

Smart CDSS for Smart Homes

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Abstract. Smart Home is an emerging area of healthcare applications. Various candidates' healthcare applications have been developed to monitor patients at their home environment. Recent developments show that most of the applications provide some conventional guidelines and reminders to patients regarding medications and related physical activities. In this paper, we proposed a novel approach of Smart CDSS that actively provides expert guidelines to patients from approved knowledge of clinicians at their home environment.

1 Introduction

With emerging technologies on hand, people are striving to facilitate the life with smart living standards. Smart Home is one of the resulting paradigm of these emerging smart technologies. The future smart homes are envisioned to be equipped with autonomic services that facilitate life from various perspectives. The most prominent services are related to healthcare. For example, in smart home environment, many decision making services are deployed to monitor activities of person. Daily monitoring of health condition is in high demand at home care to prevent diseases effecting lifestyle [1]. Based on health condition monitored for chronic diseases, the demand for formal clinical guidelines is increasing to provide patient with suggestions and recommendations that help them to manage lifestyle accordingly. Most of the above mentioned reminder systems in smart home only provide reminders and guidelines based on daily activities. In this paper, we propose Smart CDSS (Smart Clinical Decision Support System) service that provides approved guidelines and recommendations of clinician to patient in smart home environment. We have already designed and populated the knowledge base for diabetes based on HL7 Arden Syntax.

2 Smart Home Applications Layered Architecture

Keeping in view complexity of smart home applications and business workflows, smart home application can be designed into four layers. The analysis of each layer in terms of business processes to be modeled with the layered architecture addressed by [2]. At Hardware Layer variety of sensors are deployed that interact

with sensor applications to provide information of activities. Home Communication Network (HCN) support services for various networks including ZigBee, Wi-fi and blue-tooth. Autonomous Decision Making layer (ADM) incorporate minimal decision services and coordinate the structure data to service layer. Service layer resides services that are directly available to smart home stakeholders. Smart CDSS is an example that will provide guidelines and reminders to patient under care in smart home.

3 Smart CDSS Service: Design and Architecture

Smart CDSS is standard base service that provides guidelines and reminders to smart home applications. The Fig. 1 depicts overall architecture of Smart CDSS service with all intended modules.

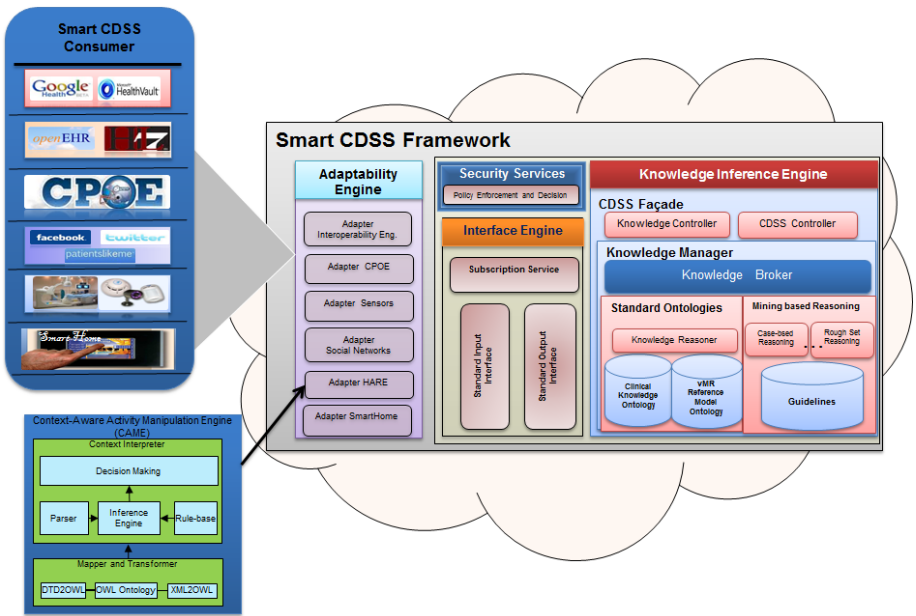


Fig. 1. Smart CDSS Architecture

Knowledge Inference Engine (KIE) include Clinical Knowledge (CK) ontologies based on HL7 Arden Syntax [3] and HL7 vMR standards [4]. The CK is represented in standard ontology where reasoning occur using SWRL (Semantic Web Rule Language). **Interface Engine (IE)** defines vMR standard input and output interfaces to ensure seamless integration of various application to Smart CDSS. **Adaptability Engine (AE)** allow to transform complex heterogeneous application input into standard base Smart CDSS input and output to application specific format.

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<?xml version="1.0" encoding="UTF-8"?>
<activities>
  <activity type="Motion">
    <detectedBy>Motion Sensor</detectedBy>
    <hasName>Mr J</hasName>
    <activityName>Leaving Bedroom</activityName>
    <id>1</id>
    <time>2011:05:16:01:00:00</time>
  </activity>
  .....
  <activity type="Medicine">
    .....
  </activity>
  .....
</activities>

```

Fig. 2. Diabetic Patient Activities under Observation

4 Smart Home Adapter Design for Smart CDSS

Smart Home Adapter (SHA) is playing pivotal role in integration with Smart CDSS services. The SHA module resides at service level of layered architecture, and transform smart home activities of interest of diabetic patient to standard clinical statement and vice versa.

4.1 Structured Information at Smart Home Activities

The partial information shown in Fig. 2 collected through application discussed in [5] , for various activities for Alzheimer patient can equally be applied for diabetic patient. This activity information becomes input to SHA to be converted to standard input for Smart CDSS.

4.2 Standard Smart CDSS Input of Smart Home Activities

Smart CDSS take standard input with patient information and corresponding clinical statements. Clinical statements represent problem, encounter, procedure, goal, supply, substance administration, observation and adverse events. So the diabetic patient activity information shown in Fig. 2, can be represented via problem and substance administration clinical statements mentioned in vMR specifications [4].

5 Conclusion

The paper introduced clinical decision support service for smart home. The proposed solution is based on existing standards like HL7 Arden Syntax and HL7 vMR that enables Smart CDSS as semi plug and play service for various applications. The structured input of diabetic patient has been modeled into standard input specified by HL7 vMR standard that is used as reference input by Smart CDSS. Using Smart CDSS at smart home environment, we can extend solution for various diseases particularly for monitoring and managing elderly peoples.

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References

1. Motoi, K., Taniguchi, S., Yuji, T., Ogawa, M., Tanaka, N., Hata, K., Baek, M., Ueno, H., Wakugawa, M., Sonoda, T., et al.: Development of a ubiquitous health-care monitoring system combined with non-conscious and ambulatory physiological measurements and its application to medical care. In: 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBC, pp. 8211–8214. IEEE (2011)
2. Agoulmine, N., Deen, M.J., Lee, J.S., Meyyappan, M.: U-health smart home. IEEE Nanotechnology Magazine 5(3), 6–11
3. Vetterlein, T., Mandl, H., Adlassnig, K.P.: Fuzzy arden syntax: A fuzzy programming language for medicine. Artificial Intelligence in Medicine 49(1), 1–10
4. Domain analysis model: Virtual medical record for clinical decision support (vmrcds), release 1
5. Khattak, A.M., Truc, P.T.H., Hung, L.X., Dang, V.H., Guan, D., Pervez, Z., Han, M., Lee, S., Lee, Y.K., et al.: Towards smart homes using low level sensory data. Journal of Sensors 11(12), 11581–11604