# CARA Pervasive Healthcare

## - Context Modeling & Reasoning Framework

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## Introduction

Pervasive computing is allowing healthcare to move from care by professionals in hospital to self care, mobile care, and at-home care. The pervasive healthcare system, the CARA (Context Aware Real-time Assistant), is designed to provide personalized healthcare services for chronic patients in a timely and appropriate manner by adapting the healthcare technology to fit in with normal activities of the elderly and working practices of the caregivers.

We implement a fuzzy based context model and a related context-aware reasoning middleware that provides a personalized, flexible and extensible reasoning framework for the CARA. It enables context-aware data fusion and representation as well as inference mechanisms that support remote patient monitoring and caregiver notification.

## Overview

Basically, the CARA system consists of four sub systems:

- Body Area Sensor Network
- Remote Monitoring System
- Data & Video Review System
- Healthcare Reasoning System

An overall architecture of the CARA pervasive healthcare system is shown in Figure 1.

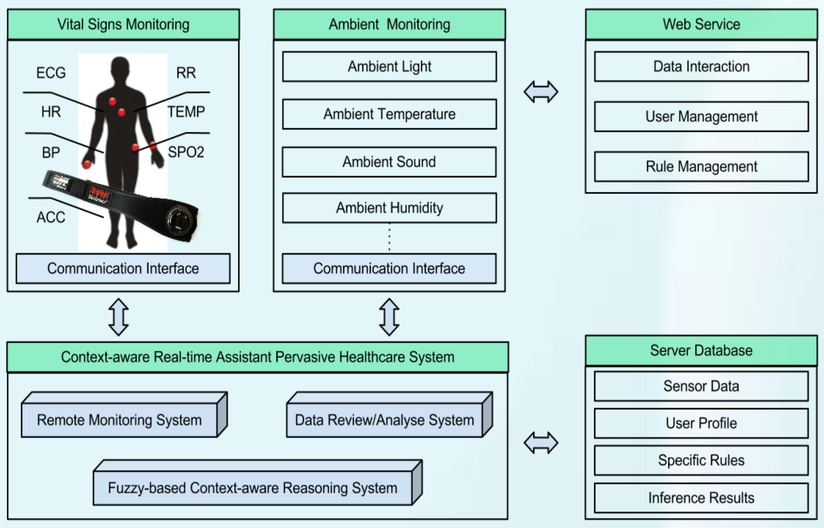


Figure 1. CARA pervasive healthcare architecture

## Context Modeling

Context modeling is a key feature in context-aware systems to provide context for intelligent services.
We adopt a Fuzzy Logic Model to represent the relevant variables and to build low level and high level context models. An overview of the context model is shown in Figure 2. All pieces of information gathered by various sensors can be indexed as attributes of the context entities. In our work, we map each attribute into individual Fuzzy Set.

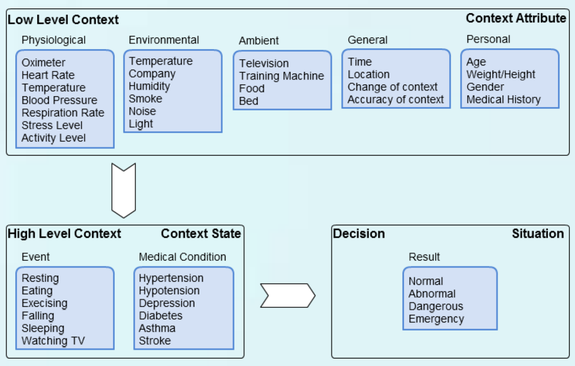


Figure 2. Overview of context model

## Reasoning Engine

To achieve intelligent monitoring in the CARA system, we adopted a rule-based approach for context reasoning. The fuzzy-based rule engine provides a simple way to get a definite conclusion based upon ambiguous, imprecise, noisy, or missing input information.
A Fuzzy Logic System usually consists of three parts: fuzzy set, rules, and inference engine. The general architecture is shown in Figure 3. The interactions in the reasoning engine are presented in Figure 4.

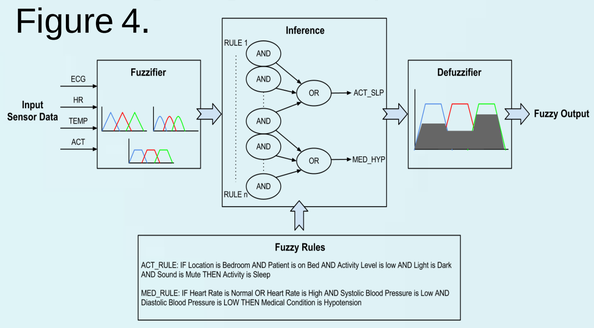


Figure 3. Fuzzy Logic system

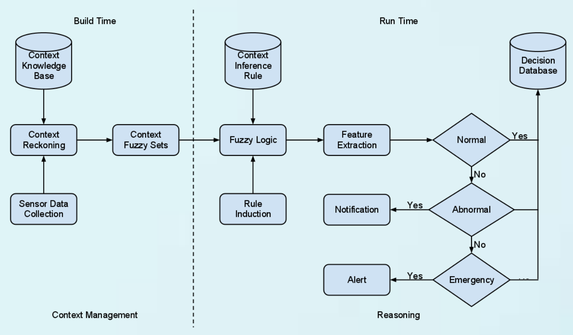


Figure 4. Workflow of context-aware reasoning

## Evaluation

It is difficult to evaluate the CARA system entirety without extensive field deployment and medical consultant support. However, we conducted simulation experiments in our lab to test the correctness of the proposed reasoning framework in a pervasive environment. In our test scenario, we deploy the CARA system composed of Healthcare Sever, Wearable Sensor and Client Application in our lab.
Figure 5 illustrates the screen shot of our demo application and the wearable sensor that is used in test scenario. Some performance results are shown in Figure 6.

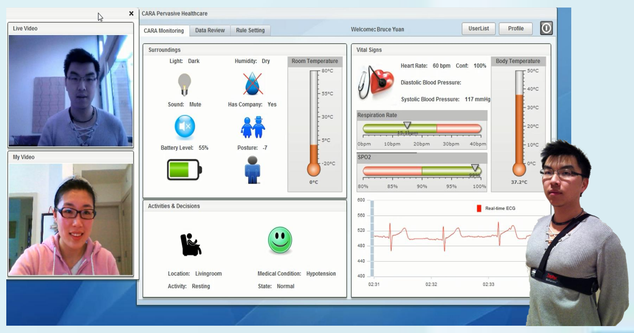


Figure 5. Snap shot of demo application

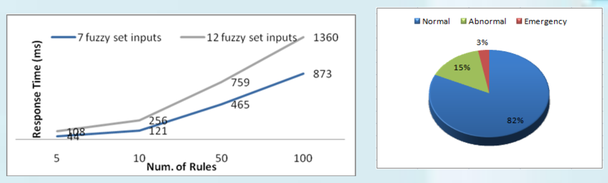


Figure 6. Inference performance and scale

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