Learning Deep Models for Face Anti-spoofing via Auxiliary Supervision

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Introduction

- **X** Binary Supervision
- **✓** Auxiliary Supervision

- Simply training a binary classifier leads to overfitting.
- There are auxiliary information that can help.
- We prefer a model that can explain its decision.

Auxiliary Supervisions

- **Auxiliary spatial supervision: Depth Map Estimation**
  - $S_F = S_0 + \sum_{i=1}^{N} n_i S_{S_i} + \sum_{i=2}^{N} s_{i2} S_{S_{i2}}$
  - $S = rRSF + t$
  - Normalize the z values of the 3D vertices within [0, 1].
  - Apply the Z-Buffer algorithm.

- **Auxiliary temporal supervision: rPPG Signal Estimation**
  - rPPG signal provides temporal information about liveness of the face.
  - Related to changes in the intensities of the face skin over time.
  - Intensity changes are highly correlated with the blood flow.

Proposed Method

- Non-rigid registration layer
  - Register the CNN feature maps for LSTM training.
  - Use 3D face shape to do non-rigid registration.
  - Differentiable

Non-rigid Registration Layer

- Classification score
  - Compute the estimated depth map
  - Compute the estimated rPPG signal
  - $F(i,j) = U(S(m_{ij},1), S(m_{ij},2))$

- Demo systems
  - 3 FPS on phone
  - 26 FPS on laptop

Experimental Results

- Spoofing in the Wild (SiW) Databases
  - Contain 165 subjects
  - Pose range: -90° to 90°
  - Include print, replay, funny eye, and mannequin head attack
  - Lighting variation
  - Scene variation

- Successful cases
  - $90.01\%$
  - $9.97\%$
  - $2.65\%$

- Failure cases
  - $28.36\%$
  - $0.03\%$
  - $8.31\%$

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