BU STUDENTSHIPS 2015

PROJECT DESCRIPTION

PROJECT DETAILS

Project Title

Time-varying 3D Face Reconstruction

Project Summary

Rationale

Reconstructing time-varying 3D faces from the images and videos of a face not only emphasizes facial expressions but also time lapse. Facial expressions are reliably associated with certain emotional states. To recognize the seven emotions, it is possible to correctly classify face images into seven categories. In facial animation, lots of spatial-temporal cues of facial expressions from videos/image sequences are needed. Moreover, a recent psychology study[1] indicates the existence of microexpressions which reveal the true emotions, but occur so fast that they are easy to miss. Reading facial expressions of emotion by capturing microexpressions is becoming the new focus. The desired outcome of this research is to generate a sequence of moving 3D faces in slow motion, to use for extracting 3D cues of expressions in computer animation and capturing subtle expressions as studied in Psychology. Additionally, this will likely bring a promising cutting-edge technology to the Forensics and Security field. For example, one of research foci is to extract 3D cues of a face, enhancing witness memory to aid manhunts and Identity Parades. Due to the limited viewpoint variance and a lack of depth cues in 2D images/videos, the available reconstruction methods inevitably have unbearable distortions. This project will tackle this challenge, further reconstructing a sequence of 3D faces with expressions from a video/image sequence. Further research will apply such 3D approach separately to facial expression editing in animation production and identifying subtle expressions of emotion in Psychology. This will test the hypothesis that the reconstructed 3D faces can provide more expression cues than the 2D counterparts.

The aims of this project are,
(1) Time-varying 3D face reconstruction;
(2) To test the current hypothesis through applications of facial expression editing and microexpression study.

Figure shows the reconstructed results from a 2D image sequence by a remarkable prototype of method in[2,3]. Due to the highly nonrigid nature of human face, coupled with our ability to discern very minute facial details and geometry flaws, it is so amazing to achieve such high quality results. However, it remains a great challenge to apply this method in practice, i.e. computing dense 3D optical flows involves human intervention.

Methodology

The core of this research is to compute dense 3D optical flows, which can recover realistic details. It is worth mentioning that the authors of[2,3] have shared their source codes with us to support our work. On this basis, this project will complete three studies,
(1) Initial estimation of the shape and appearance model for a face (Year 1). The accuracy of 3D optical flows depends on the initial estimation. Due to a variety of pose and lighting, 3D reconstruction from images is still challenging, but we will employ cutting-edge techniques, such as "trial and error" iteration.
(2) Implementation of the dense 3D optical flow algorithm without human intervention (Year 1/2). The new algorithm can borrow ideas from the available source codes and is assessed by quantitative comparison. To validate the robustness, the algorithm aims to reconstruct all the time-varying 3D faces from available video databases, such as VIPER or CMU-PIE databases.
(3) Expression editing (Year 3). For animation production, the algorithm will be utilized in extracting facial expressions from a 3D face sequence and retargeting expressions to the other objects, or even inanimate ones. In the meantime, this algorithm will also be employed in the microexpression study, achieving our second aim.

[1] D. Matsumoto and H.S. Hwang, Evidence for training the ability to read microexpressions of emotion. Motivation and Emotion, 35(2):181-191
[2] S. Suwajanakorn, I. Kemelmacher-Shlizerman, S. Seitz, Total Moving Face Reconstruction, in Proc. of ECCV 2014.

[3] T. Hassner, Viewing Real-World Faces in 3D, in Proc. of ICCV 2013.

Academic Impact

Currently, reconstructing facial expressions is very attractive, but there are still many technical barriers in implementation. The framework for the project stemmed from a couple of recent papers published in leading conferences, ICCV and ECCV, setting the academic agenda in this area. Moreover, the authors of these papers (i.e. Washington Univ. group and Israel Open Univ. group) have shared their source codes with us to support our research. Here, we have a unique chance to develop a collaborative partnership with these two leading research groups, which would position BU and NCCA research in particular on the international stage. The deliverable of this project will directly lead to multiple research articles in leading journals and conferences. Supervisors have a track record of publications in high international journals. Moreover, it is most likely used as a platform for microexpression study in Psychology and face composite/reconstruction in Forensic Science, as well as involving in the production pipeline of animation and games. This will promote an interdisciplinary research from computer vision, graphics, psychology to information forensics and security, and tackle some challenging issues.

Expected output

With assistance of international collaborators, the outcome will be desirable. Its potential applications in multiple fields, such as animation production, Psychology and Forensic Science, will lead to future external funding.

Societal Impact

The deliverable of this project is likely involved in the production pipeline of movies and games, where animating expressions is ubiquitously used for a variety of visual effects. NCCA has established an Industrial Advisory Board consisting of practitioners from leading VFX and games companies around the world. The links with industry and collaboration experiences are unique and extremely valuable in knowledge transfer of this project: as inputs/advices can be taken from industry and outputs/guidance/influence of the project can feed back to industry through existing channels. Moreover, this research is likely applied to face composite and recognition in manhunts and identity parades at the moment. In the relevant departments of the Police Force and Home Office, the usual approaches mainly rely on a set of 2D face images/videos. This project will deliver a 3D approach where witnesses and victims can see a sequence of 3D faces with expressions from arbitrary viewpoints rather than images/videos. At present, Video Identity Parade Electronic Recording (VIPER) has been widely utilized in Europe. Integrating this 3D approach into VIPER will disseminate the influence of this research across countries. We have contacted these potential beneficiaries, and have been advised that once we could deliver a practical software toolkit, they would like to integrate it into their systems. Thus this project has all the necessary components, e.g. academic excellence, collaborative partnerships and global societal impact, to lead to an Impact Case Study for the next REF.

Training Opportunities

The training programme will be directed by Dr H. Yu, with co-supervisor provided by Prof CH Liu. The training programme will concentrate on facilitating the delivery of the four primary objectives:

(1) Attending relevant modules in the unit of numerical optimization methods that is currently running for Eng.D students in Centre for Digital Enterprise (CDE);

(2) Computer vision and graphics methodology. Dr H Yu also runs a series of advanced seminars on geometry modelling, 3D reconstruction, tracking and rendering;

(3) Motion capture. Prof CH Liu and Dr H Yu will provide hands-on training in the use of eye-tracking and motion capture equipment;

(4) Communication skills, including the preparation of oral/poster symposium communications and peer-reviewed publications; delivery will be through attendance of BU's extensive training course for new researchers and through active participation in BU internal seminars.

SUPERVISORY TEAM	
First Supervisor	Dr Hongchuan Yu
Additional Supervisors	Dr Changhong Liu
Recent publications by supervisors relevant to this project	[1] H. Yu, Y. Qin & J.J. Zhang, Eigenface based surface completeness, J. Electron. Imaging. 24(2); [2] H. Yu, T.-Y. Lee, I-C. Yeh, X. Yang, W. Li & J.J. Zhang, An RBF-Based Reparameterization Method for Constrained Texture Mapping. IEEE Trans. Vis.&Comp. Graph. 18(7); [3] H. Yu & J.J. Zhang, Topology preserved shape deformation, The Visual Computer, 28(6-8); [4] H. Yu, J.J. Zhang & T.-Y. Lee, Foldover-free shape deformation for biomedicine. J. of Biomedical Informatics, 48:137-147; [5] H. Yu & J.J. Zhang, Tensor-Based Feature Representation with Application to Multimodal Face Recognition. Int'l J. of Pattern Recognition and Artificial Intelligence, 25(8); [6] H. Yu & J.J. Zhang, Mean value coordinates-based caricature and expression synthesis. Signal, Image and Video Processing 7(5); [7] Liu, C.H., Chen, W., & Ward, J., Remembering faces with emotional expressions. Frontiers in Psychology, 5:1-7. DOI:10.3389/fpsyg.2014.01439. [8] Liu, C.H., Chen, W., & Ward, J., Effects of exposure to facial expression variation in face learning and recognition. Psychological Research. DOI:10.1007/s00426-014-0627-8. [9] Sui, J., Hong, Y-y., Liu, C.H., Humphreys, G.W. & Han, S., Dynamic cultural modulation of neural responses to one's own and friend's faces. Social Cognitive and Affective Neuroscience. DOI: 10.1093/scan/nss001. [10] Sui, J., Liu, C.H. & Han, S., Cultural difference in neural mechanisms of self-recognition. Social Neuroscience, 39:939-947.

INFORMAL ENQUIRIES
To discuss this opportunity further, please contact Dr Hongchuan Yu via email: hyu@bournemouth.ac.uk
ELIGBILITY CRITERIA
All candidates must satisfy the University's minimum doctoral entry criteria for studentships of an honours degree at Upper Second Class (2:1) and/or an appropriate Masters degree. An IELTS (Academic) score of 6.5 minimum (or equivalent) is essential for candidates for whom English is not their first language. **Additional Eligibility** Applicants should have a good experience in programming.
HOW TO APPLY
Please complete the BU Research Degree Application 2015 and submit it via email to the Postgraduate Research Administrator for Admissions **Suzy Kempinski** - pgradmissions@bournemouth.ac.uk by **1 November 2015**. Further information on the application process can be found at www.bournemouth.ac.uk/phd-2015