



BU STUDENTSHIPS 2021

PROJECT DESCRIPTION

PROJECT DETAILS

PROJECT TITLE

Next generation of contextually-aware and AI-powered human computer interaction technology

PROJECT SUMMARY

Due to a promising market, human computer dialog is becoming an active topic in academic and creative industry fields. Most of famous companies launched the individual products such as MS Cortana, Xiaoice, OpenAI GPT, Google chat etc. Besides text or text-to-speech, non-verbal channels, such as facial expressions, postures and gestures, combined with emotion in speech, are important in understanding the dialogue. This is because in human communications, the information is often transmitted from multiple channels, including facial expressions, emotional voices, postures and gestures. Understanding of people's intentions from their multichannel information plays a key role in natural interaction. This PhD project aims at multichannel user behaviour detection and multimodal data fusion in multimodal human-computer interaction (HCI), which helps improve the believability in human computer dialogs.

Machine learning and computer vision technology have contributed to the improvements for single channel behaviour perceptions, including speech recognition, facial expression recognition, emotional understanding, gesture comprehension, posture analysis, gaze detection etc. The computer has some ability to understand the user from single channel information. However, it is still a great challenge to understand human users' intention accurately from their multichannel behaviours. The main challenge is that we need to improve multimodal information fusion in theories, methodologies and practical systems.

Currently, many methods exist for multi-modal information fusion, including Bayesian decision model, Cross modal learning Neural Networks and Graph model based information fusion. However, accurately recognising the user's intension remains challenging. To improvement on these fronts, this PhD project will focus on:

- (1) A novel integration approach of multi-channel interaction information. Multi-channel user behaviour, including voice, posture, emotional expressions etc., in interaction is more likely to lead to uncertainty than the single channel counterpart. The richness and fuzziness of such expressions make it difficult to be accurately mapped to the traditional human-computer interface, which makes the system feedback inaccurate. One of the objectives is to develop novel representation forms for such high dimensional multimodal data and associated multisensory learning algorithms.
- (2) Novel multi-channel human-computer interaction learning model. An ideal interaction model should be able to learn, understand and integrate new knowledge into the existing knowledge bases and explore new domain. This is the 2nd objective.
- (3) In user interface design, personified avatars prefer that facial expression of a talking head is driven by speech, while capturing and recognizing your expression changes. Moreover, it is desired to make the synthesized facial expression photorealistic rendering in real time. The 3rd objective is to develop a photorealistic talking head as virtual avatar.

This will be a fruitful research journey. The outcomes are very suitable for SMEs and start-ups. Many successful examples related to UI are continuing to bring out in HCI sector in this era of AI.

For applicants, it is essential to have programming experience in C, or C++, or python, or JavaScript. It is desired to have experience in machine learning (e.g. deep learning technology, data mining etc).

ACADEMIC IMPACT

As a part of HCI, the Interactive and Intelligent UI enables virtual avatars to perform human-like communications with real humans. It is required to deliver sensible conversations, appropriate body gestures and facial expressions; and be able to detect the motion and emotions of human users. By performing such human-like functions, the virtual avatar will be able to play an active role in assisting the mankind in countless applications, such as healthcare, training, education, marketing and decision making, to name but a few. Taking healthcare as an example, we all are aware of the acute pressure the NHS is under and it usually takes a long wait even to see our GP. If some/most of the GP's tasks can be undertaken by intelligent virtual avatar, it will not only save the NHS a huge budget, but also significantly shorten the waiting time. In addition to the role of a GP assistant, in healthcare alone there are many other applications where intelligent virtual avatar can play an important assisting role.

Research-wise however, despite some preliminary progress, due to the fundamental challenges, it is still at a very early stage. Many research questions are either not answered, nor are they even asked. The aim of this PhD project is to investigate and create novel algorithms and techniques leading to the development of the aforementioned Interactive and Intelligent UI. The research outputs will benefit REF directly.

SOCIETAL IMPACT

Communities in UK are facing certain common social and economic challenges related to improving the R&D ability of SMEs and start-ups, including strengthening collaboration among different fields of SMEs and collaboration between universities and industry, encouraging SMEs to invest in R&D. In fact, SMEs have been one of the main economic players, particularly in ICT and in the creative industry. For example of Bournemouth & Poole, in the report of Tech Nation 2017, the digital Gross Value Added (GVA) was around £ 352 million, the digital high growth firms reached 26% of growth rate, and 199 Start-ups birthed in last year. In Continental Europe, for example of the business start-ups in France, in the INSEE Premiere 2018, the total number of business start-ups increased by 7% in 2017, reaching the highest since 2010. This project will tackle the challenges by enhancing the SMEs R&D's ability within ICT and creative industry.

DEVELOPMENT OPPORTUNITIES

We will arrange regular supervision meetings. The student will therefore benefit by understanding the global picture of the project; getting advice from the supervising academics; and reporting the problems.

In the same time, the student will be exposed to the knowledge and practice relevant to his investigation, such as the necessary tutorials for data mining, computer graphics and HCI.

The training courses from the Doctoral College, such as research methodology, academic writing and presentation, research ethics, project management, career development, will help the students develop their research skills in a wide context.

Additionally, the student will have opportunities to present his research outcomes on prestigious conferences (e.g. Siggraph, SigCHI) and participate in high-profile public engagement activities.

SUPERVISORY TEAM

First Supervisor	Hongchuan Yu
Additional Supervisors	Jian J Zhang
Recent publications by supervisors relevant to this project	<p>[1] J. Wang, X. Wang, F. Tian, C.H. Liu and H. Yu, 2017, Constrained Low-Rank Representation for Robust Subspace Clustering, IEEE Trans. on Cybernetics, Vol.47, No.12.</p> <p>[2] J. Wang, F. Tian, H. Yu, X. Wang, C.H. Liu, K. Zhan, Diverse multi-view Nonnegative Matrix Factorization for Multiview Data Representation, IEEE Trans. on Cybernetics, Vol.48, No.9</p> <p>[3] Jianwei Zheng, Hong Qiu, Weiguo Sheng, Xi Yang, Hongchuan Yu, 2018, Kernel group sparse representation classifier via structural and non-convex constraints, Neurocomputing, Vol.296, pp.1-11.</p> <p>[4] J. Zheng, C. Lu, H. Yu, W. Wang and S. Chen, 2018, Iterative Reconstrained Low-Rank Representation via Weighted Nonconvex Regularizer, IEEE Access, Vol.6, pp.51693-51707.</p> <p>[5] J. Zheng, M. Qin, X. Zhou, J. Mao and H. Yu, (2019) Efficient Implementation of Truncated Reweighting Low-rank Matrix Approximation, IEEE Trans. on Industrial Informatics, doi: 10.1109/TII.2019.2916986</p> <p>[6] Yunfei Fu, Hongchuan Yu, Chih-Kuo Yeh, Jian J Zhang, Tong-Yee Lee, High Relief from Brush Painting, IEEE Trans. on Vis. & Comp. Graph., doi:10.1109/TVCG.2018.2860004.</p> <p>[7] H. Li, G. Li, L. Lin, H. Yu, Y. Yu, 2018, Context-Aware Semantic Inpainting, IEEE Trans. on Cybernetics, doi:10.1109/TCYB.2018.2865036.</p> <p>[8] Kan Wu, Guanbin Li, Haofeng Li, Jian Jun Zhang, and Yizhou Yu, 2019, Harvesting Visual Objects from Internet Images via Deep-Learning-Based Objectness Assessment, ACM Trans. Multimedia Comput. Commun. Appl., 15(3), Article 72, doi:10.1145/3318463</p> <p>[9] Z. Li, M. Wu, J. Zheng and H. Yu, 2019, Perceptual Adversarial Networks With a Feature Pyramid for Image Translation, IEEE Computer Graphics and Applications, Vol.39, No.4, pp.68-77, doi: 10.1109/MCG.2019.2914426</p> <p>[10] Fu, Yunfei; YU, Hongchuan; Yeh, Chih-Kuo; Lee, Tong-Yee; Zhang, Jian J., Fast Accurate and Automatic Brushstroke Extraction, IEEE Trans. on Emerging Topics in Computing (accepted)</p>

INFORMAL ENQUIRIES

Please contact the lead supervisor on the following email for informal enquiries: hyu@bournemouth.ac.uk

ELIGIBILITY CRITERIA

The BU PhD Studentships are open to UK, EU and International students.

Candidates for a PhD Studentship should demonstrate outstanding qualities and be motivated to complete a PhD in 4 years and must demonstrate:

- outstanding academic potential as measured normally by either a 1st class honours degree (or equivalent Grade Point Average (GPA) or a Master's degree with distinction or equivalent
- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.
- Good computer programming ability is essential.

ADDITIONAL ELIGIBILITY CRITERIA

An ideal candidate should have a background in computer science, mathematics, engineering or a relevant subject.

HOW TO APPLY

Please complete the online application form by **31 October 2021**.

Further information on the application process can be found at: www.bournemouth.ac.uk/studentships