Detecting and Recovering Sequential DeepFake Manipulation

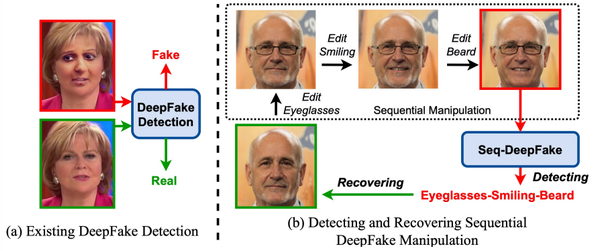
Rui Shao, Tianxing Wu, Ziwei Liu

S-Lab, Nanyang Technological University

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | S-LAB FOR ADVANCED INTELLIGENCE

ECCV TEL AVIV 2022

New Research Problem



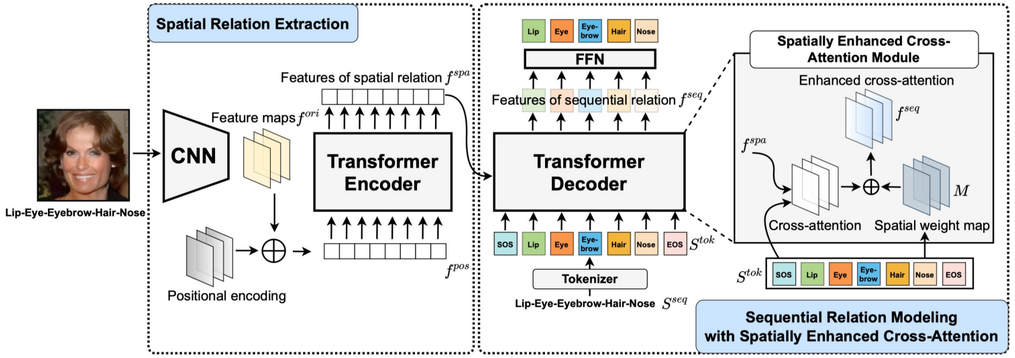
(a) Existing DeepFake Detection

(b) Detecting and Recovering Sequential DeepFake Manipulation

Detecting and Recovering Sequential Deepfake Manipulation (**Seq-Deepfake**).

- Detect **sequences** of facial manipulations with diverse sequence lengths.
- Recover original faces based on detected sequences of facial manipulation

Our Approach



- **Spatial Relation Extraction**:
  - Spatial manipulation traces

$$f_i^{spa} = \text{Softmax}(K_i^T Q_i / \sqrt{d}) V_i, f^{spa} = \text{Concat}(f_1^{spa}, ..., f_D^{spa})$$

- **Sequential Relation Modeling with Spatially Enhanced Cross-Attention:**
  - Sequential manipulation traces

$$t_h, t_w = \text{sigmoid}(\text{MLP}(S^{tok})), r_h, r_w = \text{FC}(S^{tok})$$

$$M(h,w) = \exp\left(-\frac{(h-t_h)^2}{\lambda r_h^2} - \frac{(w-t_w)^2}{\lambda r_w^2}\right)$$

$$S = \text{FC}(S^{tok}), K, V = \text{FC}(f^{spa}),$$

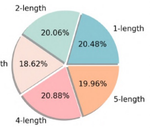
$$f_i^{seq} = \text{Softmax}(K_i^T Q_i \sqrt{d} + logM) V_i,$$

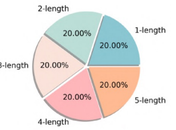
$$f^{seq} = \text{Concat}(f_1^{seq}, ..., f_D^{seq})$$

Sequential Deepfake Dataset

(a) Sequential facial components manipulation

(b) Sequential facial attributes manipulation





Sequence Length Distribution

- **Two different** facial manipulation techniques:
  - Sequential facial component manipulation
  - Sequential facial attributes manipulation
- Diverse sequence lengths

Experiments

- Accuracy of detecting Seq-Deepfake

Table 1: Accuracy of detecting Seq-Deepfake based on sequential facial components manipulation

Methods	ResNet-34		ResNet-50	
	Fixed-Acc	Adaptive-Acc	Fixed-Acc	Adaptive-Acc
Multi-Cls	69.66	50.54	69.65	50.57
DETR [5]	69.87	50.63	69.75	49.84
Ours	**72.13**	**54.80**	**72.65**	**55.30**

Table 2: Accuracy of detecting Seq-Deepfake based on sequential facial attributes manipulation

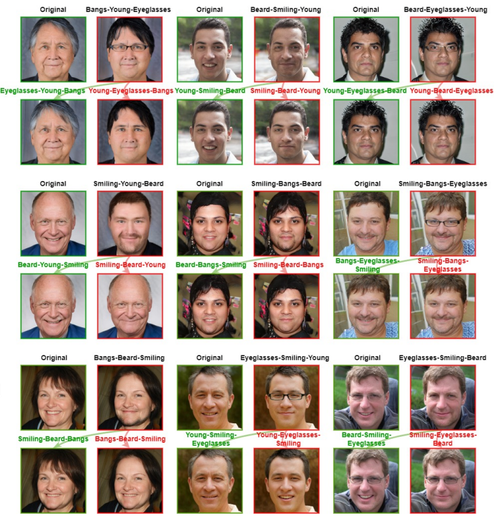
Methods	ResNet-34		ResNet-50	
	Fixed-Acc	Adaptive-Acc	Fixed-Acc	Adaptive-Acc
Multi-Cls	66.99	46.68	66.66	46.00
DETR [5]	67.93	48.15	67.62	47.99
Ours	**67.99**	**48.32**	**68.86**	**49.63**

- Comparison with deepfake detection methods

Table 3: Accuracy of detecting Seq-Deepfake compared to deepfake detection method

Methods	Face Components Manipulation		Face Attributes Manipulation	
	Fixed-Acc	Adaptive-Acc	Fixed-Acc	Adaptive-Acc
DRN [47]	66.06	45.79	64.42	43.20
MA [52]	71.31	52.94	67.58	47.48
Two-Stream [28]	71.92	53.89	66.77	46.38
Ours	**72.65**	**55.30**	**68.86**	**49.63**

- Face Recovery



Code: https://github.com/rshaojimmy/SeqDeepFake

Project Page: https://rshaojimmy.github.io/Projects/SeqDeepFake