INTERNET OF THINGS FOR MEDICATION CONTROL:
E-HEALTH ARCHITECTURE AND SERVICE IMPLEMENTATION

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ABSTRACT

The use of Radio Frequency IDentification technology (RFID) in the medical context enables drug identification but also a rapid and, of course, precise identification of patients, physicians, nurses or any other health caregiver. Combining RFID tag identification with structured and secure Internet of Things (IoT) solutions, one can establish a ubiquitous and quick access to any type of medical related records, as long as one can control and adequately secure all the Internet mediated interactions. This paper presents an e-Health service architecture, along with the corresponding Internet of Things prototype implementation that makes use of RFID tags and Electronic Product Codes (EPC) standards, in order to easily establish in a ubiquitous manner a medication control system. The system, presented and tested, has a web interface and allowed for a first evaluation of the e-health proposed service. As the service is mainly focused on elderly Ambient Assisted Living (AAL) solutions, all these technologies - RFID, EPC, Object Naming Service (ONS) and IoT – have been integrated into a suitable system, able to promote better patient/physician, patient/nurse and, generally, any patient/health caregiver, interactions. The whole prototype service, entitled “RFID-based IoT for Medication Control”, and its web interface are presented and evaluated.

Keywords: Ambient Assisted Living (AAL), E-Health, Electronic Product Codes (EPC), Internet of Things (IoT), Medication Control, Object Naming Service (ONS), Radio Frequency IDentification Technology (RFID)

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INTRODUCTION

The Radio-Frequency IDentification, commonly known as RFID, is used in many applications (Sharma & Siddiqui, 2010; Ziegler & Urbas, 2011). The use of this technology is constantly evolving, expanding at an 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. Therefore, RFID is an easy-to-use and versatile acquisition information technology.

RFID is a system where a radio signal is transmitted to a specific transponder and to which it responds with another radio signal. Its aim is to carry data in suitable transponders (e.g. tags) and get it through by automatic reading, in the right place, at the right time, depending on the target application.

The tags contain silicon chips and antennas that allow it to respond to radio signals sent by a transmitter base. These elements are small proximity cards which can be found in different formats: passive, semi-passive, semi-active or active. Passive tags are not made up of a power source of their own and operate with the energy sent by the reader and transmitted through the antennas. As they do not require a battery, the manufacture of such tags is cheaper. Most existing RFID tags are this type. When the radio waves from the reader reach a passive tag, the spiral antenna within the tag creates a magnetic field; the tag draws power from the reader, transmitting power to its circuits, accessing the information encoded in the tag’s memory and enabling it to communicate. Unlike passive tags, the active tags are made up of a power source, are more complex, have memories with higher capacity, and they can store additional information sent by the transmitter - receiver. They have a small size (about the size of a coin), a practical range of ten meters and consist of a battery with several years’ duration. The third kind of RFID tags, the semi-passive, have an operation very similar to the passive tags; however they consist of a smaller battery (which allows the integrated circuit of the tag to be constantly powered). Finally, the semi-active tags are only active when programmed to send a signal at previously predetermined intervals or in response to a specific event (Vacca, 2009).

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 (Ziegler & Urbas, 2011) to a host computer, a supporting information system and software programs to deal with all the data usages (Figure 1).

Each of the components of an RFID system varies according to the frequency band defined for the system. Each frequency range has different characteristics and behavior. RFID tags are usually categorized into Low-Frequency (LF), High-Frequency (HF), Ultra-High-Frequency (UHF) and microwave transponders. Briefly, the LF tags exhibit a range of values between 125KHz to 134KHz. This type of RFID solution has a low rate of data transfer (only read one tag at a time, and if they are passive) and a poor performance when near metal. They only work for short reading distances and are widely used for access control, animal identification and athletes, etc.. On the other hand, RFID solution based on HF (13.56 MHz) show a good rate of data transfer, read multiple tags, work only with passive tags and display a reading distance of one meter. These solutions are used in hospitals (e.g. patient identification), access and food control, and libraries. In the range of 860MHz to 960MHz is where the ultra-high-frequency tags operate. This RFID solution is capable of performing readings up to 10 meters for passive tags, and 100 meters for active tags, has a high rate of data transfer and is made up of small size tags. Its main applications are traceability of items, vehicle identification, inventory management, etc.. Finally, the microwave tags (2.5 GHz) use active tags that allow a large reading distance and a high speed of data transfer. Due to the high cost of active tags, this type of system
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