Style Transfer for privacy preserving eye tracking

Milestone 1

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Eye images serve as unique biometric information in various applications. Eventually eye tracking is becoming more prevalent. Essential to develop techniques that can protect important biometric information. This project explores the use of style transfer to preserve user privacy while still providing aesthetically pleasing and plausible images of the eyes.
Deliverables for **milestone 1**

**Read Research Papers**
- Style Transfer
- Privacy-Preservation while eye-tracking

**Start preparing final report**

**Dataset Collection**
- OpenEDS
- IIT-Delhi

**Setup RITnet**
RITnet: Real-time Semantic Segmentation of the Eye for Gaze Tracking

- A semantic segmentation architecture
- Classifies eye images in four classes:
  - Iris
  - Pupil
  - Sclera
  - Background
- Produces coherent regions with crisp region boundaries.
- Deals with imbalanced pixel classes by minimizing following loss functions:
  - Generalized Dice Loss
  - Boundary Aware Loss
  - Surface Loss
RITnet - How is it related to the proposed approach?

- Provides real-time, more robust, more accurate and efficient gaze estimation.
- Provides segmentation at 301 Hz.
- This project uses sequential images.
- Hence, RITnet can be used for real-time semantic segmentation of eye images.
- These segmented images help towards efficient eye-tracking using images with noisy cases like varying contrast, low resolution, distorted images, etc.
RITnet: Real-time Semantic Segmentation of the Eye for Gaze Tracking
Deep Photo Style Transfer

- Addresses two fundamental challenges:
  - Structure preservation
  - Semantic accuracy and transfer faithfulness.
- Objective function for style transfer (originally):
  \[ L = \text{Content Loss} + \text{Augmented Style Loss} \]
- Proposed Objective function:
  \[ L = \text{Content Loss} + \text{Augmented Style Loss} + \text{Photorealism regularization} \]
Why use **Deep Photo Style Transfer**?

Figure 4: Content Image

Figure 5: Style Image

Figure 6: Output Image without Deep Photo Style Transfer

Figure 7: Output Image with Deep Photo Style Transfer

Figure 4,5,6,7: *[Luan, Fujun, Sylvain Paris, Eli Shechtman, and Kavita Bala. "Deep photo style transfer." In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 4990-4998, 2017.]*
Privacy-Preserving Eye Videos using **Rubber Sheet Model**

- Prevents Iris identification using rubber sheet model.
- Goal: Match the target iris with the source iris
- Example:

Fig 8: Real Eye Image

Fig 9: Target Image (Fake iris)

Fig 10: Generated Output Image

Figure 8, 9, 10: *(Chaudhary, A. K., & Pelz, J. B. (2020, June). Privacy-Preserving Eye Videos using Rubber Sheet Model. In Symposium on Eye Tracking Research and Applications (pp.1-5)).*
Then why are we still trying another approach to solve the *Privacy* problem?

- This approach only focuses on iris.
- User identification can be done using other features like pupil, sclera, eye corners, facial structure, eyelids, etc.
- The replacement technique often hides the eyelashes resulting in discontinuity in iris/pupil border.

Figure 8, 9: *(Chaudhary, A. K., & Pelz, J. B. (2020, June). Privacy-Preserving Eye Videos using Rubber Sheet Model. In *Symposium on Eye Tracking Research and Applications*(pp. 1-5).)*
Tasks completed in milestone 1

Milestone 1
- Dataset Collection.
- Reading Papers based on Style Transfer and Privacy Preservation.
- Setup RITnet
- Start writing final report

Milestone 2
- Implement Deep Neural Style Transfer with Privacy Preservation.
- Implement user identification on the output of style transferred images.
- Continue editing the final report.

Milestone 3
- Test the pipeline on larger dataset
- Result and Analysis

Poster and final report
- Poster Presentation.
- Complete final report.
Tasks to be done in milestone 2

Milestone 1
- Dataset Collection.
- Reading Papers based on Style Transfer and Privacy Preservation.
- Setup RITnet
- Start writing final report

Milestone 2
- Implement Deep Neural Style Transfer with Privacy Preservation.
- Implement user identification on the output of style transferred images.
- Continue editing the final report.

Milestone 3
- Test the pipeline on larger dataset
- Result and Analysis

Poster and final report
- Poster Presentation.
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References


Thank You