Radio Frequency Identification and Mobile Technologies for Personnel Tracking in a Hospital Environment

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***Abstract*— The purpose of this design project is to develop a system for tracking patients and staff members in a hospital environment by using the radio frequency identification (RFID) and smartphone technologies. A RFID system includes a reader and numerous tags containing individual identification numbers. These tags can communicate with a mounted tag interrogator using radio waves. The system is intended to be installed at the entrances of specific rooms or areas, allowing for real-time tracking of persons carrying the RFID tags. The focus of this endeavor is on the integration of an Android smartphone platform that provides instantaneous information of hospital personnel, anywhere and anytime. The prototype system of this project will provide a running record of patient/staff locations with tag identifications, to be displayed on an Android application and shared through Bluetooth communications.**

Keywords—radio frequency identification, Bluetooth, hospital environment, patient and staff tracking, Android application

I. Introduction

Topics related to tracking patients and staff in hospital environments have been studied for the past three decades [1]-[3]. Various approaches have been exploited, such as telephone [4], dedicated radio-frequency transmitter [5], motion and pressure sensors [6], radio frequency identification (RFID) [7], and wearable sensors [8]. Among all available technologies, the RFID technology seems to be the most promising [9],[10].

First introduced in 1948, the RFID technology has taken many years to become affordable, available, and reliable for widespread use [11]. Devices that utilize RFID technology fall into one of two broad categories; those with a power supply, known as "active tags," and those without a power supply, or "passive tags." Active tags are almost always more expensive and larger in size. These type of tags contain a battery that can last up to 10 years. Active tags typically operate at a higher frequency, and in turn can be "read" or identified from a longer range. Passive tags are inexpensive, smaller, and often have an unlimited life. However this type of tag has limited data storage capability and a shorter read range [11].

RFID systems operate at different frequencies, ranging from 100 KHz to 900 MHz. Low frequency tags operate from 100-125 KHz, high frequency tags operate at approximately 13.56 MHz, and ultra-high frequency systems operate as high as 850-900 MHz. Low frequency tags are inexpensive, use less power, and are better able to penetrate non-metallic substances. These tags are ideal for scanning objects at close range (less than a foot) [12].

The application of the smartphone technology is still relatively new to healthcare [13]. The mobile health (mHealth) technology involves the use of smartphones in medical care, with applications to areas such as preventive health care services and lifestyle self-management in individuals with chronic illnesses [14].

This project aims at bringing the RFID technology and the smartphone technology together in order to create a platform for personnel tracking in a hospital environment.

II. Methods

A. Hardware

As shown in Fig. 1, the hardware of the prototype system consists of a microprocessor (Arduino UNO), a RFID tag interrogator (MIFARE RFID-RC522, NXP Semiconductors, Eindhoven, Netherlands), two Bluetooth modems (BlueSMiRF Silver, SparkFun, Boulder, CO), all powered by a portable USB charger. An Android tablet is used to communicate with the RFID interrogator and for developing the Android application.

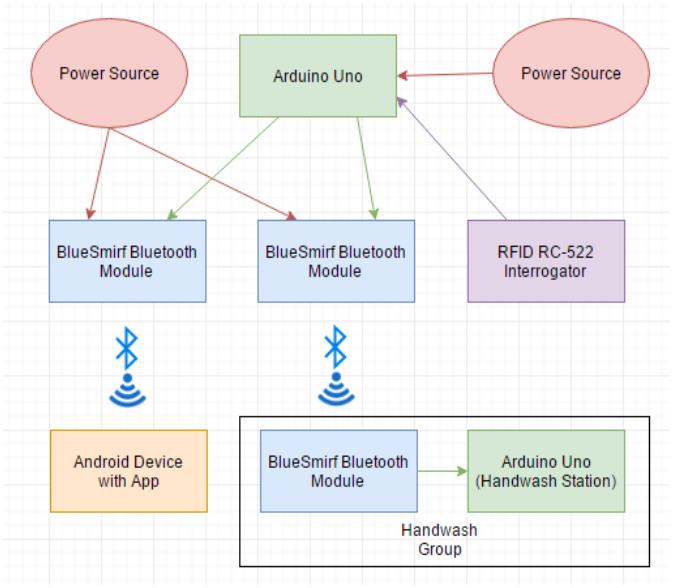

Figure 1. Block diagram of the RFID-smartphone based personnel tracking system for a hospital environment.

Figure 2: The functional prototype of the RFID-smartphone based personnel tracking system. During the development, an Android tablet was used instead of a smartphone.

B. *Arduino Software*

The software for controlling the RFID interrogator was programmed into the Arduino processor by use of the Arduino Integrated Development Environment (IDE version 1.6.13). The code was written in the C++ language.

C. *Android Software / Application*

On the smartphone side, the Android operating system was chosen due to its affordability and compatibility with the hardware. The development tool was the Android Studio (version 2.2) and the programming language was Java.

III. Results

Fig. 2 shows the functional prototype of the personnel tracking system, realized on a breadboard and with an Android tablet. A list of the personnel's names and the assigned RFID tag numbers are stored in the Android tablet. When a tag is scanned by the RFID interrogator, the tag ID number is transmitted to the tablet via a Bluetooth link. The tablet looks up the person's name based on the received ID, and displays the name of the person on the screen.

IV. Discussion

A prototype system has been successfully developed to identify personnel based on their RFID tags as they go through a specific doorway. The major advantage of this system pertains to its affordability. The system is also easy and flexible to install because of its capability of wireless communications. These advantages are important considering the need to stall many such units in order to track the personnel throughout a hospital. The RFID interrogators would need to be installed at various room doors and strategic points.

The drawback of the present prototype is the limited range (1-10 centimeters) of the low-frequency RFID reader. To increase the scanning range, an higher frequency RFID reader should be used. The typical range is up to 1 m for the high-frequency RFID reader (13.56 MHz), and about 5-6 meters for the ultra-high-frequency RFID reader (865-960 MHz).

For future work, a Wi-Fi communication link to a hospital server should be established. This would allow the Android app to download its ID database from and upload the location data to the hospital server.

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