SenseCare: Using Affective Computing to Manage and Care for the Emotional Wellbeing of Older People

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Abstract. This paper discusses an opportunity for using *affective computing* modalities to support the monitoring of emotional wellbeing of older people. The ageing population is escalating and is associated with an increase in the number of persons with dementia. It is also reported that older people can suffer from social isolation and that people with dementia can experience a range of negative emotions such as anxiety and depression. We present a model to care for a person's emotional wellbeing in the home using multiple-modalities such as video, audio, electrodermal activity and photoplethysmography.

Keywords: Affective computing · Emotion · Older people · Ageing · Dementia

1 Introduction

The number of persons exceeding 85 years of age has almost doubled in the past decade and it is well documented that the entire ageing population will at least double by the year 2050 [1]. This will result in escalating health care costs and chronic diseases such as dementia. Healthcare institutions and researchers have been investigating potential solutions and new healthcare paradigms to alleviate this burden. These paradigms have included a number of connected health solutions. Whilst connected health research has received special attention in recent years, there is no agreed definition for this concept. Nevertheless, according to Caulfield et al. [2] *"Connected Health is where all stakeholders in the process are 'connected' by means of timely sharing and presentation of accurate and pertinent information regarding patient status through smarter use of data, devices, communication platforms and people"*. Connected health research has had a focus on the use of smart environments, home

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automation, ambient intelligence, telehealth and mHealth and has involved the use of sensors in the home coupled with algorithms to detect certain events such as activities of daily living and events such as falls. Whilst these are important areas of research, there is also a need to provide solutions for monitoring and caring for the emotional wellbeing of older people and in particularly people with dementia. This is needed given that an increasing proportion of the ageing population often suffer from social isolation or social exclusion [3]. Social isolation has an obvious effect on emotional wellbeing and can yield negative emotions such as depression, sadness and fear and people with dementia can have periods of agitation and aggression [3]. Others have suggested the use of social media networks that are tailored for the demographic of older people [4]. Nevertheless, the emerging area of affective computing has provided the opportunity to monitor and care for the emotional wellbeing of older people and in particular people with dementia.

2 SenseCare Model

Affective computing is the study of how machines can understand and respond to human 'affect' and emotions [5]. Paul Ekman, a pioneer in emotion research, stated that there are six universal emotions, i.e. anger, fear, disgust, surprise, joy, sadness [5]. Affective computing is inter-disciplinary in nature and spans computer science and psychology. If the affective computing vision is to be realised, it will bring about a revolution in artificial intelligence, which will have an impact on how humans interact with machines. Researchers in this discipline experiment using a range of modalities to determine human emotions. This includes 2 Dimensional (2D) and 3 Dimensional (3D) video (to classify facial expressions and body gestures), audio (to classify voice intonations and prosody), electroencephalography (EEG - brain signals), photoplethysmography (PPG - for measuring pulse rate/valence), Electrodermal Activity (EDA - for measuring skin conductance/arousal) and facial electromyography (EMG - for measuring facial muscles). A requirement for the SenseCare project is to monitor emotion via non-invasive sensors using a platform that does not require excessive interaction or cognitive effort from the user. Consequently, since EEG and EMG require considerable resource to setup and are not regarded as convenient wearable technologies, we have initially decided not to consider these modalities in the SenseCare platform. However, the modalities we are considering have been presented in Table 1 along with a number of strengths and weaknesses for each sensor. These strengths and weaknesses are pertinent to the context of the SenseCare project. Figure 1 also illustrates the current SenseCare model where sensor data (video, audio, EDA and PPG signals) are streamed to a server for feature extraction and emotion classification via machine learning algorithms. To protect privacy, video/audio features can be extracted outside the cloud. If there is a deviation from positive emotions, a next of kin or carer is automatically notified to intervene personally or provide appropriate digital content via the home entertainment system (this can involve a voice-over-IP conversation, streaming the person's favourite television programmes or family videos/photos from social media). Alternatively, a next of kin or carer can access the system's dashboard at any time. By default the system will indicate which days, times

Table 1. Relevant strengths/weaknesses of each selected modality in SenseCare model.

Mode	Strengths	Weaknesses
EDA	Validated for measuring arousal Conveniently measured from the wrist using a wristband Not infringing on privacy	Relies on a person wearing a device and thus is dependent on a person with dementia remembering to wear it daily and to recharge it
PPG	Measures pulse rate and can be used to infer heart rate variability. It also complements EDA in using the arousal-valence space Can be conveniently measured from the wrist using a wristband or from the ear lobe Not infringing on privacy	Not always an accurate measure of heart rate and accuracy is affected by activity Relies on a person wearing a device and thus is dependent on a person with dementia remembering to wear it daily and to recharge it
Video	Established science for classifying emotions from facial expressions An inexpensive sensor that can be easily placed around the home, e.g. above mirrors, TVs and kitchen sinks	Not all emotions are expressed facially No data is collected if the user is not in the frame Infringing on privacy
Audio	An inexpensive sensor that can be easily placed around the home, e.g. near telephones and in social areas such as the longue and kitchen	Not all emotions are expressed verbally No data is collected if the user is not speaking Infringing on privacy

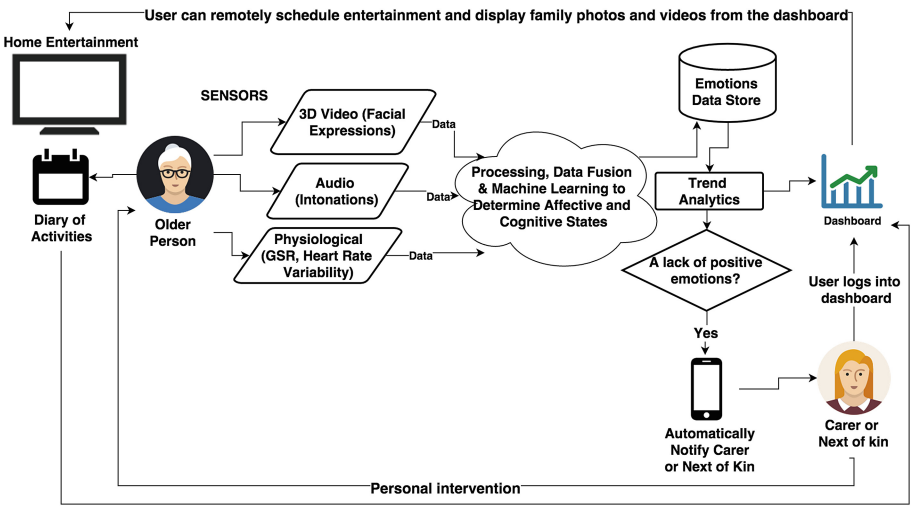

Fig. 1. Framework for monitoring and caring for the emotional wellbeing of older people.

Table 2. Vignettes illustrating potential use case scenarios of the SenseCare platform.

SenseCare use case scenarios
1. Sonia is an elderly lady who has dementia and lives on her own. She gets frequent phone calls from family members and often receives a call from her nephew Ben. The SenseCare platform has computed that Sonia's emotional wellbeing has been declining over a short period of time and the carer has been notified of this. The carer logs onto the dashboard and observes some trends. It highlights that Sonia's positive emotions peak during a periodic phone call she receives once a month on a Tuesday afternoon. The carer visits Sonia and carries out a mental health assessment. Sonia's health seems to be fine but after gaining permission, the carer phones Ben to reinforce that his phone calls have a positive effect on Sonia's emotional wellbeing and he is encouraged to phone more often, perhaps weekly. Ben is delighted to be notified of this and calls Sonia once a week. A few months later, the SenseCare platform shows that this weekly phone call has had a significant effect on Sonia's emotional wellbeing
2. Jim is an elderly man with dementia and lives on his own. He is normally happy throughout the week but still gets a visit from a carer once a month. The SenseCare system detects that Jim has been feeling down during the start of each week because of a lack of visits and he feels isolated on Mondays especially. The system notifies his daughter Susan via SMS. Susan is a busy professional and can't physically intervene early in the week as she travels for business meetings and needs to provide for her young family. Susan logs onto the dashboard the following Monday and has a video Skype conversation with her Dad. She then sets up a TV schedule for her Dad and selects recent family videos and photos from her Facebook to be streamed to her Dad's home entertainment throughout the day. During mid-week, Susan logs back onto the dashboard and selects the emotion analysis feature and is reassured that her Dad was much happier during Monday and decides to set up a programme for every Monday

and activities (recorded from a diary) provide the periods of 'happiness' or 'unhappiness'. For example, the system will indicate which personal visit, phone call, television programme or any other activity correlated with various emotional episodes. Table 2 provides two vignettes that illustrate potential use case scenarios for the SenseCare model.

3 Conclusion

We present a model that uses affective computing to help care for the emotional wellbeing of older people and specifically those people with dementia. The project team are currently developing this model and will test it in a number of scenarios.

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