A Neural Lip-Sync Framework for Synthesizing Photorealistic Virtual News Anchors

Abstract

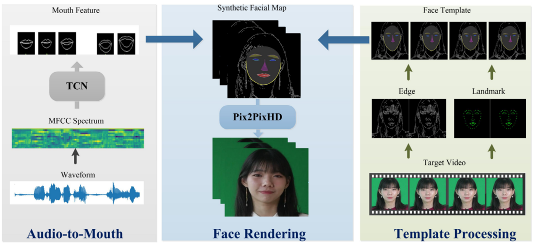
Here we present a novel lip-sync framework specially designed for producing a virtual news anchor for a target person. A pair of Temporal Convolutional Networks are used to learn the seq-to-seq mapping from audio signals to mouth movements, followed by a neural rendering model that translates the intermediate face representation to a high-quality appearance. This fully-trainable framework avoids several time-consuming steps in traditional graphics-based methods, meeting the requirements of many low-delay applications.

Challenges

Two main problems in applying current methods to the virtual anchor projects.
1. The lack of **enough resolution, visual consistency in details, and natural appearance** in synthetic videos.
2. The lack of **training, inference, and processing efficiency** also prevent current methods from many low-delay application scenarios. The candidate frame selection in traditional graphics-based methods is laborious and time-consuming.

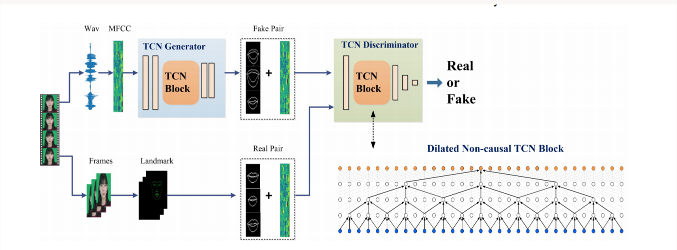
Our Solution

Our solution can be interpreted as two stages of work:
1. A pair of Temporal Convolutional Networks(TCN) learning the seq-to-seq mapping from audio signals to lip motion
2. An image-to-image translation-based neural renderer generating high-resolution and photorealistic texture from the synthetic face representation.



Mapping from Audio to Lip Motion

Different from RNN-based implementations, we employ a pair of Temporal Convolutional Networks (TCN) to learn the audio-to-mouth mapping, bringing the TCN's strength such as large perceptive field, stable gradients, and low memory requirements into the lip-sync task. A TCN-based generator learns the mapping from audio features to mouth features. It consists of four 1-D convolutions layers, two fully-connected layers, and a TCN block. The TCN block is wrapped with 1-D convolutions layers which downsample the rate of audio features to the video rate. We also devise a similar TCN-based discriminator to support the training of the mapping network. The discriminator takes the combination of audio and mouth sequences as input and outputs a real or fake label.

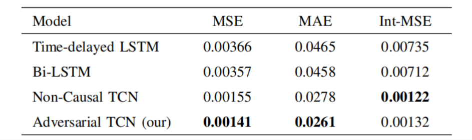


Neural Face Rendering

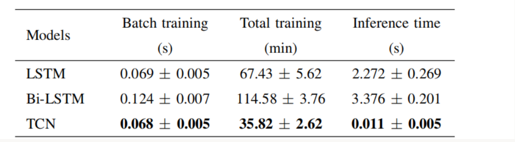
We devise a neural rendering module based on the hierarchical image-to-image translation model. We first synthesized the specially designed facial maps as an intermediate face representation. Then these facial maps are sent to the rendering network to generate high-resolution face appearance. For building **Synthetic Facial Maps**, we integrate the generated mouth into a face template. Generating continuous and accurate details is one of the main challenges for current rendering methods, especially for generating high-resolution videos. Instead of using the optical flow or temporal-consistent losses to improve visual consistency, we directly provide necessary information via the Canny edges from target frames.

Experiments

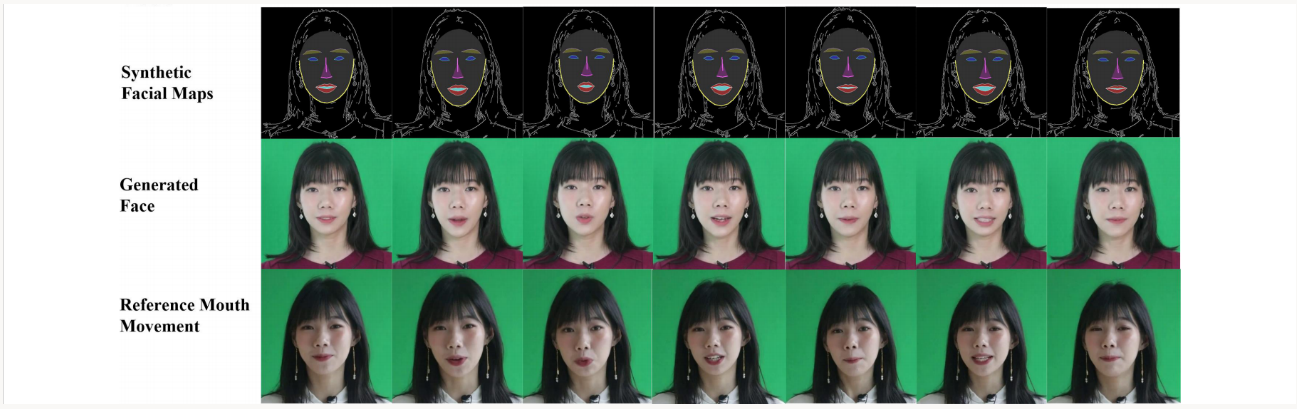
We evaluate the lip-sync framework at both the audio-to-mouth mapping and the rendering stages. We compare the audio-to-shape mapping performance between our model, two representative RNN-based baselines from recent lip-sync studies, and a basic TCN generator. Inter-Frame MSE measures the frame-wise velocity. We also compare the training time and inference times. The synthesized final frames show good visual compatibility and embouchure consistency, accurately capturing the mouth movements in the sound-source video while representing realistic facial expressions.



Model	MSE	MAE	Int-MSE
Time-delayed LSTM	0.00366	0.0465	0.00735
Bi-LSTM	0.00357	0.0458	0.00712
Non-Causal TCN	0.00155	0.0278	**0.00122**
Adversarial TCN (our)	**0.00141**	**0.0261**	0.00132



Models	Batch training (s)	Total training (min)	Inference time (s)
LSTM	0.069 ± 0.005	67.43 ± 5.62	2.272 ± 0.269
Bi-LSTM	0.124 ± 0.007	114.58 ± 3.76	3.376 ± 0.201
TCN	**0.068 ± 0.005**	**35.82 ± 2.62**	**0.011 ± 0.005**



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