Disentangled Representation based Face Anti-Spoofing
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Face anti-spoofing is an important problem for both academic research and industrial face recognition systems. Most of the existing face anti-spoofing methods take it as a classification task on individual static images, where motion pattern differences in consecutive real or fake face sequences are ignored. In this work, we propose a novel method to identify spoofing patterns using motion information. Different from previous methods, the proposed method makes the real or fake decision on the disentangled feature level, based on the observation that motion and spoofing pattern features could be disentangled from original image frames. We design a representation disentangling frame-work for this task, which is able to reconstruct both real and fake face sequences from the input. Meanwhile, the disentangled representations could be used to classify whether the input faces are real or fake. We perform several experiments on Casia-FASD and ReplayAttack datasets. The proposed method achieves SOTA results compared with existing face anti-spoofing methods.

Algorithm 1 Training and inference process

**Training**
Input: Face video sequences \( \{v_A = v_{1}, v_{2}, ..., v_{N}\} \), labels \( \{L_A = l_{1}, l_{2}, ..., l_{N}\} \), number of epochs \( k \)
1: while \( i \) is less than \( k \) do
2: Choose image pairs \( \{I_{k}^{1}, I_{k+1}^{1}\}, ..., \{I_{k}^{N}, I_{k+1}^{N}\} \), with labels \( l_{1}, ..., l_{N} \)
3: for each image pair \( \{I_{k}^{i}, I_{k+1}^{i}\} \) and its label \( l_{k} \) do
4: Encode \( \{I_{k}^{i}, I_{k+1}^{i}\} \) into \( \{R_{k}, R_{k+1}\} \)
5: Decode \( \{R_{k}, R_{k+1}\} \) into images \( \{\hat{I}_{k+2}, \hat{I}_{k+3}\} \)
6: Reconstruct image pairs \( \{I_{\text{real}}, I_{\text{fake}}\} \)
7: Disentangle motion pattern map \( I_{m} \)
8: Update the parameters of functional networks based on the computed losses \( L_{g} \)
9: Combine the disentangled motion pattern and spoofing pattern
10: Classify the spoofing type
11: Update the parameters of spoofing classifier based on classification result and input label \( l_{k} \)

**Output:** Pretrained functional networks

**Inference**
Input: Test face video sequence \( v_{T} \)
1: Choose image pair \( \{I_{k}^{T}, I_{k+1}^{T}\} \) from \( v_{T} \)
2: Disentangle the motion pattern and spoofing pattern
3: Decide the spoofing type by spoofing classifier

**Output:** Whether \( v_{T} \) is a real or spoofing face sequence