OCareClouds: improving home care by interconnecting elderly, care networks and their living environments

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ABSTRACT

In order to reduce costs related to an aging population, health care will increasingly rely on in-home care as an alternative to admission in a medical facility. Even when hospitalization is necessary, it should be feasible to discharge elderly patients sooner and instead rely on in-home care that is on par with in-hospital care. Today however, there are many obstacles that remain open for delivering high-quality care at home. For one thing, environments to which discharged patients return are often not adapted to the patient's specific health care needs. For another, organizing in-home care with a large number of caregivers is often costly and cumbersome. Therefor, this paper presents OCareCloudS: a computer system that aims to improve in-home care by combining information pertaining to the care and the home environment of a patient with information relating to their network of caregivers. By means of a portable miniature home, this paper demonstrates how the interconnection of these three elements combined with ontology-based reasoning can improve the in-home health care in case of a patient with a physical disability.

Categories and Subject Descriptors

J.3 [**Computer Applications**]: Life and Medical Sciences—*Health, Medical Information Systems*

General Terms

AAL, eCare, sensors, ontology

1. INTRODUCTION

As the population of elderly people in more developed countries keeps on increasing rapidly, health care-related costs are growing at a rapid and non-sustainable pace. In order to keep this growth under control, health care organizations are considering cost-friendly alternatives to the way health care is organized today. One of such alternatives is ambient assisted living systems (AAL). By assisting elderly people in their day-to-day lives, AAL systems aim to maximize the time span that elderly can spend in their preferred environment [1]. While this helps to unburden (often already over-occupied) medical facilities, it also pose challenges for organizing high-quality health care in a home environment at a reasonable cost. Sensory systems deployed throughout the home can provide feedback on the well-being of elderly and can be used to increase the quality of care given.

Furthermore, the processes for in-home care involve a larger variety of actors than is the case in conventional care situations (such as nursery homes). Here, the care network, i.e. all actors involved in providing care, typically includes medical staff as well as relatives and next-door neighbors. Administrative and organizational overhead for ensuring that all these different parties can co-operate harmoniously to provide high-quality home care, should not be overlooked. Thus, a system that facilitates communication and information exchange between all involved parties is indispensable.

To meet these challenges, the authors developed the OClareClouds system. The OClareClouds system aims to combine all available patient-related data (through sensory as well as human input), as well as disseminating all this information throughout the care network, for improving the coordination and level of provided home care.

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2. SYSTEM DESCRIPTION

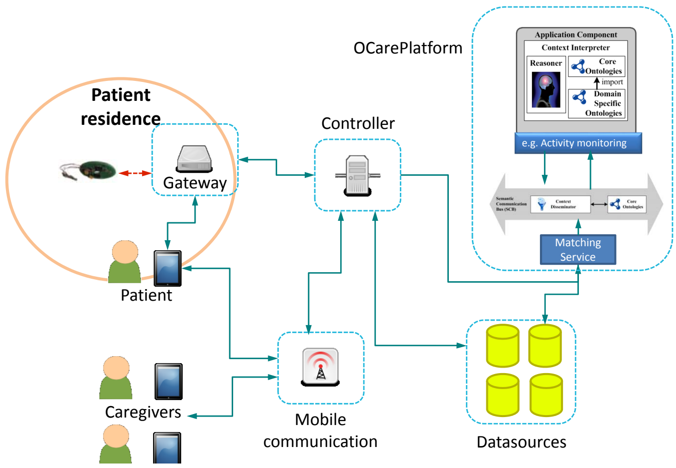

Figure 1: Architecture of the OCareCloudS system

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Before discussing the details of the demonstration, we give an overview of the entire OCareCloudS system in figure 1. In the upper-left corner the patient's residence is equipped with a variety of sensors (shown left) that communicate through a gateway (shown right) with the rest of the system. Sensors measure the patient's surroundings and report their readings to the gateway. The gateway tags the sensor data with concepts from the OCarePlatform ontology (upper right corner) and sends the resulting data to the controller (depicted in the middle). It is the controller's task to annotate the tagged sensor data with a patient-specific identifier and forward the resulting information to the OCarePlatform for analysis. The OCarePlatform is at the heart of the system and is able to offer a number of services based on the specific needs of the patient. It consists of a matching service that translates incoming messages to instances of ontology concepts. These instances are then broadcast on an internal bus which allows services to consume the instances and react accordingly (figure 1 includes an exemplary activity monitoring service). The data sources in the lower-right corner store care tasks, patient's medical and environmental information and information related to the caregivers.

The mobile communication component connects the caregivers to the OCareCloudS system. To this end, each caregiver is supplied with a smart phone that supports push-based notifications and that offers an additional application through which care is organized. Organizing care is achieved by delegating care tasks to the right caregiver at the right time. This selection is based on reasoning by the different services available at the OCarePlatform. Furthermore, the platform can chose to re-delegate tasks or create new care tasks when it deems appropriate. Examples of care tasks include cooking meals, groceries shopping, getting someone out of bed, etc. As a result of this micro-management, the quality of the provided care is expected to rise.

3. DEMONSTRATION

In order to display the various components identified in the previous section, a real-life scenario running on the system is demonstrated. The scenario revolves around a fictional elderly named Youssuf, who is living alone with a physical disability. The demo includes a miniature home equipped with sensors, which represents the patient's residence. The miniature home contains a gateway and a variety of sensory equipment such as pressure, motion, RFID-reader, temperature and light intensity sensors that are all installed on a 2D representation of a typical home embedded inside a portable casing [2]. The controller, the OCarePlatform and the mobile communication platform are all available as Cloud services that are accessible via the Internet. As a final component, the demonstration also uses two Android smart phones for showcasing the interactions between the caregivers and the system in the forms of notifications, caregiver registration and task management. The demonstration consists of performing the following scenario using the portable miniature home. The scenario relies on only two of the available sensor types, namely a pressure sensor that is installed in Youssuf's bed and a RFID-reader that is located near Youssuf's front door. The demonstration scenario is described in the next paragraph.

Due to his disability, Youssuf is unable to get out of bed independently in the morning. Therefor, there is a daily care task, that is assigned to Youssuf's next-door neighbor, Lidia, for helping him get up before 9 am. However, on this specific morning, Lidia overslept and Youssuf is still in bed at 9am. The periodic reports from the pressure sensor in Youssuf his bed, allow the OCarePlatform to detect that Youssuf is still abed at 9 am. Technically, these reports are formatted as JSON messages such as shown below:


```
{
  "prefixes": {
    "wsna": "http://example.com/ontology/wsna.owl#",
    "ca": "http://example.com/ontology/ca.owl#",
  },
  "timestamp": "2013-11-04T16:30:13+01:00"
  "dataSourceType": "wsna:SensorBoard",
  "dataSourceID": "wsna:c30c2",
  "data": {
  "e": [
    { "n": "force/sta", "v": 1, "u": "", "rt": "ipso.sen.force.status",
      "ontology-uri": "wsna:c30c2.ipso.sen.force.status",
      "tag": "wsna:PressureSensor"},
    { "n": "loc/sem", "v": "bedroom-bed", "u": "", "rt": "ipso.loc.sem",
      "ontology-uri": "wsna:c30c2.ipso.loc.sem", "tag": "ca:Location"}],
  "bn": "coap://[aaaa::c30c:0:0:2]:5683/"
  }
}
```


Based on this information, the OCarePlatform decides to remind the next-door neighbor of her care task via a notification on his or her smart phone through the mobile communication platform. The notification ask the neighbor to re-accept the care task via a “yes or no question”. In case Lidia accepts, the care task is reassigned and the scenario starts again (with 9 am changing to 9:05am). In case Lidia declines (or fails to respond within a predetermined amount of time), the list of recipients for the alert is broadened to include everyone in the care network that can help Youssuf out of bed and the notification is sent again. As soon as a caregiver accepts the care task, it is reassigned and the question is revoked. As a result, the entire care network can see that the task has been accepted by the caregiver in question and the scenario starts from the beginning.

When the caregiver arrives at Youssuf's residence, he or she registers by swiping their personal RFID card. The OCarePlatform logs the registration of the caregiver and presents the list of pending care tasks in the application running on the smart phone. After helping Youssuf out of bed, the caregiver signals the completion of the task by ticking off a checkbox on their smart phone. The OCarePlatform verifies that the pressure sensor readings' indicate that Youssuf is indeed no longer lying in bed. Now that the caregiver is at Youssuf's residence, he or she can decide to complete any additional tasks available on the list. When leaving Youssuf's residence, the caregiver sign outs via a button in the application. Again, this information is made available to the entire care network.

4. ACKNOWLEDGMENTS

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5. REFERENCES

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