Emotional Wellbeing of Older Adults within Aware Homes – Detection and Intervention

Julie Doyle   Brian O'Mullane   Ben Knapp

CASALA, Dundalk Institute of Technology
Co. Louth, Ireland

julie.doyle@casala.ie, brian.omullane@casala.ie, ben.knapp@casala.ie

Supporting positive emotional wellbeing is a critical challenge in an ageing population. Aware homes have significant potential to enhance the lives of older adults, extending the period of healthy ageing, through monitoring their health and wellbeing, detecting decline and applying interventions to arrest this decline. Our research aims to create a new method of preventative care based on early prediction of changes in emotional state and, based on this early detection, use novel "human-in-the-loop" intervention methods specific to the needs of the individual to improve the quality of life of the older person *before* severe problems arise. This paper discusses our research involving older adults who live in aware homes. We discuss our approach in detecting changes in emotional wellbeing, combining behavioural data from embedded sensors in the home with self-report data from the residents. We also discuss the challenges involved in interventions to support emotional wellbeing.

Assisted living. Aware homes. Emotional wellbeing. Older adults.

1. INTRODUCTION

Population projections estimate a significant increase in the number of older adults in the near future (Hayutin, 2007), (Kinsella & Phillips, 2005). By 2050 an estimated 22% of the world's population – nearly 2 billion people – will be aged 60 or over (United Nations, 2007). This will result in a shortage of workers and facilities to care for the ageing population. Thus, supporting older adults where they live and in an environment that will adapt to their needs as they age, is a pressing need and represents a critical challenge.

Aware homes support the monitoring of older adults, with the potential to detect a wealth of information regarding the person's functional, cognitive, social and emotional wellbeing. Within the CASALA research centre we are very well placed to carry out such research, through our 'living lab' at Great Northern Haven (GNH), located in Dundalk in the North-East of Ireland. GNH is a demonstration housing project consisting of 16 purpose-built homes, each equipped with a combination of sensor and interactive technology to support ambient assisted living (AAL) for older adults. There are a total of 2240 sensors and actuators throughout the development, with approximately 100 sensors embedded in each home.

To date, we have collected a vast amount of data from the embedded sensors within each of these homes and models are being built to detect patterns in activities of daily living and health. The sensors include PIR sensors to detect motion; window and door sensors to detect and report open and closed events and sensors to detect power consumption and heating usage. Each home has a number of alarm cords and buttons, a home security system and a telecare device that links to a third party monitoring service. Two interactive devices, an Internet connected TV and a touch screen tablet device (soon to be replaced by the iPad 2) have been installed into each home. The touch screen device currently provides information on home security (e.g. door/window open, stove left on) and weather.

Our research goals within GNH are to:
- Use unobtrusive and low cost ambient measurement to obtain behavioural and physiological data.
- Use algorithms to infer and predict changes in emotional state over time.
- Gather ground truth data from GNH residents on emotional state, using validated questionnaires and delivered through interactive technologies in the home.
- Improve the quality of life of older adults by way of interventions delivered through technologies in the home and that address the detected changes in emotional state.

While research on sensor systems and detecting patterns of behaviour dominates the AAL research space, the challenge of predicting changes and prompting positive preventative intervention measures, aiding the avoidance of severe physical or mental harm, has not adequately been addressed.

2. DETECTING CHANGES IN EMOTION

For some older people, the notion of growing older can severely negatively affect their emotional state, as can the loss of a spouse, or general worries about coping, becoming ill and/or death. This can have negative effects on overall health and wellbeing. Thus, supporting emotional wellbeing is a pressing need. Emotional, or 'affective' computing research has grown significantly in recent years with the primary focus on developing computer-based systems that recognise the user's emotional state and respond to this in some way. However, most research within this space examines immediate or 'once-off' detection of emotion, for example, through facial expressions (El Kalioubi & Robinson, 2004), voice detection (Johnstone & Scherer, 2000), physiological monitoring (Liu et al, 2008) and linguistic cues (Hancock, Landrigan & Silver, 2007).

At GNH our approach is to monitor and detect changes in emotion over time, through unobtrusive embedded sensors within the home. If we can predict these changes, we can apply interventions to address them in a timely manner.

2.1. Detection using Sensors

As mentioned, we have a range of sensors in each of the GNH apartments that can detect presence, flow of movement through the homes, use of electrical appliances, when a person leaves the home and when they return etc. Thus we can detect changes, and possibly decline, in patterns of social, physical and cognitive behaviour and from this infer changes in emotional wellbeing. As a first step towards modelling this behaviour, we have begun to examine the data we have collected to date to understand the patterns that lie within (Loane et al, 2011).

To help visualise behavioural patterns we represent the sensor data on a spiral plot called a "last clock". Two such clock plots, representing data from a sensor that measures when a resident leaves and re-enters their home can be seen in Figures 1 and 2. These particular images represent data collected between July and December 2010. They show data on a 24- hour clock with midnight at the top and spirals out from the centre. Each circuit represents a day. Complete circles indicate when a resident was away from the home, on holiday for example.

Figure 1 shows data for an 'inactive' resident, while Figure 2 shows the stark contrast of out-of-home behavior of an 'active' resident. From Figure 1 we can see that this resident typically leaves the home just before midday and returns by early afternoon. This data also shows that this resident became less active during winter. Baseline data gathered from this resident prior to moving into GNH illustrates high levels of depression. Interviews with this resident suggest that possible reasons behind the depression include worries about declining health but primarily a lack of social contact with others.
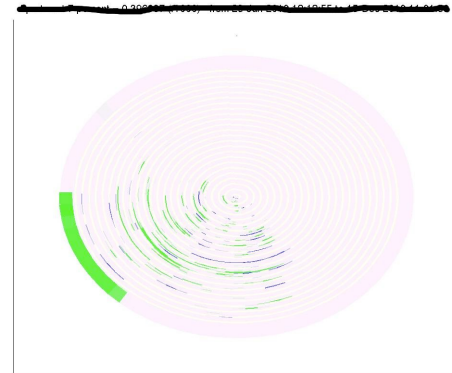

Figure 1. Clock plot showing an inactive resident

In contrast, the resident who's data is depicted in Figure 2 is very active, spending much of their day outside the home, including at night time when this resident reports enjoying going out for a social drink with friends.
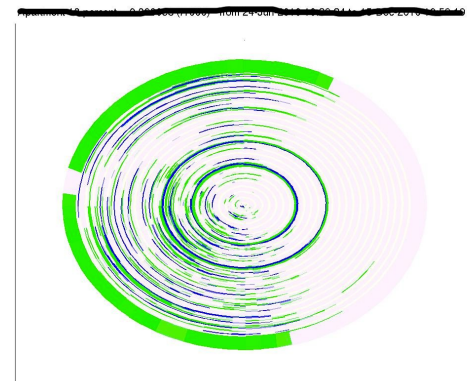

Figure 2. Clock plot showing an active resident

Thus a visual comparison of Figures 1 and 2 provides us with a clear picture of the behavioural differences of someone who is emotionally unwell compared with someone who is emotionally healthy.

2.2 'Detection' through Self Report

Questionnaires are widely used in the field of psychology to measure emotional wellbeing. One of the most commonly used is the PANAS (Positive Affect Negative Affect Scale). The expanded version of this, PANAS-X, developed by Watson and Clarke (1994) is commonly used and consists of a number of words and phrases that describe different feelings and emotions. There are two higher order scales of positive and negative affect, which are further refined. Within positive affect, there are 3 subscales including joviality, self-

assurance and attentiveness. Negative emotion scales are broken down to feat, hostility, guilt and sadness. There are also subscales for other affective states including shyness, fatigue, serenity and surprise.

Given that we are interested in collecting daily data from residents regarding their emotional wellbeing, the traditional method of researchers administering questionnaires is not feasible. Delivering a questionnaire through technology, however, has the potential to overcome this barrier. To address this issue, we are currently implementing a daily health survey that asks the resident a short number of questions each day about their wellbeing, including their emotional wellbeing. We are currently piloting the acceptability of a validated short form of PANAS with older adults, to determine how they feel about answering questions relating to emotional wellbeing. Gathering regular input from the person on how they are feeling day to day has the potential to 'fill in the gaps' that might occur with sensor-only measurement and help researchers to determine 'why' certain changes might be occurring. The questionnaire will be delivered through both the Internet-connected TV as well as the iPad 2, allowing the resident to choose the method of interaction that best suits them, or that they prefer.

3. PROVIDING FEEDBACK ON EMOTIONAL WELLBEING

Our research aims to create a new method of preventative care based on early prediction of changes in emotional state and, based on this early detection, use novel "human-in-the-loop" intervention methods specific to the needs of the individual to improve the quality of life of the older person *before* severe problems arise. What is important, critical even, is how the technology can communicate our findings and help the person to adapt and to help them to have more positive emotions.

There are a number of challenges associated with providing feedback on emotional state. Emotion and particularly depression is for many a very sensitive issue. There are questions as to whether we make the person aware of changes in their emotional wellbeing or whether we simply 'intervene' somewhat implicitly through an intervention, whether this is through home-based technology or by facilitating social interaction and participation in the community, for example. There are also issues surrounding motivation to use technology that has long been a focus of our work with older adults and which we are continuing to address.

To date, our research focus has been around the space of monitoring and detection (Loane, 2011), whilst working with the residents of GNH to introduce them to technology, to understand their attitudes towards technology and to gather requirements on how they feel about feedback on their health and emotional wellbeing (Doyle et al, 2011). The next phase involves intervention, to provide the residents with feedback on the data we are collecting. At this workshop we are interested in sharing our experiences to date on our work with residents from GNH including attitudes towards sensor and interactive technology. We are hoping to learn from others with particular experience in emotional wellbeing and are eager to work with this community in the development of a set of guidelines for the development of technologies that improve emotional wellbeing.

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