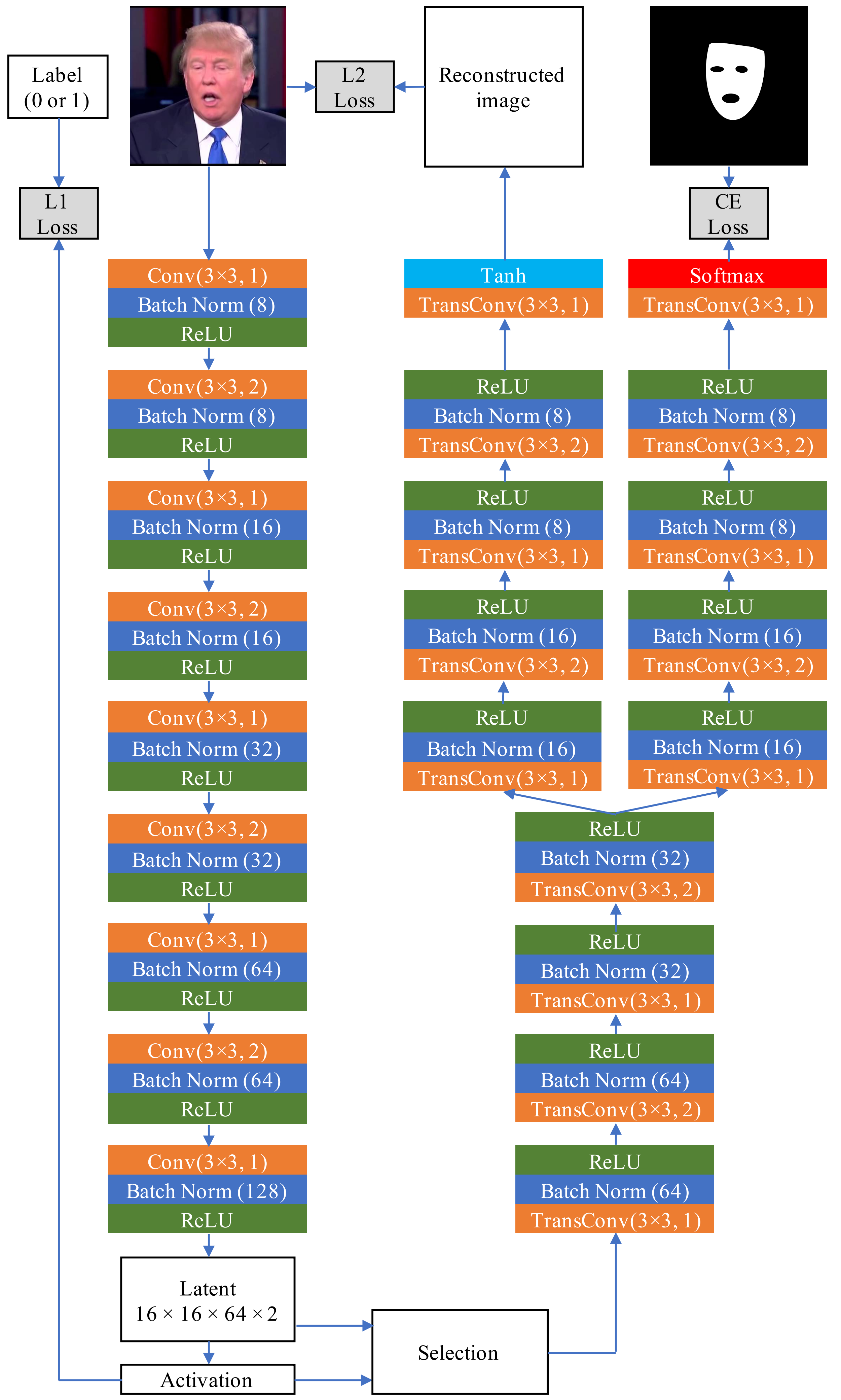
→ Sharing mutual information between tasks to improving the overall performance.

- Giving more information to judge the origin of the input (real or fake).

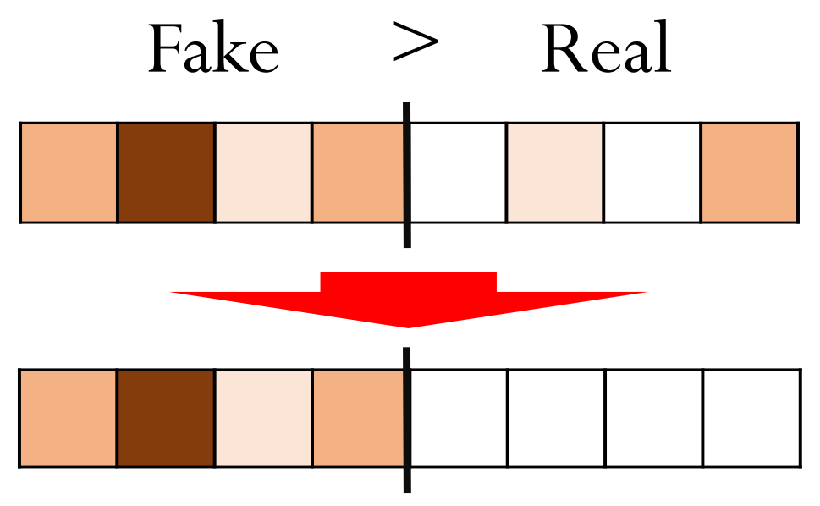


Pre-processing
Classifying & Segmenting
Spoof Probabilities
Aggregating
FAKE

Network Architecture

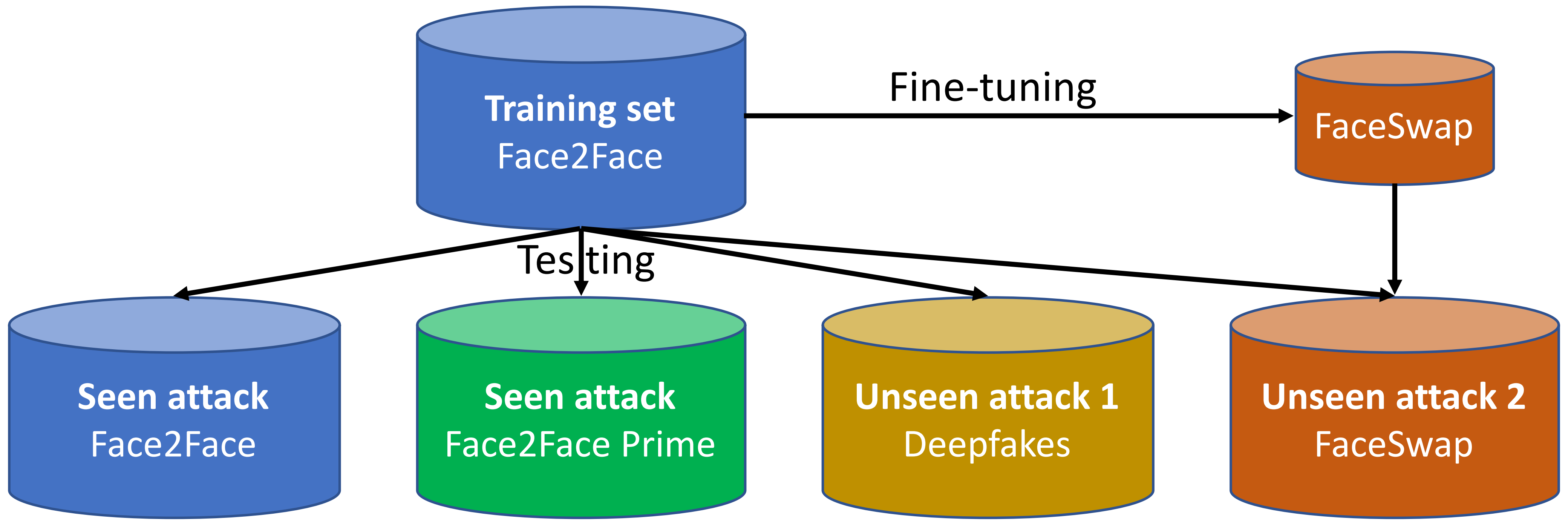


Label (0 or 1)
L1 Loss
L2 Loss
Reconstructed image
CE Loss
Conv(3×3, 1) Batch Norm (8) ReLU
Conv(3×3, 2) Batch Norm (8) ReLU
Conv(3×3, 1) Batch Norm (16) ReLU
Conv(3×3, 2) Batch Norm (16) ReLU
Conv(3×3, 1) Batch Norm (32) ReLU
Conv(3×3, 2) Batch Norm (32) ReLU
Conv(3×3, 1) Batch Norm (64) ReLU
Conv(3×3, 2) Batch Norm (64) ReLU
Conv(3×3, 1) Batch Norm (128) ReLU
Latent 16 × 16 × 64 × 2
Activation
Selection
TransConv(3×3, 1) Batch Norm (64) ReLU
TransConv(3×3, 2) Batch Norm (64) ReLU
TransConv(3×3, 1) Batch Norm (32) ReLU
TransConv(3×3, 2) Batch Norm (32) ReLU
TransConv(3×3, 1) Batch Norm (16) ReLU
TransConv(3×3, 2) Batch Norm (16) ReLU
TransConv(3×3, 1) Batch Norm (8) ReLU
TransConv(3×3, 2) Batch Norm (8) ReLU
TransConv(3×3, 1) Tanh
TransConv(3×3, 1) Batch Norm (16) ReLU
TransConv(3×3, 2) Batch Norm (16) ReLU
TransConv(3×3, 1) Batch Norm (8) ReLU
TransConv(3×3, 2) Batch Norm (8) ReLU
TransConv(3×3, 1) Softmax



Latent features are divided into two halves. The one with stronger activation will go through the decoder. The other one will be silent.

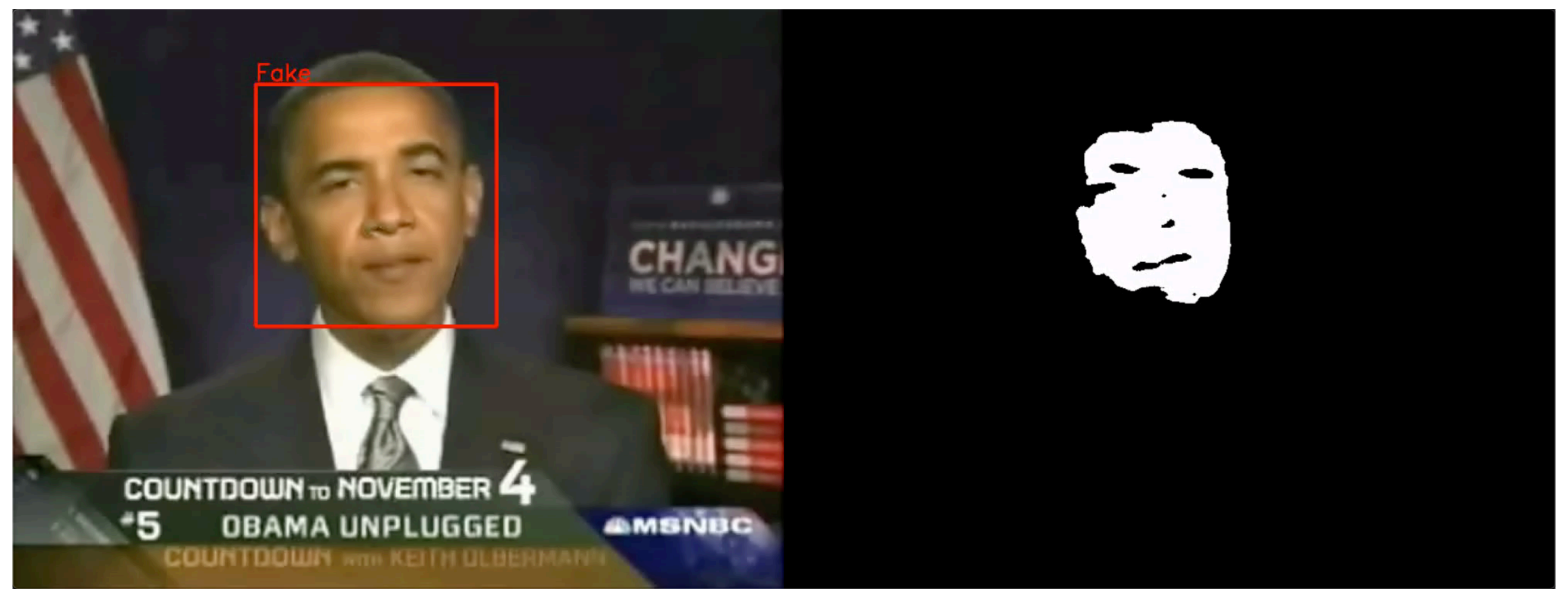
Evaluation



Training set Face2Face
Fine-tuning
FaceSwap
Testing
Seen attack Face2Face
Seen attack Face2Face Prime
Unseen attack 1 Deepfakes
Unseen attack 2 FaceSwap

Type of attack	Database (Medium compression)	Classification		Segmentation
		Accuracy (%)	EER (%)	Accuracy (%)
Match condition of seen attack	FaceForensics (Face2Face) Source-to-target	92.77	8.18	90.27
Mismatch condition of seen attack	FaceForensics (Face2Face) Self-reenactment	92.50	8.07	90.20
Unseen attack 1 (without fine-tuning)	FaceForensics++ Deepfakes	52.32	42.24	70.37
Unseen attack 2 (without fine-tuning)	FaceForensics++ FaceSwap	54.07	34.04	84.67
Unseen attack 2 (fine-tuning on small data)	FaceForensics++ FaceSwap	83.71	15.07	93.01

An example of detection and segmentation result on a video frame of the former US president Barack Obama modified by Face2Face method.



JST-ANR VoicePersonae Project

GitHub

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