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Developing a well-being monitoring system—Modeling and data analysis techniques

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Abstract

This paper describes how complex data analysis algorithms are being employed to develop a new generation of telecare aimed at helping older people remain living more independently in their own homes for longer. The paper begins by explaining why governments throughout the world are encouraging the development and deployment of new telecare solutions—due in the main to a gradual but constant shift in demographics. Details of a new generation of telecare called 'well-being monitoring' being developed in the UK under the DTI (Department of Trade and Industry) NWTM initiative are provided, DTI [1]. The paper describes how the DTI funded 'Care in the Community Centre' led by BT, has developed a concept model to represent an individual's well-being. The paper goes on to provide an in depth explanation of the Intelligent Data Analysis techniques to be used for monitoring changes in well-being.

Keywords: Telecare; Well-being monitoring; Data analysis; Sensors

1. A global shift in demographics

Much has been written about how the world's population is becoming increasingly older. Perhaps this is not surprising given the fact that through medical advances and healthier lifestyles we are living longer. In 1950, there were 205 million persons aged 60 or over throughout the world. Fifty years later, this has increased to 606 million. Currently, the growth rate of the older population (1.9%) is significantly higher than that of the total population (1.2%), United Nations [2].

Whilst increasing life expectancy is viewed as a positive trend, many Governments throughout the world are concerned with the simultaneous fall in birth rates brought about by a general reduction in fertility, United Nations [3]. The net result of higher life expectancy with lower birth rates is that we will begin to see fewer people of a working age available to care for an increasing number of older people. The development and introduction of new technology into the health and social care space is seen as one way of addressing the challenges presented by an ageing population. Telecare is one such technology, which has already proven to be useful, but through further development might prove to offer a great deal more.

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2. Three generations of telecare

Telecare can be described as the use of information and communication technology (ICT) to support independent living for older, frail and disabled people.

Telecare is not a new concept; in fact telecare solutions have been available for several years from companies within Europe and the US, and many telecare trials are in operation today [4]. Many of these existing telecare solutions have been used successfully and have proven to be cost effective in addition to saving lives. But the fundamental aim of these existing solutions is to *alert* a carer to an immediate problem where, for example, a person has become incapacitated, or is in immediate danger within their own home. We refer to these existing systems as 1st and 2nd generation telecare systems. The difference between 1st and 2nd generation telecare is the way in which an alert is generated: 1st generation telecare relies upon the person themselves activating the alert through the use of a pull cord attached to the ceiling, or a pendent worn around the neck and connected wirelessly to a base station receiver within the home. However, in cases where the person is unable to raise the alert, or may feel they do not want to disturb carers, then the system becomes ineffective. To remedy this some telecare solutions have progressed to monitoring particular activities or inactivity within the home through the use of ambient sensors. These systems incorporate a degree of intelligence allowing an alert to be raised automatically. These intelligent systems are known as 2nd generation telecare systems. Systems that can be categorised as 2nd generation have been reported in by Sixsmith [5], Garner et al. [6] and Barnes et al. [7].

Advances in sensor design and the continuing reduction in the cost of processing data mean that it is now becoming practical to develop a new generation of telecare capable of monitoring the general well-being of an individual. We call this 3rd generation telecare and its aim is *preventing* incidents from occurring within the home rather than just *responding* to them. One example of such a system is the Independent Life Style Assistant (ILSA), which is developed by Honeywell. ILSA employs an agent-based home environment that can aid elderly people to live longer in their homes [8,9]. Ogawa et al. [10] developed a system for long-term behavioural monitoring of elderly people using a network of passive sensors. The work reported by this paper introduces the DTI-funded Care in the Community Centre, which has designed and developed a 3rd generation system. The Centre aims to begin testing and demonstrating the capabilities of well-being monitoring during 2005.

3. A well-being concept model

There is an underlying idea that well-being is in some way about the ‘goodness’ in someone’s life, but beyond this there appears to be no straightforward or agreed definition. In order to build a system capable of monitoring changes in well-being, it was first necessary to develop an understanding of what constitutes well-being for frail older people. Essentially a working definition, framework or model was required.

Fig. 1 is the model of well-being used within the Care in the Community Centre. The model shows how we view well-being as three separate but interrelated components: mental well-being, social well-being and physical well-being.

Our well-being is determined by our experiences of everyday life, and our experiences are determined by the activities we perform, or in some cases fail to perform. In addition to this our experiences of performing or not performing activities are affected by personal and context factors, which also affect the type of activities we perform.

4. Monitoring activities to determine changes in well-being

Current methods used by carers for determining changes in an individual’s well-being are based upon observing the individual and asking them relevant questions about their everyday lives. However, many older individuals are fiercely independent and may not always be willing to provide honest answers if they believe this might lead to a loss of independence or might create extra burden for carers. In addition to this observing an individual in this way provides only snap-shots of their well-being, the frequency of which will be dependent upon the resources of the carers. We