Developing Data Assimilation and Machine Learning Approaches to Analysing Complex Multimodal Biometric Data: Towards a More Personalised and Adaptive Mental Health Care

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Background

Somatic and mental health are interrelated components in a person's well-being. People living with long-term medical conditions are known to experience anxiety and depression (Cimpean & Drake, 2011), whereas people living with mental health issues are likely to be less active and have an increased risk of cancer (Batty et al., 2017) or coronary heart disease (Chaddha et al., 2016). Treating long-term medical conditions can be challenging, with common problems being poor adherence to treatment (WHO, 2003), over-prescription of pharmaceutical interventions (Gorman and Gorman, 2018) and potential adverse or unsafe responses in young people as a result of being prescribed drugs designed for adults (DoH, 2004). There is an increasing interest in the development of personalised approaches to healthcare leading to better prognosis and improvements in the patients' quality of life. During the initial research into anxiety, Dr Wilson identified that anxiety disorders (generalised and social) were present in Birmingham City University's student population (unpublished data). Therefore, there is a cohort of young people that the team can work with to develop the proposed systems.

The PhD research will be to design and implement personalised adaptive computer-based interventions to support mental health issues, for example, in people experiencing anxiety disorders. These interventions may be software-based apps to support mindfulness practices, game-based systems or virtual / augmented reality experiences. However, to create the adaptive component of these systems, the team will look at the types of emotion, as measured by multimodal biometric and physiological responses, which are typically being experienced by the volunteers. Once profiled, computerised-based interventions will be developed, which will adaptively respond and encourage a shift from negative emotions to positive ones as a result of the implementation of personalised biofeedback loops.

Motivation

While there are many wearable solutions enabling capturing physiological signals, there is still no consensus on how translate these into mental states. At the same time, the traditional questionnaires designed to capture mental and emotional states are subjective. This project will attempt to bring together multiple cues related to physical and mental states and understand their interconnection under various conditions to enable more personalized health care and well being interventions.

Proposed research

In 2017 the Faculty of Computing, Engineering and the Built Environment invested £20,000 in biometric hardware and the innovative biometric software platform iMotions. This software allows simultaneous data collection from different sources including electro dermal activity, electrocardiographs, electroencephalographs, facial recognition and eye gaze. By combining these together, it is possible to better predict the emotional state or feelings of the user.

The system can generate large quantities of physiological data, and therefore, data assimilation and machine learning approaches are needed to 'understand' these data and what they mean in terms of profiling a person. The specific objectives of this project involve the following:

- Analyse experimental data to confidently predict emotional status of an individual after exposure to a range of multimedia sources.

• Explore optimal conditions and settings in the software to accurately identify positive or negative responses from the range of stimuli.
• Identify the best combination of biometric hardware that can detect emotional responses to the respective intervention: mindfulness apps, games or virtual / augmented reality experiences.
• Create machine learning protocols able to accurately interpret the biometric data, predict the emotional state and then influence the intervention to move the user from a negative emotional state to a positive one.

Potential impact

1. Developing non-pharmaceutical interventions that can have a positive impact on a person's well-being. This will initially be with university students. However, if successful approaches have been identified, they can be further explored with the help of the West Midlands Clinical Research Network.
2. Working with iMotions to explore and develop machine learning tools that can enhance their existing software. They do not currently work in machine learning.
3. Looking at the commercial viability of the interventions being created, building on the existing work between Dr Wilson and Mr Assim Ishaque (RIE).
4. Creating data sets for researchers and data scientists in the school of computing and digital technology to work with.
5. More undergraduate and postgraduate projects based upon iMotions software.
6. Gaining a better understanding of the potential of iMotions software with a view to offering consultancy work and generating third stream revenue for the school.
7. Opportunity to collaborate with Professor Mariano Alcaniz at Leni Labs, University Polytechnic Valencia.
8. Possible collaborations with Thomas Lambertsen Binzer, Psykiatrien i Region Syddanmark (Southern Denmark University).
9. Generation the potential for future bids, especially providing the collaborations this project can bring.

References

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