A Multi-Level Slow Intelligence System for Visualizing Personal Health Care
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Abstract: This paper describes the design of an experimental multi-level slow intelligence system for visualizing personal health care, called the TDR system, consisting of interacting super-components each with different computation cycles specified by an abstract machine model. The TDR system has three major super-components: Tian (Heaven), Di (Earth) and Ren (Human), which are the essential ingredients of a human-centric psycho-physical system following the Chinese philosophy. Each super-component further consists of interacting components supported by an SIS server. This experimental TDR system provides a platform for exploring, visualizing and integrating different applications in personal health care, emergency management and social networking.

Keywords: slow intelligence system, distributed sensor networks, component-based software engineering, visual computing, visualization.

1. Introduction

Recently there are growing interests in human-centric psycho-physical systems, especially in health care applications. Such human-centric psycho-physical systems have two common characteristics. From the decision-theoretic viewpoint these systems usually have multiple decision cycles such that the actions of slow decision cycle(s) may override the actions of quick decision cycle(s), resulting in poorer performance in the short run but better performance in the long run. From the architectural viewpoint these systems usually have multiple levels to monitor, control and manage many sensors and actuators.

The slow intelligence system is an approach to design such human-centric psycho-physical systems. A slow intelligence system (SIS) is a system that (i) solves problems by trying different solutions, (ii) is context-aware to adapt to different situations and to propagate knowledge, and (iii) may not perform well in the short run but continuously learns to improve its performance over time. The general characteristics of a slow intelligence system include enumeration, propagation, adaptation, elimination, concentration and multiple decision cycles [1]. In our previous work, an experimental test bed was implemented that allows designers to specify interacting components for slow intelligence systems [2].

To facilitate the design of complex slow intelligence systems such as human-centric psycho-physical systems, the concept of super-components is formulated [3]. A complex slow intelligence system basically consists of interacting super-components, which further consists of many interacting components supported by an SIS server. Communications in SIS are through the SIS server and the messages are layered, i.e., each message type has its hierarchical scope. A super-component can thus be viewed as a collection of components interacting by messages within the same scope. From an architectural viewpoint the result is a multi-level slow intelligence system as illustrated by Figure 1.1.

![Figure 1.1. A multi-level slow intelligence system.](attachment:image.png)

This paper describes the design of an experimental multi-level slow intelligence system for visualizing personal health care, called the TDR system, which mainly consists of three super components: Tian, Di and Ren. According to the Chinese philosophy these three super-components are the essential ingredients of a human-centric psycho-physical system. They can be thought of as human beings (Ren) interacting with the environment consisting of heaven (Tian) and earth (Di). Decision making in TDR system is through multiple computation cycles involving the super components to increase the chances of survival of human beings. Any action based on only one aspect of the environment without considering the other aspects could reduce the chances of survival, thus iterative, multiple computation cycles are crucial for the TDR system.

The paper is organized as follows. Section 2 presents an abstract machine model for the computation cycles. The TDR system architecture is described in Section 3. The two super-components Tian and Di are each described in detail in Section 4 and 5, respectively. Since the Ren super-component has been described in the first author’s previous paper on slow intelligence system for health care [4], it will not be repeated here. A user-friendly GUI for the TDR system to visualize personal health care situations is also presented.
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