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Mini Review

Smart Built-Environments for People Living with Dementia

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Review

Ageing population is a world-wide rapidly growing phenomena [1,2]. Increased longevity is often associated with susceptibility to diseases which lead to cognitive or physical decline of human body. There are an estimated 47 million people worldwide living with dementia in 2015. According to a recent estimate, by 2035 the population of people living with dementia will double. With the current trends in population demographics, it is becoming increasingly difficult for governments worldwide to fully support the health and social care systems. One of a recent challenge for civil engineering is to create Dementia friendly communities and housing.

Advances in the area of civil engineering, smart built-environments [3]. robotics and autonomous sensing systems [4-8] are driving the development of the in-home smart technological solutions for the aged population. The idea of smart homes is not new and there is a range of existing smart services on the market. A major issue is the low adoption of robotics technology by health and social housing because of many factors, including that the technology is often incompatible with the personalised demands of the resident and the technology is not yet affordable for an average consumer. Moreover, there are ethical issues associated with the technological advancements which need to be addressed, too. The hallmark of dementia is the severe memory loss, and decline in the cognitive abilities, which imply that people with dementia would not be able to interact with the technology at their homes. The vision of this mini paper is that it should be possible to make autonomous sensing embedded in civil works design, while completely invisible to the users, hence users are not required to interact with such robotic devices directly.

The embedded sensors will primarily be used to monitor the actions and movements of the occupants which can build behaviour signatures [9] and respond accordingly in an autonomous way. With the advent of low cost commercially available vision sensing technology, e.g. Microsoft's Kinect V2 sensor (which costs less than A$300), it is possible to embed them in smart homes as an affordable behaviour monitoring entity as shown in Fig.1. The user's actions can be recognised by tracking the joint movements in 2D or 3D space. Human actions can be represented by complex patterns in data, and thanks to the state-of-the-art artificial intelligence, e.g. Deep neural networks (DNN) which have the ability to recognise these patterns in data efficiently which makes it possible for detecting human actions [10]. A DNN can predict the human activity using the joint data [11] (Figure 1A & 1B).

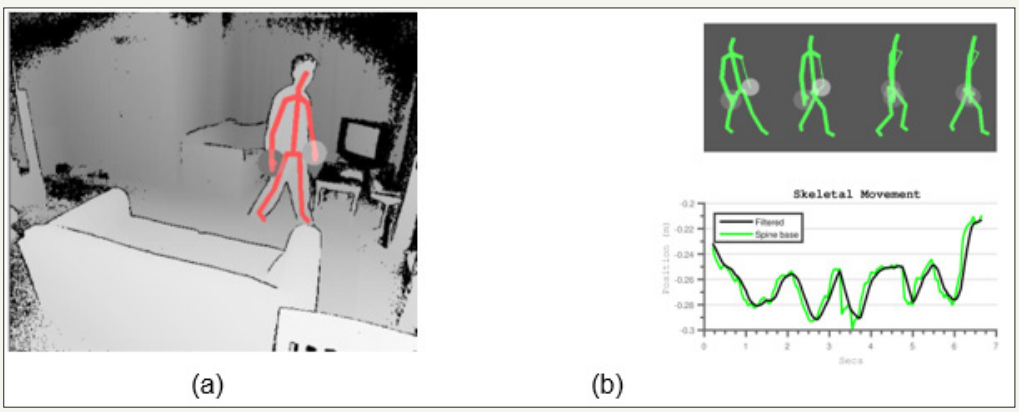

Figure 1A& 1B: Human skeletal tracking by Kinect sensor (a) In-home tele-monitoring and skeletal tracking system. (b) Signals emanating from human joint movements.

The use of joint data as a representative of human actions has the benefit of lower dimensionality than image or video stream data. Moreover, the interaction of users can also be recognised with household appliances and ask autonomous systems to only intervene to provide prompts and reminders, or to turn household devices on or off in appropriate circumstances. In other words, the house should act as a virtual carer, providing care for twenty-four hours a day without becoming frustrated or tired. In order to design smart home equipment that is suitable and effective for people with dementia, it is clearly important to involve the patients, carers and clinicians in the design process. This paper emphasis that patients, carers and clinicians should be involved at different stages of the design process. Initially, smart techniques should be adopted to gather information about user needs, and a repository of activity action database should be developed to be used for the design approaches that were used.

The evaluation of smart home and the embedded autonomous systems require a rigorous evaluation of the sensors and how they respond to the human behaviour. This evaluation necessitates the logging of sensor data. This data can be shown to the carers and clinicians in a meaningful way and fine tune the sensors accordingly. This data feedback is crucial to measure a direct interaction between the smart home users and the autonomous sensors. The notion of interaction between, people living with cognitive loss or dementia and smart homes is quite complex. There is a vivid need for new effective civil engineering designs. This requires a considerable effort to be undertaken to ensure that the intelligent adaptive aspects of the design are carefully considered.

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