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Implementing a Multi-agent System for Recording and Transmitting Biometric Information of Elderly Citizens

Malcolm Reid^a, Elhadi M. Shakshuki^{a,*},

^aAcadia University, 15 University Ave. Wolfville, NS, B4P 2R6, Canada

Abstract

Canada and many other developed nations around the world are facing a growing population of elderly citizens. As a result, the economic and resource cost associated with providing high quality healthcare will increase as the population of elderly citizens grows. The primary objective of this paper is to present the architecture and prototype implementation of a Multi-Agent System designed to facilitate healthcare for elderly citizens. A Computer Science perspective is applied to theoretical research conducted on the subject of Multi-Agent Systems in healthcare. A prototype application to monitor and disseminate health information about patients to healthcare professionals is developed and presented. We focus on the implementation specifics of the proposed system and presented prototype application. Future work and open issues with this research are discussed.

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1. Introduction

Autonomous agents and multi-agent systems (MAS) represent new ways of analyzing, designing, and implementing complex software systems¹⁻³. These new systems may solve challenging problems or perform dangerous tasks in the real-world, but ultimately their goal is to improve peoples quality of life.

* Corresponding author. Tel.: 1-902-585-1524.
E-mail address: elhadi.shakshuki@acadiau.ca

Exactly how lives can be improved is not always clear. For example consider two systems: one provides a more efficient process for refining oil into petroleum, while the other performs constant monitoring of biomedical information from a human patient^{2,4}. The first system improves people's lives by not only increasing the yield of resources, petroleum in this case, but also reduces the cost of the resource by increasing the supply. In the case of the second system, there is a financial savings in the cost of monitoring patients. This is easy to see when by comparing how much it costs to hire human staff to monitor a patient 24 hours a day, compared to the cost of operating sensors.

The World Health Organization estimates that between the years 2000 and 2050 the proportion of the world's population over 60 will double from 11% to 22%⁵. Health Canada estimates that one in four citizens will be over the age of 65 by 2036⁶. Furthermore, in the same time period the number of people aged 80 and over will quadruple across the globe⁵. This is an unprecedented event in human history. Given that people tend to consume more health services as they age, this occurrence will without a doubt place a considerable strain on existing healthcare infrastructure.

In this paper we focus on the challenge of providing healthcare to aging citizens by proposing and implementing an application to monitor and dynamically respond to changes in patients' biological signals. The system is designed for healthcare professionals (such as doctors, nurses, and technicians) and elderly patient users. Data monitoring is accomplished by interfacing wireless sensors on the human body with a coordinating android OS enabled device to capture data. Once captured, the data is examined by a software agent and stored for recall. Furthermore, additional functionality is facilitated by inter-agent communication. An example of this functionality would be one agent's ability to notify a doctor that his or her patient is having a heart attack.

Section 2 provides background research and a proposed system architecture utilized in development of this system. Section 3 presents an implementation of the system architecture. Section 4 describes the feasibility of the proposed system and presents a comparison with three known healthcare systems. Section 5 contains the conclusion and several future directions for this research.

2. Background

This section briefly presents concepts related to the proposed system: MAS, BASN and RL. Three existing healthcare applications are presented. Finally, the proposed system architecture is presented.

2.1. Related Concepts

The following briefly discusses important topics utilized in the proposed system.

2.1.1. Multi-Agent System

Various definitions from different disciplines have been proposed for the term multi-agent system. From a distributed artificial intelligence perspective, MAS are a loosely coupled network of problem-solver entities (or agents) that work together to find solutions to problems that are beyond the individual capabilities or knowledge of each entity⁷. More recently, the term has been given a more general meaning, and is used to describe all types of systems composed of multiple autonomous components showing the following characteristics²: each agent has incomplete capabilities to solve a problem, there is no global system control, data is decentralized, and computation is asynchronous.

2.1.2. Body Area Sensor Networks

A Body Area Sensor Network is a specific type of Wireless Sensor Network with the goal of gathering information about a human body using sensors located in and on the target body, as illustrated in <BASN

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