

Using Fuzzy Logic for Decision Support in Vital Signs Monitoring

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Abstract

This research investigated whether a fuzzy logic rule-based decision support system could be used to detect potentially abnormal health conditions, by processing physiological data collected from vital signs monitoring devices. An application of the system to predict postural status of a person was demonstrated using real data, to mimic the effects of body position changes while doing certain normal daily activities. The results gathered in this experiment achieved accuracies of >85%. Applying this type of fuzzy logic approach, a decision system could be constructed to inform necessary actions by caregivers or for a person themselves to make simple care decisions to manage their health situation.

Keywords: fuzzy logic, patient monitoring, decision support, assistive technologies, care management.

1 Introduction

Current trends in health within our society include the move towards an ageing population profile, and increased needs for complex care management for people with chronic diseases and multiple co-morbidities. These are fast growing segments of the population; and so is the need for covering their broad ranging and diverse care requirements. External support to manage high-risk (or unsafe) health situations is often needed for them to continue their everyday living routines. This support is typically given by both professional and informal caregivers.

Due to technological advances in wireless data communication systems in the last decade, the application of wireless-based vital sign monitoring devices for patient monitoring has gained increasing attention in the clinical arena. Patient health status can be determined based on the acquisition of basic physiological vital signs, suggesting that a system providing wireless monitoring of vital signs has potential benefits for clinical care management of independently living patients as well as their carers. A patient's physiological state, which includes heart rate, blood pressure, body temperature etc., can be monitored continuously using wearable medical body sensor devices. The remaining challenge is to gain sufficient understanding of this data to assist in health care needs.

The overall aim of this research was to utilise information gathered from personal vital signs monitoring in a laboratory-based smart home environment, and to assist with clinical care decisions using a fuzzy logic rule-based clinical decision support system. Fuzzy logic has benefits over other algorithmic approaches, as it has the potential to incorporate values from ordinal, nominal and continuous datasets within its rules, and can capture the knowledge associated with these rules in ways that are more intuitive to humans.

2 Vital Signs Monitoring Concepts

There are numerous examples in literature describing how monitoring of basic vital signs (i.e. heart rate, blood pressure, temperature and respiration rate) can play a key role in health care, e.g. Norris (2006) [39]. This approach requires software to discover patterns and irregularities as well as to make predictions. By collecting and analysing vital signs continuously it can be shown how well the vital organs of the body are working, e.g. heart and lungs (Harries et al. 2009) [40].

Lockwood et al. (2004) [30] provided a review of the clinical usage of vital signs, including monitoring purpose, limitations, frequency and importance of vital signs measurements. They suggested that vital signs monitoring should become a routine procedure in chronic disease patients' care. Bentzen (2009) [43] defined chronic diseases as:

"diseases which are long in duration, having long term clinical course with no definite cure, gradually change over time, and having asynchronous evolution and heterogeneity in population susceptibility."

Living with a chronic disease, which increases in severity with age, has a significant impact on a person's quality of life and on their family. Chronic disease patients would be able to play a more active role in managing their own health by taking vital signs measurements daily and participating in meaningful electronic information exchanges with clinicians.

A number of authors have suggested that using smart homes for health monitoring is a promising area for health care. Chan et al. (2009) [2] in their review paper described the smart home as a promising and cost-effective way to improve home care for elderly people and people suffering with different chronic diseases.

Vincent et al. (2002) [19] identified three research areas, which combined to produce the concept of "health smart home". These three areas are *medicine*, *information systems*, and home based automatic and remote *control*

