Intelligent Tele-Homecare – The Application of Soft-Computing Models in Sensor Agent Network Systems

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ABSTRACT

This paper conceptualises the development of an Intelligent Home Care system to assist health care professionals and carers in providing an enhanced level of support to senior citizens. The social demographics in the developed world indicate a decline in population growth, indicating a need for greater resources to be dedicated towards enhancing the lives of an aging society. Furthermore, the dissociation of extended family structures in modern society results in senior citizens to take greater independence in managing their own lives. With the technological advances in the Tele-Homecare domain, there is an impetus to develop improved computational techniques that reflect the nature of complex systems in medicine and biology.

Keywords: Information Technology, Intelligent Agents, Health Care, Aged Care, Tele-Homecare, Soft-Computing, Software Engineering

INTRODUCTION

The context for Tele-Homecare is anticipating the demand for aged care support services with the increase of an aging population in the developed world. In countries where statistical population trends indicate negative population growth and the increasing average age of the population, governments of all persuasions need to take an active role in managing the welfare and well-being of their senior citizens. The advances in wireless technologies is providing a distinction in the way aged-care professionals and carers can monitor the aged unobtrusively, while providing a balance between the independence that our senior citizens desire and the practical assistance that they may need in their day-to-day living.

The development of autonomous wireless sensors in the past decade, in terms of cost, performance and component size, has reached a point where the practical application of this technology in Tele-Homecare applications has become a feasible option in monitoring the aged. Meanwhile, the demand for aged-care professionals to assist in the personal needs of our aging population is placing an increasing financial imposition on their extended families, and the health care systems of governments. [3]. Aged care assistance is a sensitive issue from a social context, as a balance needs to be maintained by providing an adequate level of personalised care to the aged while ensuring the government maintains fiscal responsibility of aged health expenditure.

The implementation of Tele-Homecare in such contexts seeks to address the needs of individuals who require occasional assistance from carers. The technology to monitor the daily activities of such individuals is not designed to supplant the role or responsibilities of carers; rather it should be viewed as a way to enhance the living of people who need the occasional support of carers. The research investigation is designed to analyse different methodologies in evolutionary algorithms and genetic programming techniques to monitor personal traits of patients and to detect possible signs of distress from variances in their daily activities [3].

The theoretical potential of sensor agent networks (SANETs) can be viewed beyond the traditional domain of patient management systems. The project aims to demonstrate how a sensor-agent network environment can be analysed effectively with soft-computing methods in a health care facility.

EXAMINING EXISTING PRACTICES IN HEALTH CARE

The development of Soft-Computing systems to meet the special needs of health care facilities can be modelled on industry knowledge of sensor network technologies and driven by scientific initiatives for Smart-Systems in health organisations. The demand for the implementation and development of such systems cannot always be met by commercial enterprises, so there is a considerable interest to appoint local staff to manage and direct the effort [2]. These staff however, would have limited experience in designing, coding, configuring, interfacing and installing traditional systems and frequently would not have experience in management responsibilities. Thus, an emphasis training in the simulation and modelling should be a priority in the final model, for the health professionals to provide feedback as to the authenticity of the simulation model.

The fundamental concepts to be examined in realising the Tele-Healthcare System are as follows [3, 4]:

- 'Tele-Healthcare' refers to the remote assistance and monitoring of the aged in a hostel or semi-independent aged-care environment. The context of an aged-care facility, with each patient having distinct, particular needs is the topic scope.
- 'Soft-Computing' in a health context is concerned with the implementation of genetic programming techniques and algorithms to disseminate patient records and characteristics.
- Health records must be concerned with specific characteristics of the patient; each individual will have different physical and mental states of health, requiring a different approach in the way they are monitored.
- Each health record contains unique information about the patient, including their age, medical history, and medical prescriptions and pre-existing ailments that will affect their living conditions.

For these main reasons, the automation of record-keeping and the monitoring the well-being of the aged in an aged health-care facility reaffirm the need to ensure that personal records remain consistent and accurate. Furthermore, the automation of a patient monitoring system with a patient's health records and medical history allows for decentralised access to records. Individuals and their carers can have instantaneous access to records to provide a consistent and reliable level of personal support.

The cost trends of technology and labour consistently show how computerised automation is most effective when tasks are tedious and monotonous in nature, as shown in Figure 1. Common activities that carers need to undertake, such as determining what medicines an individual should take and in the correct dosage are typical examples of manual procedures accomplished in aged-health care environments that are potentially prone to error.

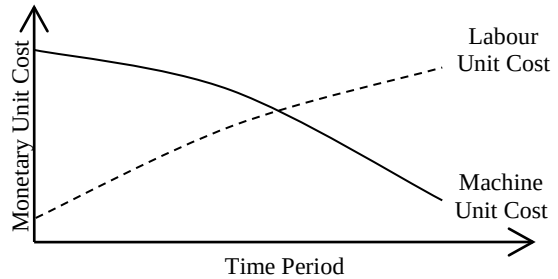

Fig. 1: *Cost Trends of Labour and Technology [3]*

EFFECTIVENESS OF THE CONCEPT

A Soft-Computing based approach to software system analysis, design, simulation and delivery has significant benefits to the developers and end-users. In addition to this there are economic advantages that benefit the aged health-care community. These advantages have many dimensions that may pertain to effective use of ICT technology in patient management strategies [8]:

- **Strategic Advantages:** A net social benefit from improved management and increased awareness of effective monitoring of patient health care systems failing less often, or perceived to fail less often. It is common that the organisation is not rewarded directly through higher reliability, scalability, robustness, maintainability and usability, yet these are tangible economic consequences from utilising better solutions in a health-care context.
- **Knowledge Advantages:** Developers will disseminate their skills and methods through their professional and informal contacts, thus providing a multiplier effect of the experience in medical monitoring systems.
- **Broad-range Applications:** There is a strong potential for adaptation of similar to Tele-Homecare System to venture into broader patient health applications beyond the aged-care domain.

The implementation comprises of a distributed architecture encompassing a multi-agent simulation that simulates the activity of an aged-care facility that implements smart wireless badges to track activities of individuals. This simulation system will comprise of individual intelligent agents, including the individuals wearing smart badges who interact in a two-dimensional environment, in which their personal trends can be monitored as they go about in their daily activities.

The design of the Tele-Homecare System emphasises the use of Voronoi algorithms and genetic programming techniques to determine behavioural patterns, such that the unique traits of individuals can be established over a period of time. Individuals who deviate in their normal activities beyond a determined threshold can be indicated by the monitoring system to be further monitored by their responsible carers.

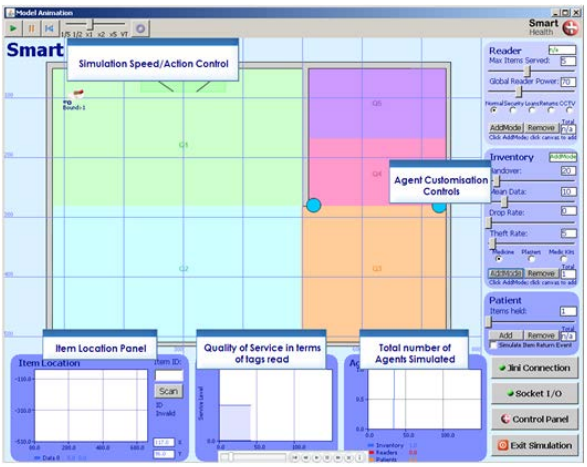

Fig. 2: *Tele-Homecare Intelligent System Sample*

The Tele-Homecare Intelligent 'Smart-tag' demonstration in Figure 2 gives an example of the compact and unobtrusive nature of wireless sensors embedded into patient tags, in which real-time patient activity can be monitored and managed by a graphical administration application. Non real-time events, such as patient history and prescribed medical dosages are saved to the central database for analytical processes and assist in personalised patient health care. Statistical graphs present the real-time state of the simulation in terms of quality of service. This is concerned with the wireless infrastructure's capability to handle transaction events in the health care institution's daily operations [6].

A comprehensive middleware solution will assist in providing a compact, intuitive framework to build a simulation model that can effectively demonstrate concepts on patient health care management for the benefit of health professionals [7]. The main purpose of the simulation is to encompass a working prototype, in which ideas can be drawn and allow a greater understanding of the challenges in current health care practice.

CONCLUSION

The Tele-Homecare System, through its design and demonstrative capability, provides an insight to facilitate an effective software simulation for managing the needs of senior citizens in an aged-care environment. There is significant potential to integrate the system in an open distributed middleware architecture, such that the health-care professionals can assess their patient monitoring strategies from a remote location.

Through a functional simulation environment, incorporating a 'virtual' sensor agent network, the system simulates a monitoring environment for aged health care. The data is analysed using soft-computing techniques to enable healthcare professionals to examine their own circumstances for which sensor-agent networks could improve their operational procedures. The use of statistical performance modelling allows the end user to quantify in real terms the benefits of using sensor network technology in an aged-care organisation. The simulated data can be examined externally through data mining to plan for future infrastructure strategies and health planning initiatives.

In future, effective consultation with health care professionals, the simulation will implement more practical cases and scenarios common to patient health care management. This should provide a better understanding of the main concerns that lie ahead, in terms of research scope and encompassing the problem domain in the main research concepts.

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