# A Cloud-based Context-aware Framework for Assistive Healthcare

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***Abstract*—The research focuses on the development of a scalable context-aware framework for providing diversified assistive services in the aged healthcare domain. Here a generic model is proposed which will be a useful tool for numerous context-aware services integration in assisted eldercare. The goal of this research is to ease the daily lives of people with disabilities or chronic medical conditions. Assisted living system consists of multitudes sensors and ambient devices, generating large amount of high level contexts from medical and ambient data. Contexts are also obtained from different sources like activity histories of the patient. The observed contexts are then aggregated to deliver on-demand assistive services to the patient with the help of intelligent service management system. Traditional healthcare systems are limited in specific services and have low computational capability. The proposed cloud-based model seeks to address such issues and design a service oriented architecture (SOA) for abstract context model generation. The objective is to develop an ideal framework to support large number of assisted living systems together with wide range of services.**

## I. Introduction

Throughout the world, rapidly growing aging populations and higher disability rates has intensified pressure on already burdened healthcare infrastructures. The challenge of providing comprehensive care to an aging population is a global concern particularly in Australia and other Western nations. In near future there will be huge lack of human and institutional resource to support this aging population. Another issue at hand is the economic cost to strained healthcare systems, with increasing numbers of aged people requiring extended stays in hospitals and other nursing facilities. So, smart technology-based healthcare systems having huge storage and processing ability are required for the wellbeing of such group of people.

Existing architectural solutions are confined to specific services [1][2][3] and mostly depend on a local smart agent (i.e. mobile device) for context discovery and management. The lacking of storage and power in wearable sensors and mobile devices limits them to process limitless sensor data using decent computational method. Moreover, traditional solutions are not capable of handling large number of users together [3][4]. Most of the systems are not alterable, cannot be personalized and not flexible enough for all participants such as patients, doctors, caregivers and healthcare professionals. Moving raw sensor data to the cloud server will strengthen the facility of handling data in big volume, storing record and the provision of versatile services. This persuades us to build a well-collaborative system by transferring context processing task from local smart device to distributed cloud environment which improves the processing time of context generation for conveying complex services and competent enough to handle a good number of clients simultaneously. To achieve the milestones the proposed research will focus on the following research questions.

- How to aggregate the raw data of heterogeneous sensors and devices to a standard context model which is easily adaptable for different assistive services?
  There is no generalized context representation method that is easily understandable by services and easily producible from sensor data. We will develop a unified context model through an appropriate feature selection and aggregation method.
- How context information is processed, managed and retrieved and how services are distributed using cloud computing?
  A massive amount of contexts arrive from different assisted systems at a high sample rate. The system needs to ensure that appropriate context information is stored for a particular user and it can be retrieved properly. A distributed context management system will be developed to overcome the issue.
- How the system will support wide range of assisted services for specific sceneries using single model?
  Service can be classified as daily activity monitoring, autonomous, emergency, vital sign detection, social service, medical data visualization and other software service. The goal here to support different services using same cloud platform.

## II. Architectural Overview

An abstract architecture of the proposed cloud-based context-aware service model is depicted in Fig 1.

The system comprises of five main cloud-oriented components. Ambient Assisted Living (AAL) systems, context aggregators, context providers, service providers and context management system(CMS). Each of the AAL system consists of a target user (i.e. elderly person), body sensors network, ambient devices and software applications. The raw data generated by sensors are collected in a personal cloud server by a data acquisition process. Context providers perform filtering, reasoning and classification to derive high level primitive contexts. Context Aggregator merges the required information in a single context model using web ontology language (OWL) [5]. The heterogeneous service providers enrich service repository of the system. Service rules and actions are described by same ontology model. The roles of distributed CMS are to manage context, store context history and map appropriate services for a given context. The CMS have access control mechanism

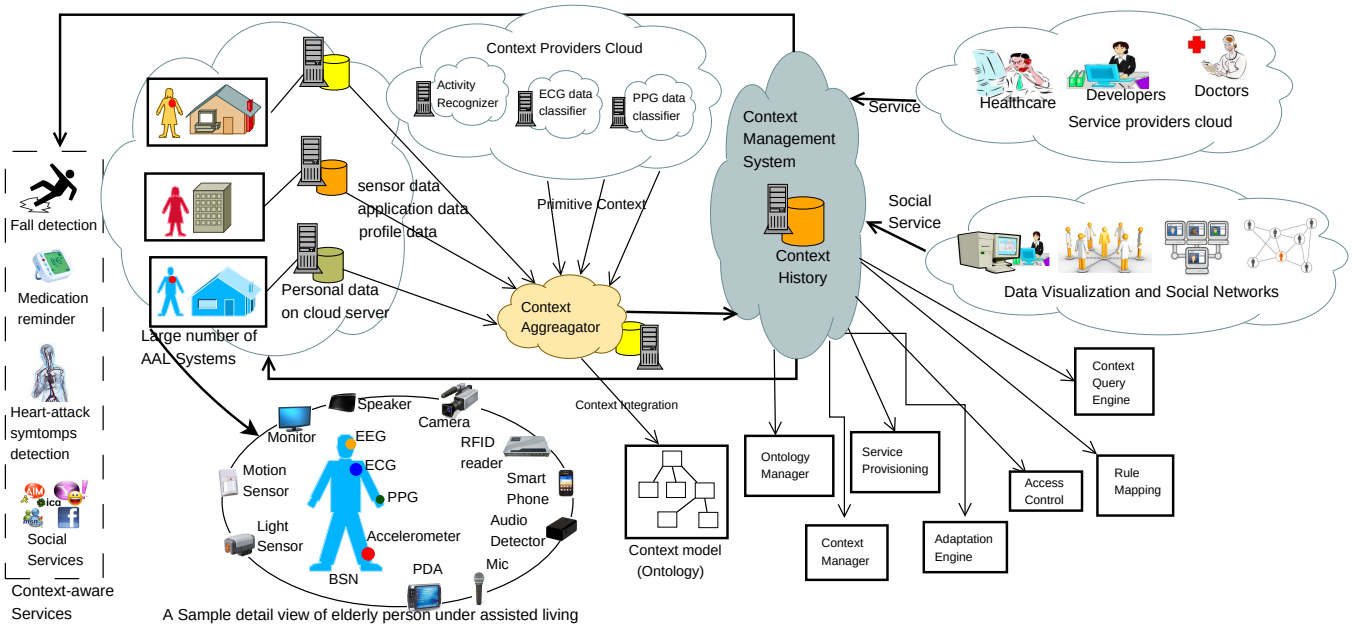


Fig. 1. **The Generic Model**: Data generated in *AAL systems* converted to context model in *Context Aggregator* with the help of various *Context Providers*. *CMS* manages context from users and service from *Service Providers* and associates context-aware services. Different modules runs inside CMS as cloud service

as it contains context history of patients which are sensitive information. The major functionalities of the CMS are also described in Figure 1.

## III. Evaluation

We are using Apache Jena to design our ontological context model. We will utilize Google App Engine to implement different modules of our model as cloud service. WEKA will be used for data mining and data clustering. Using Context Toolkit [6] we will create different types of services. The main evaluation criteria will be performance, reliability and accuracy of the application domain. For performance evaluation we will calculate data to context conversion time, the transmission time required to deliver service for a context and will compare them statistically with existing approach. Reliability and accuracy will be ensured by measuring the success rate of service mapping from context.

## IV. Research Completed To Date

Extensive literature review has been done in context-management middleware, context-aware systems, context modelling and healthcare services. The limitations of existing methods are identified. We have defined the data structures of the major entities of our context model and their semantic relationship. We have created some services using context toolkit. We have generated synthetic data that represents the daily log in terms of high level context of activity and biomedical conditions of the user. At present we are working to store those data in cloud database, detection of anomalous situation in context inside CMS and mapping of services based on the anomaly. As example, the service is when the blood pressure of the user goes above a certain threshold then raise and alert message. We are working to produce more data for a single user for mapping of different types of services.

## V. Conclusion

As part of ongoing work, we will develop the functionalities of context management system using google app engine an evaluate the performance of context generation and service mapping for single user scenario.

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