Visual Computing for Human Faces

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1 Research Problem Statement

Visual computing of human faces has attracted noticeable attentions in the communities of computer graphics and vision. It involves a wide range of real-world tasks, such as face recognition, face spoof detection, face reconstruction and so on.

3D face reconstruction. 3D face reconstruction, which is to reconstruct 3D face surfaces from other types of data like 2D images, point clouds, is very fundamental problem in visual research. Recently, the authors in Tran et al. (2018) proposed a method that can provide detailed 3D reconstructions of faces under extreme conditions unlike previous methods that used near frontal, unobstructed viewpoints for reconstruction. A method that can simultaneously reconstruct the 3D facial structure and provide dense alignment was proposed in Feng et al. (2018), which designed the UV position map to record the 3D shape of the face in UV space and used CNN to regress it from a single 2D image. In Jiang et al. (2018), the authors present a coarse-to-fine method to reconstruct a high-quality 3D face model from a single image. In order to solve the issues of 3D Morphable Model (3DMM) due to the type and amount of training data,as well as the linear bases, a non-linear 3DMM model was proposed in Tran and Liu (2018) which is end-to-end trainable with only weak supervision.

Spoof face detection. Face anti-spoofing, that is to distinguish spoof faces from live faces, is very essential to prevent face recognition systems from a security breach. To facilitate face anti-spoofing research, CASIA-SURF was released in Zhang et al. (2019), which is the largest publicly available dataset for face anti-spoofing in terms of both subjects and visual modalities. Since existing live face verification methods can be easily attacked by recorded facial expression sequence, some researchers proposed a patch-wise motion parameterization based verification network infrastructure Lin et al. (2018). It explores the underlying subtle motion difference between the facial movements re-captured from a planer screen and those from a real face.

We only introduced 3D face reconstruction and spoof face detection in this section. Also, only some recent works have been discussed. Interestingly, there are other visual computing tasks such as face recognition (He et al. (2005); Masi et al. (2019)). We believe visual face computing has great potential in its future.

2 Reasons and Significance

Reasons. To start with, I have a great interest, which is an important motivation, in visual computing. During my undergraduate study, I took courses in computer vision and image processing and have attended some projects about image processing, image object detection, etc. More importantly, the principal supervisor I expect (Dr. Xuequan Lu) has

extensive expertise in 3D/2D visual computing, in particular, 3D/2D data processing, modelling and analysis. With the fantastic platform and strong background in Dr. Lu's group, I am able to deepen myself into the above research tasks and make high-quality research achievements during my PhD career.

Significance. As for the significance, it is known to us all that face data is a crucial type of data, which can be easily collected by cameras or depth sensors. The data has been used in our daily lives, which involves security and privacy risks. Moreover, there are many interesting research topics related to human faces such as face recognition, spoof face detection, 3D face reconstruction and so on. Our target is to do high-quality research on visual face computing, which has impact to both research communities and industry. For the former, we intend to release our source code or executable program for researchers' use. For the latter, we can provide research foundations for companies and conduct technology transformation, hoping to offer real-world applications to users.

Alignment and anticipated outcomes. Security is one of Deakin's key research area. This research proposal is very relevant to it, due to the sensitivity and privacy of human faces (He et al. (2005); Masi et al. (2019)). Moreover, AI is becoming another important area of Deakin, and this research proposal belongs to it, to some extent. As such, our research proposal aligns well with Deakin's strategy. We expect that our proposed research can have impact to both research and industry communities. For example, we intend to make our framework publicly available once a research work is published. Also, we will pay efforts to seek collaboration opportunities with industry and release commercial applications for real world.

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