EHEALTH SMART HOME ENVIRONMENT SERVICE PLATFORM

Enabling Remote Monitoring and Service Composition through Social Media

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Abstract: Demographic changes with the growth of elderly populations implies a need of developing efficient technology tools in order for the patients to stay in their own home for as long time as possible feeling safe and secured, and where the medical follow up can be achieved by remote home monitoring equipment. The lack of actual international standards has the consequence of proprietary solutions being used by vendors, making interoperability difficult. On the other hand, social media has become an integral part of modern society and has changed the way people interact with one another. It can potentially be extended to support well-being at home as well. In this paper we argue that social media have the potential to play an important role in remote home monitoring and remote service composition for provisioning health-care-related services in the future. An overview of a proposed platform based on Service-Oriented Architecture (SOA) paradigm for interoperability between different devices is also presented.

1 INTRODUCTION

Demographic changes in population with increased number of elderly people is a huge challenge for future health care services. The new generation elderly people are supposed to give new requirements to those services compared to the elderly generation today. In Norway, a public report used Mick Jagger as an icon representing the new generation elderly (Teknologirådet, 2009). This generation is supposed to bring new challenging requirements to the future health care services mainly because they opposed the existing authorities in their younger days and are still a generation with an active lifestyle.

In order for this new generation elderly to be able to continue an independent living with high degree of self-care and self-management, new technology developments will compensate for their needs in daily living activities. This generation is known as the digital immigrants, compared to younger generations as digital natives, described by Prensky (2001). However, during their active working life, they have been trained and got used to new information and communications technology (ICT) solutions such as the Internet, email, Facebook, and smartphones. In their elderly days, it is reasonable to expect them to require updated technology solutions both for ambient assisted living purposes and for their electronic collaboration with healthcare service providers.

Their needs of new technologies for an active and independent lifestyle will give a future private market for technology solutions. However, in many countries the social welfare services will support the elderly person with actual need of assistive technologies. This paradox will have tremendous consequences to interoperable solutions for future eHealth solutions, in order for the elderly to have home-care installations being able to communicate with public healthcare services.

Today, there is a lack of common standards for Tele-home-care technology; those challenges are focused in the European project HITCH (2011), still having a long way ahead trying to have acceptance for the use of international standards. Alternatively, the use of open standards and open source solutions can contribute to rapid development of inter-operability in the home healthcare solutions. In this paper, we will highlight how open standards can be developed as a fundamental platform for future development. With the rapid growth of social media users around the globe (Backstrom et al., 2006),

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social media becomes a promising tool to be integrated into Tele-home-care services.

2 MOTIVATION

eHealth is defined as the use of ICT to access health and lifestyle information, to give support and improved health care services (European-Commission, 2011). Tele-home-care is a specific instance of telehealth that focuses on providing remote healthcare services to patients in their homes. Healthcare personnel can use remote communication mechanisms either in consulting and cooperating with their colleagues or in advising and guiding their patients at home. Patients at home may need to interact with measurement devices which in turn will generate clinical information that can be analysed by healthcare personnel remotely. Several examples of measurements that can be acquired include heart rate, blood pressure, oxygen saturation, and weight. In addition, monitoring of activities of daily living (ADL) can be provided as well by making use of various different devices installed within the home environment (Le et al., 2008). These devices combined by the computer system being deployed transform the home environment to smart home.

Besides the elderly population growth and the decreasing number of healthcare workers, other important driving force for adopting Tele-home-care is cost (Menkens and Kurschl, 2010). Tele-home-care services are expected to reduce the cost of healthcare services in general, enabling a personalised treatment based on long-term personal records with final goal of improving quality of medical treatments. By employing Tele-home-care solutions, patients can reduce hospitalisation periods, reduce energy and carbon emissions generated by transportation means, as well as decrease the number of necessary hospital facilities. However, new devices are needed to be installed within the home environment to support the provisioning of Tele-home-care services. In addition, Internet connectivity and other backup communications channels (e.g. telephone network) are needed to be provisioned as well. These additional requirements may need a huge amount of initial set-up cost if everything is owned and managed by the inhabitants at home. To tackle this issue, different business models can be used by healthcare service providers, such as bundling the devices and services in a monthly subscription manner, so that the patients at home do not need to buy the devices. From this standpoint, different healthcare service providers can provide different types of healthcare services to the patients at home.

Various different devices available in a home environment, including medical devices, may not be utilised to their full potential without combining their capabilities with one another. For example, a smart carpet detects a falling patient. After five minutes if no movement is detected by motion sensors in that particular room, then the patient's private doctor, nurses, and relatives should be informed by means of text messaging and email. In addition, the main door of the house will be unlocked to enable first aid personnel to come in. To deploy this scenario, capabilities from several different devices should be combined (i.e. smart carpet for fall detection, motion sensors for movement detection, clock for timing, mobile phone for sending text messages, personal computer for sending emails, door actuator for locking and unlocking a door). In order to achieve this, capabilities from different devices should be exposed by means of standardised application programming interfaces (APIs) which form basic services in a home environment. These services will then act as building blocks for composite services (Trinugroho et al., 2011b).

Social interactions in Tele-home-care should not be limited to interactions between healthcare service providers and patients. Involvement of relatives and colleagues is crucial as well for encouragement of better lifestyle at home (Abdullah and Zakaria, 2010). However, direct physical interactions may not always be possible due to location and timing constraints. Collaboration tools are needed to fulfil this requirement, and as the Internet plays a crucial role as a communications backbone in a smart home environment, social media is expected to contribute as a collaboration platform for virtual meetings (Thygesen et al., 2011). Figure 1 shows an overview of social media's role in Tele-home-care.

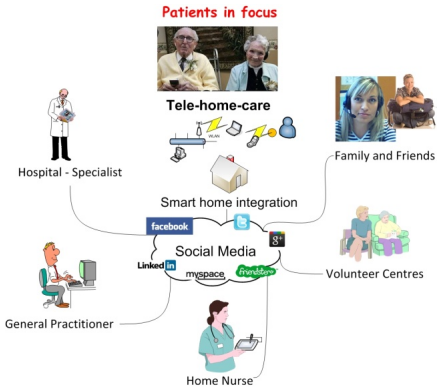

Figure 1: Social Media and Tele-home-care.

3 SOCIAL MEDIA SERVICES IN TELE-HOME-CARE

Social media services can play different roles in Tele-home-care scenarios. Table 1 shows a classification of possible Internet-based social media services for home health care.

Table 1: Classification of Internet-based social media services for home health care (Dale et al., 2010).

Internet-based social media services	Cognitive support systems	Memo planner system
		Clock/calendar functions
		Time-dependent reminders
		Remote control systems
	Secured communities	Home healthcare information exchange
		Family and friends social care and information exchange
		Virtual meeting places for social activities
		Voluntary social services
	Web-based services	Internet communities
		Internet information search
		Entertainment
		Music & films/videos
		News and channels

Table 1 classifies Internet-based social media services into three main categories: cognitive support systems, secured communities, and web-based services. All these three categories can be used in Tele-home-care systems, although the secured communities category may be used more often than the others. What may be missing in this classification is the usage of social media services to remotely compose services in the smart home environment. Taking the previous example of patient fall detection service that involves capabilities from different devices, what if the waiting period is to be changed from five minutes to ten minutes? Or what if the personnel being alarmed should be changed? What if a new device should be involved in the sequence such as turn on every single light in the house when the accident happened at night?

A home automation system should provide the possibility to be remotely administered. This can be accomplished by making use of the Internet, by providing a web-based home management system to remotely compose services from available devices installed in the corresponding home. This web-based tool can then also be used to remotely monitor the patient's conditions. This will enable healthcare personnel (e.g. a doctor) to remotely monitor patient as well as compose services from existing devices at home to fit best with the patient's situation and condition. However, this tool should be accessible not only by healthcare workers, but also relatives and colleagues of the patient. This will turn the web-based tool to a social media, where different users can monitor the patient's condition, communicate with one another, as well as review any change in deployed services at home. A web-based role-based access control (RBAC) is needed to be implemented in the system (Chungen et al., 2001) so that not everyone can alter services being provisioned at home.

However, if the deployed web-based remote home monitoring and management system is a standalone dedicated application, colleagues and relatives of the patient may not access it frequently. In this case, it is beneficial if the web-based tool is integrated with available social media services such as Facebook. Instead of deploying the tool as a standalone system, a dedicated Facebook application can be developed for this purpose. When integrating the use of unsecured social media in remote home care services, this implies security and juridical issues not clearly defined (Williams and Weber-Jahnke, 2010).

In order to incorporate the remote access, a service platform for integrating capabilities of various devices at home is needed to be deployed in the smart home environment. In the next section we will discuss about such platform.

4 HOME EHEALTH SERVICE PLATFORM SOLUTION

Healthcare service providers can collocate different devices in a smart home environment to provide specific health-related services. These devices' capabilities, combined with one another, can provide various composite services, which can lead to better personalised services to the patient at home. However, different vendors being chosen for these devices may raise incompatibility issues between them. To avoid building services from scratch each time a new service is needed, service-oriented architecture (SOA) paradigm is promising to be adopted for a home eHealth service platform, as it promotes interoperability, modularity, and reusability of service components.

To further reduce the involvement of the patient in accomplishing a service's aim, a context-aware

home automation system is also needed. A context-aware home automation system should be able to gather the patient's information and the surrounding environment, then adjust the environment setting to suit the patient's needs and preferences. Such context-aware home integration platform was proposed in authors' previous work (Trinugroho et al., 2011a), shown in Figure 2.

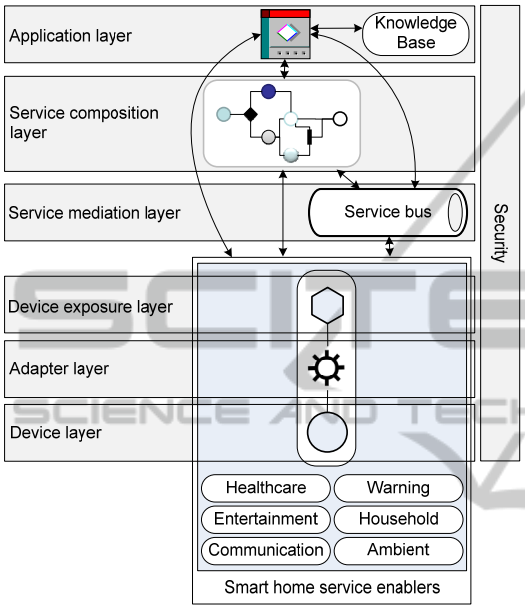

Figure 2: Home eHealth Service Platform.

The proposed platform exposes each device's capabilities as reusable services, termed as service enablers, that can be used to compose more complex services.

In order for a home automation system to be able to adapt the surrounding environment, a knowledge base should exist within the home environment, storing knowledge about different entities' situation, including the patient's. Reasoning can then take place on top of the knowledge base. Pure automated reasoning may not be desirable for Tele-home-care services as the system may infer false condition of the patient. On the other hand, healthcare specialist may know better what is best for the patient. Thus, a static rule-based reasoning mechanism may fit well, where the rules can be updated remotely by qualified personnel.

The proposed platform in Figure 2 is quite generic in the sense that it may accommodate different technologies. Since the application for remote home monitoring and management system is web-based, standardised Web Services technology will suit best for implementation purpose. This means that the capabilities of each device are exposed as Web Services end-points. Then web-based client application (e.g. dedicated Facebook application) can be developed for remote monitoring and management. Figure 3 shows the high-level overview of the proposed system.

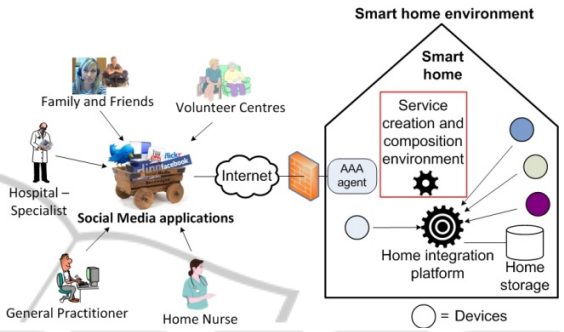

Figure 3: Remote home monitoring and management through social media applications.

By deploying this idea, social media applications can act as a web-based remote home monitoring and management tool, with three main functions:

1. Remote monitoring of patient's condition as well as the surrounding environment.
2. Remote service composition for new services to meet patient's needs. This action should be conducted by healthcare specialists.
3. Remote rule creation for automated reasoning on the knowledge base. This action should also be conducted by healthcare personnel.

Authentication, authorisation, and accounting (AAA) agent is required to be present in the smart home environment especially for security measure. Only authorised external applications (e.g. Facebook application) and authorised users may access the service creation environment within the smart home environment. And since all data are transmitted through the Internet, Hyper Text Transfer Protocol Secure (HTTPS) protocol is suggested to be used for secure transmission.

A crucial issue needed to be taken into account during the development of the web-based social media application is the user-friendliness of the graphical user interface (GUI). Icons or puzzles being used to represent the capabilities of devices should be clear enough for regular users. Message flow of a service should also be easily visible, and should be easily modified.

5 CONCLUSIONS

Social media's user base growth is intriguing, as a direct consequence of fast penetration of Internet usage in modern society. This trend can be seen as a positive reality as it enables remote collaboration between individuals, breaking time and space barriers. In this paper we argue that social media applications can be further pushed to provide remote home monitoring and management services, including remote service composition, for patients living at home. Security measure is suggested to include current best-practice approaches using AAA agent at home and HTTPS transmission protocol.

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