

# Integration of HL7 Compliant Smart Home Healthcare System and HMIS

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**Abstract.** Smart Home Healthcare Systems requires interoperability at different levels for effective provision of healthcare. Patients should be monitored regularly by medical doctors, whereas, medical doctors are themselves busy. Medical data exchange is extremely important for monitoring healthcare ubiquitously using smart home systems. Lack of standards usage such as HL7 for medical information exchange limits the usability of these smart home healthcare systems. Therefore, the need is to provide an interoperable solution in which smart home healthcare system and Hospital Management Information System (HMIS) can exchange information to provide guidelines to the patient. The proposed system caters this deficiency in smart homes by standardization the health related information and communicating it with HL7 compliant HMIS for the physicians to provide guidelines. Sensors data in raw form is initially converted to XML form and then converted to HL7 CDA document. This data is communicated to HMIS for physicians to evaluate data and provide recommendations. The proposed system ensures effective monitoring of patients health data and timely information exchange among Smart Home and HMIS to ensure effective treatment and management of patient disease.

**Keywords:** Smart Home, HL7, HMIS, Interoperability, Sensors.

## 1 Introduction

The demand for best available healthcare is on rise due to increase in chronic diseases in the population [1]. An independent individual (more specifically ageing population and chronic or alzheimer's disease patients) are moving towards concept of smart homes equipped with advanced technologies to monitor their activities and detect health related problems earlier in order to get better healthcare. In order to achieve the vision of remote monitoring of patient's healthcare at smart homes, interoperable services are required among smart home systems and Health Management Information System (HMIS).

This interoperability of smart homes systems and HMIS for sharing patients information with physicians requires practicing standards. HL7 Clinical Document Architecture (CDA) [2] is a standard that lies in HL7 family and is used to specify the structure and semantics of "clinical documents" for the purpose of exchange [2]. In smart home environment, the sensory data needs to be mapped to CDA format and communicated with HMIS. Therefore, it is necessary to have a system that make effective use of sensory data for interoperable exchange of the extracted information using healthcare standards.

The proposed system is based on HL7 compliant Smart Home Healthcare system, that filters raw sensory data to extract health related information and transform it in HL7 CDA format; communicates the information with HL7 compliant HMIS. The physicians evaluates the information transmitted and responds with appropriate recommendations. These recommendations are communicated by HMIS with smart home system in return.

## 2 Human Activity Recognition Engine (HARE)& CDA

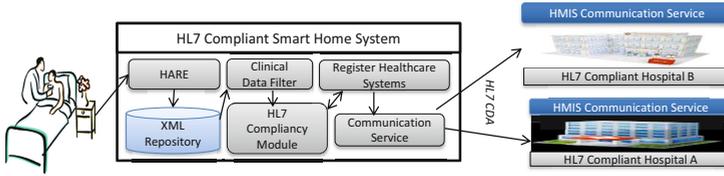
HARE engine is designed and developed by our lab for monitoring the activities of Alzheimer disease patients. HARE [3] focuses on monitoring human activities (Alzheimer's patient as case study) using heterogeneous sensor technology and intelligently processing these activities for analyzing the context of the activities performed. The activities of the Alzheimer's patients are recognized using motion sensors, video based, wearable sensor based, and location based sensors. These activities are intelligently processed by Context-Aware Activity Manipulation Engine (CAME). HARE has the capability to become part of the smart home environment and identify activities. The only weak link of the HARE engine is its ability to communicate these high level activities identified, with HMIS of a particular hospital where physicians can evaluate the results and accordingly provides recommendations/guidelines. The sensors data gathered, processed, and then filtered is made part of CDA document as observations. Our proposed system will transform the output into HL7 CDA format and communicate with HMIS compliant to HL7 CDA standard. This makes the interoperability among systems possible, as communicating systems interpret the data as desired and responds accordingly.

## 3 Proposed Architecture

The proposed system is based on HL7 compliancy to smart home healthcare system as shown in Figure 1. The detail of the components of the system is as follows:

### 3.1 Sensory Data Repository and Preprocessing

The health related information about the patient is mainly provided by the motion sensors. The data collected about the different activities are stored in



**Fig. 1.** Working Model

Sensory Data Repository. The data is obtained from different sensors. All the data stored in this repository is in raw form and requires pre-processing to communicate it with HMIS. This preprocessing is carried out using different algorithms that are proposed and implemented in our lab for sensory based [4], video based [5] and location tracking [6] activity recognition. We assume that the algorithms are applied on the sensory data has stored the preprocessed information in XML format.

### 3.2 XML Repository and HL7 Compliancy Module

This XML format records different activities of the patient. Each activity detected includes information about type of activity, sensor information that detects activity, name of the person, activity name, unique id of the sensor location and occurrence time of the activity. After every hour the smart home system needs to communicate this gathered information with the physicians of a particular hospital. The physicians that have agreed to monitor patients data continuously and provide recommendations, requires the data to be communicated with their HMIS. HL7 Compliancy module generates clinical document, transmitted to all the registered healthcare systems with smart homes.

### 3.3 Registered Healthcare Systems and Communication Service

This component is responsible for storing the information about the HMIS that requires the patient information to be transmitted to them on regular basis. After every hour the gathered data is transmitted to these HMISs in HL7 CDA document using Communication Service. This service is responsible for communicating information to and from Smart Home System to the HMIS's. The information obtained from the HL7 Compliancy module is transmitted to the desired healthcare systems.

## 4 Conclusion

The integration of smart home healthcare systems with HMIS is critical for treatment and management of patients. The vaccum of integration is filled by use of standards such as HL7 CDA. The use of sensory information and molding to CDA document for communication ensures exchange of medical information

at the right time, resulting in improved patient health due to guidelines provision at appropriate time.

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