Improving the generalization ability of face anti-spoofing methods from the perspective of the domain generalization.

Learning a generalized feature space that is shared and discriminative.

**Network Components**

- **Multi-adversarial Domain Generalization:**
  \[ L_{DG} = \sum_{i \neq j} \left( D_{ij}(x_i, x_j) + D_{ji}(x_j, x_i) \right) \]
  - Train one feature generator to compete with all the N domain discriminators simultaneously.
  - A shared feature space is learned after one feature generator fools all the N domain discriminators.

- **Dual-force Triplet-mining Constraint:**
  \[ L_{DG} = \sum_{i \neq j} \left( D_{ij}(x_i, x_j) + D_{ji}(x_j, x_i) \right) \]
  - Fake face with the same identity has similar facial characteristics; real face with the different identity has different facial characteristics.
  - Distance of each subject to its intra-class domain positive smaller than to its intra-cross-domain negative.

- **Auxiliary Face Depth Information:**
  \[ L_{DG}(X; Dep) = \| Dep(G(X)) - 1 \|^2 \]
  - Feature space guided to exploit generalized differentiation cases related to the face depth in the learning process.

**Experimental Results**

- **Datasets**
  - CASIA
  - MSU
  - Oulu

- **Comparison Results**
  - Ours
  - Ours_w/o

- **Ablation Study**
  - Methods
    - Ours
    - Ours_w/o

- **Limited source domains**
  - Methods
    - M4L to C
    - M4L to O

- **Attention Map**
  - Original
  - Binary CNN
  - Ours

- **Multi-adversarial Discriminative Deep Domain Generalization for Face Presentation Attack Detection**
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