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INTERNATIONAL JOURNAL OF INFORMATION TECHNOLOGIES, ENGINEERING AND MANAGEMENT SCIENCE

Modern monitoring technologies in Healthcare

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Abstract

Internet of Things combined with Radio Frequency IDentification technology enable a whole new context for smart objects that are able to combine their physical and virtual existences. Radio Frequency IDentification, putting an identification label into every object, enables a smart system to get information, either real-time or virtual-linked information, without any physical contact. Information retrieved from such an object, turns it into a potential smart object, certainly able to auto identify itself and, if security problems are suitably treated, most probably able to connect to the global Internet. This way, one can get an ubiquitous framework to access, monitor and control any of those smart objects over an Internet of connected things. RFID tags in medical context enable a rapid and precise identification of each smart entity, enabling a ubiquitous and quick access to Personal Health Records over an Internet of Things. The use of smart phones with Internet access, along with strong security concerns - such as authenticity, privacy, confidentiality, integrity, data origin authentication, entity authentication and non-repudiation - turn this whole context into a decentralized and mobile healthcare system. Using the simple IoT architecture presented, combining smart objects, the security solution and mobile communications, one may remotely take care of patients' well-being, establishing an ubiquitous Ambient Assisted Living for Mobile Health applications. As an application example, a prototype m-health service, its security mechanisms and web based application, establish a use case scenario for the evaluation of the proposed architecture.

Keywords: Healthcare, services, management system, RFID, Internet of Things

Introduction

Internet of Things (IoT) refers to a recent paradigm that has rapidly gaining ground in the area of modern wireless telecommunications. IoT is then a new technological trend joining new computing and communications paradigms. Within this new trend, there are intelligent devices that have a digital entity and are ubiquitously interconnected on a network and to the global Internet. Everyday objects may integrate intelligence and the ability to sense, interpret and react to their environment, combining the Internet with emerging technologies such as Radio-Frequency Identification (RFID), real-time location and embedded sensors. The IoT concept is based on the idea of a universal presence of 'things' or 'objects', such as RFID tags, sensors, actuators, mobile phones, etc, with digital identification and addressing schemes that enable them to cooperate with neighbors in order to achieve some common goals. In the business sector, the most apparent consequences of IoT may arise in industrial automation and manufacturing, in logistics, in business or process management and in intelligent schemes for transporting people and goods.

Therefore, in general, the term Internet of Things refers to any type of devices that are interconnected by means of Machine-to-Machine Communications (M2M), each of which may be identified through a unique ID and defined through a virtual representation within the Internet.

The Radio-Frequency IDentification, commonly known as RFID, is used in many applications. The use of this technology is constantly evolving, expanding at exponential rate. There are several methods of identification, although the most common is a microchip able to store a serial number that identifies the person, object or thing. Using electronic devices that emit radio frequency signals, it is possible to perform an automatic capture of data, or a tag, from a reader.

Although it depends on the type of tag, passive or active, RFID is an easy-to-use and versatile acquisition information technology, where a radio signal is used to get data from transponders (e.g. tags) into the target application. Apart from the tags there is also the need for procedures to read or interrogate these tags (e.g. readers, antennas) in order to transmit the data to a host system where it is further processed. The main advantage of using RFID is the possibility of reading without physical contact, being that the production price of tags has been heavily declining over the years. One can put the tag inside a product and read it without unpacking or even implant it under the skin of a patient and read it from outside, even if it is moving.

Whenever we make use of RFID-enabled items, we may face privacy loss as users or items may be identified and linked together by means of tag identification. So, when using this type of technology special security concerns must be brought into place. In health care contexts, these security and privacy concerns are imperative, so any m- health solution must deal with this threat; if personal or private information is to be accessed, all the necessary security mechanisms must be in place, protecting direct data access and or information inference.

The Internet of Things enables to virtually establish links from the information residing in smart objects, for instance in tags, to any Internet connected system. This way, when working in intelligent spaces, we may establish interfaces to connect smart objects to this ”Internet of Things”, thus fostering mobile solutions for Ambient Assisted Living. RFID technologies are of special interest in such scenarios because it does not need any physical contact, or even awareness, of established communications in this Internet of Things; being this the case, of course there is a need and special concern on privacy and security issues.

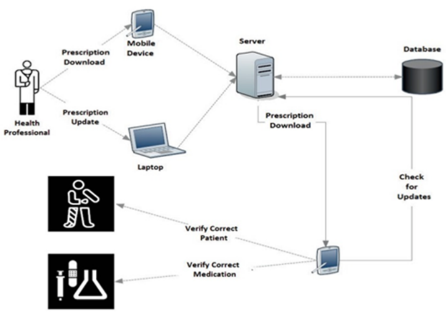

Figure 1. Smart objects and Internet of Things for Healthcare

This paper discusses these technologies and presents a new m-health service architecture, using RFID tags and structured around the Internet of Things, to establish a remote medication control system for Ambient Assisted Living, specially aimed at elderly people care in outpatient clinic. The main objective of this m-health service architecture is to allow elderly patients to self-manage their health in mobility, outside any special health care giving unit, either by monitoring their disease or by helping them to control the timely and correct intake of their medication.

Smart Patient rooms

The goal for patient rooms is to make them more patient-oriented, improving the patient experience by helping patients take a more active role in their own health care.

For instance, these “smart rooms” will be equipped with a bedside console that will potentially enable the patient to do everything from controlling the room’s lighting to speaking directly with a nurse when needed. On the wall in front of their bed will be a large, flat screen monitor that will not only offer entertainment (TV, video games, internet), but also patient education sites to learn more about a health condition or a pending procedure. They will also be able to access dietary services and order their evening meal. Appointments and reminders will automatically be displayed at the beginning of the day so they know their MRI is scheduled for 10 a.m. and rehab at 1 p.m.

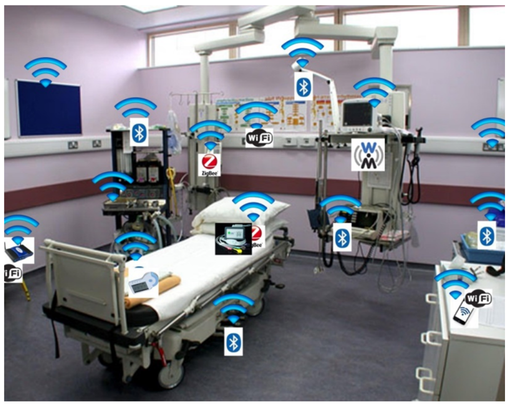

Figure 2. Smart room for patient

The rooms may also be equipped with video conferencing so a patient can visually interact with family and friends anywhere in the world. It will also allow the physician to consult with outside specialists, conduct “rounds” from a patient room, and stream video into a medical school classroom where students can ask questions. The operating rooms will have the same capabilities and offer greater opportunities for teaching residents and medical students.

Smart Clinicians and Nurses

The goal for clinicians is to ensure the information they need is immediately available, when and where they need it. Instead of having multiple devices – phone, pager, beeper, nurse call system – caregivers will have just one and it will do everything. It will most likely be hands-free and could be attached to clothing, worn around the neck, or carried in a pocket.

If a patient's vital signs change, an alert will be passed directly to the patient's caregiver through this device – reducing time spent watching monitors. If the primary caregiver doesn't respond, the system will reroute to the back-up providers until someone answers the alert.

Figure 3. Smart hospital

The caregivers will likely have sensors in their identification badges so when they enter a patient room, their name and title may appear on the patient's TV monitor. There will also be a small computer monitor next the patient's bedside which will be voice-activated to increase efficiency (keyboarding will be cut to a minimum). Based on the caregiver's badge, the computer will generate information pertinent to them. For instance, a nurse will be able to view the patient's vital signs and a doctor could call-up the latest lab results.

Conclusion

This paper presents a simple and secure Internet of Things architecture aimed at establishing a generic and ubiquitous Ambient Assisted Living framework to be used by hospital applications. The global solution presented is based on Radio Frequency Identification technology (RFID) and Electronic Product Code (EPC) normalization for the establishment of a unique identifier for each m-health related item (an object, a medicine, pharmaceutical drug, physician, patient, caregiver, drug, hospital, pharmacy, etc.).

The paper also argues that the broad development of RFID technology has the potential to increase patient safety in medical services and to reduce costs. As most health services can be enhanced with the location, tracking and monitoring, especially in mobile and ubiquitous environments, an IoT system for monitoring and position referral of any of health-related entities - people (such as patients, nurses, doctors visits, auxiliary) and goods (such as medicines, clinical analyses, wheelchairs, beds, medical equipment) - has been presented and discussed.

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