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DEVELOPMENT AND REALISATION OF DATA COMMUNICATION FOR AN RFID AND BLUETOOTH SUPPORTED THERMOMETER BASED ON THE ISO/IEEE 11073 STANDARD

Bittermann M[1], Butschek A[1], Engel R[1], Haller M[1], Gerbovics F[1], Mense A[2], Sauermann S[1]

Abstract

In order to simplify the mobile temperature measurement observation in healthcare a new solution based on the IEEE 11073 standard is being introduced. It describes the development of a thermometer agent device with an integrated Radio Frequency Identification (RFID) and Bluetooth module for patient identification and data transmission. These results in a prototype which is able to identify a patient via passive RFID wristlet measure the temperature and transmit the data to a nearby manager system within a few seconds. In addition, the name and the temperature of the patient are shown on the integrated display. The advantages of this development are the timesaving procedure of patient's temperature measurement and the correct identification of the patient with the right assignment of the data to a manager's database. Further, it is equipped with a wireless charge unit based on an inductive electric power supply without any plug which makes it easy to disinfect. Therefore the usage of the RFID/ Bluetooth thermometer can be very beneficial in the field of nursing in telemedicine, homecare and can be easily integrated into hospitals' workflows. Finally, as a prospect for the future it is possible to integrate a time schedule based temperature measurement reminder into the device in combination with the Hospital Information System.

Keywords – Temperature, Thermometer, Bluetooth, RFID, Telemedicine

1. Introduction

The idea of the ISO/IEEE 11073 standard is to enable communication between medical devices and external computer systems. Based on a simplified and optimized communication approach for personal health devices, these standards align with, and draw upon the existing clinically focused standards to provide easy management of data from either a clinical or personal health device [5].

The main aim of the ISO/IEEE 11073 standard is to convey the interoperability between different medical devices (Agents) and computer-based systems (Managers) to provide data exchange from

[1] University of Applied Sciences Technikum Wien, Department of Biomedical Engineering, Höchstädtplatz 5, Vienna, Austria

[2] University of Applied Sciences Technikum Wien, Department of Information Management and IT Security, Höchstädtplatz 5, Vienna, Austria

different types of medical and sports devices through a standardized data structure, data presentation capabilities and functionality needed for data exchange [4].

According to interoperability of a thermometer as a medical device, it shall fit its purpose to measure temperature, and to exchange the acquired medical information with a Hospital Information System (HIS), medical databases of residential doctors, and databases for scientific research.

Temperature measurement is one of the most often used methods in homecare and hospitals as a medical indication of a patient's state of health. Considering the pathophysiology of thermoregulation, pyrexia is a regular epiphenomenon of nearly every infection of the human body. This kind of immune reaction can lead to severe side effects like febrile seizures, cerebral oedema or circulatory shock when exceeding 41°Celsius. Additionally, malign hyperthermia and hypothermia are also able to cause a critical state of the patient's health [6].

As a consequence the observation of the patient's temperature has to be reliable, but easily feasible. This project deals with these requirements and provides a solution for patient identification via radio frequency identification (RFID), temperature measurement and Bluetooth data communication based on the ISO/IEEE 11073 standard which aims to realise a telemedical observation of the patient's temperature.

2. Methods

The communication model of the RFID/Bluetooth thermometer, shown in *Figure 1*, gives an overview of all necessary parts for developing a telemedical solution for temperature measurement based on the ISO/IEEE 11073 standard.

1… The patient wears a passive RFID- wristlet including a unique ID of the patient.

2… The RFID/Bluetooth module of the medical devices is able to read out passive RFID- tags as well as to communicate with external computer systems (Managers). Therefore the patient's RFID is scanned, the temperature is measured and finally the acquired data is sent to the manager.

3… The manager which can include a database, administers the received data record. In addition, the manager has the possibility to send back the name, specific to the patient's ID, to the medical device which then can be displayed.

The realisation of data communication is based on the ISO/IEEE 11073-10408 device specialisation–thermometer which defines the association procedure, device configuration exchange, data event report, data event confirmation and association release procedure of this medical device.

For transfering the patient's name to the thermometer as well as to synchronise the absolute time value between manager and thermometer the comunication rules of the device specialization are extended by the SET service out of the ISO/IEEE 11073-10201–domain information model.

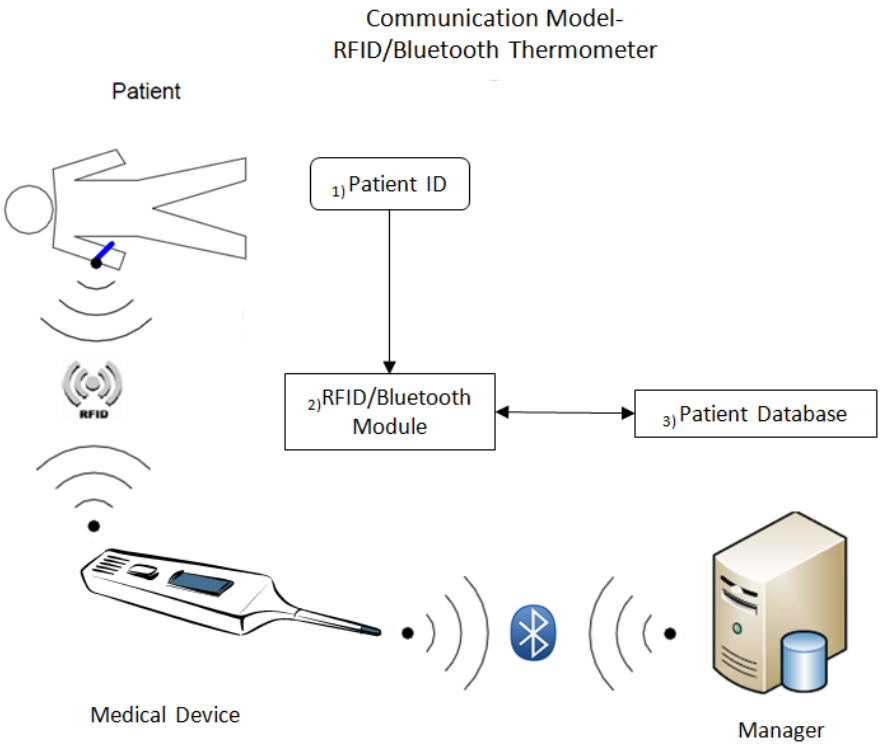

Figure 1: Communication model for exchanging relevant data concerning temperature measurement

3. Results

A thermometer prototype including an RFID-reader and a Bluetooth module was developed for the purpose of telemedical measurement of a patient's temperature. Further this prototype has an integrated display and a wireless charge unit based on an inductive electric power supply. It also has two operating buttons and an acoustic indicator.

1… The RFID-reader is a SKYETEK™ M1- MINI module based on the ISO 15693 standard for an operating frequency of 13,56MHz. The scanning range is about 5cm.

2… For Bluetooth support a LMX9838 Bluetooth serial port module class II from National Semiconductor™ is used. Its operating distance is approximately 10 meters.

3… The display is a monochrome Organic Emitting Diode (OLED) – display with a resolution of 128x32 pixels.

4… The battery is a rechargeable lithium ion accumulator with a nominal voltage of 3.7V and a capacity of 180mAh. It has to be recharged after 3 hours of intensive use.

5… The inductive electric power supply charges the battery with a charging voltage of 4.1V and a charging current of 100mA.

6… The temperature sensor consists of a PT-1000 sensor element with a measuring range of -50°C to 205°C.

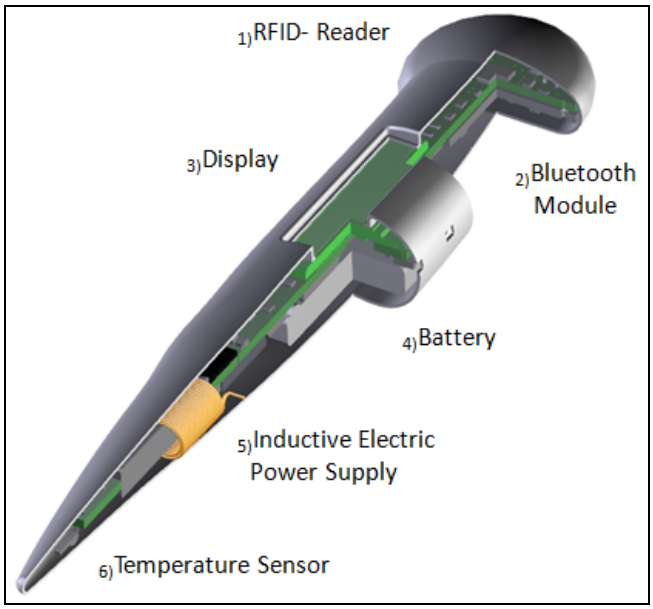

Figure 2: Model of the RFID/ Bluetooth Thermometer prototype

Additionally, a software application for the thermometer was developed and implemented which has been user- optimised for easy applicability. This application supports the main elements of the medical device:

- Temperature measurement
- RFID- reading for patient identification
- Data record storage and transmission to the manager
- Operating mode display for acquired data, status reports and menu control

Further the project realised the data exchange based on the IEEE 11073 standard, where the thermometer is able to receive a patient's name according to the already transmitted RFID and show it on the display. In addition, the time of the thermometer is automatically synchronised by the manager.

The temperature measurement itself takes only 5 to 10 seconds whereas the RFID- scanning is immediately done, if the tag is positioned in front of the reader within a range of up to 5cm.

Final tests showed that identifying a patient via passive RFID- tag, measuring his temperature and transmitting the acquired data to the manager can be easily done within 30 seconds when positioned in operating range to the manager.

4. Discussion

The development of the thermometer combines all necessary technical standards for providing a solution for clinical usage in hospitals as well as for homecare. Therefore it fits the medical requirements concerning patient identification, temperature measurement and wireless data transfer, and assures the interoperability with different computer systems supporting the ISO/IEEE 11073 standard.

Correct identification of patients is the basic principle for patient safety in health care. Risks in mixing up patient names and interchanging diagnostic findings, medical laboratory values or wrong administration of pharmaceuticals which leads to errors in treatment, can be reduced by using RFID technology [3]. Therefore the supported RFID- scanning function of the thermometer guarantees a unique patient identification for data mistake minimisation. Further it assists the user (physicians, nursing staff and home care user) in verifying the right patient by showing the patient's name on the medical device's display, when connected to an external medical database.

The Continua Health Alliance affirms in its publication of an interoperable personal healthcare ecosystem that such a personal telehealth system will require interoperability based on transport independent personal- health data and protocol standards. Further it is the task of Bluetooth to wireless transport data between medical, health, and fitness devices and systems that can aggregate and perform operations on device data (such data could be from cellular phones, health appliances, or PCs) [2]. Supporting these requirements the thermometer can be easily used in the homecare in connection with personal mobile phones or home PCs to transmit the acquired data to external medical observation establishments. Therefore the straightforward temperature data provision in homecare is a major advantage for telemedical monitoring and adjusted medical treatment of patients.

Even though the thermometer can be also used in the medical field of homecare it is to question if the integrated RFID- scanner makes that much sense, because normally people at home do not wear an RFID wristlet. Therefore a different solution to identify a person and its specific data has to be evaluated. In addition, one still needs at least a mobile phone with Bluetooth support to transmit temperature data for instance to a residential doctor who has to provide a temperature recording service for his patients.

So far the thermometer has limited Bluetooth range. Therefore a nearby PC station in a hospital is needed to transfer data for requesting the patient name and sending the measurement data. Concerning the workflow in a ward of a hospital the device could be easily integrated in computer based patient record systems like computers on wheels which will be preferably used by nurses and physicians in hospitals [1]. According to the possibility of measuring several patients' temperature and storing the acquired data in the medical device it could also work fine with fixed computer stations by scanning and measuring several patients and storing the data meanwhile in the medical device. After having finished the mobile procedure, the acquired data of all measured patients can be transferred to a fixed computer station at once. This variant is more user-friendly but it provides no real- time identification of the patient and can only be verified when connected to a computer later on.

The short procedure of identifying and measuring a patient, and the compact design with a wireless charge supply for easy disinfection makes a quick reuse of the device possible. Therefore it is time-saving which can be beneficial for medical staff and their workflow in hospitals as well.

In the future it also might be possible to combine a time schedule out of the HIS with the thermometer, where health personnel is able to find the next date and time on the device's display when to measure a certain patients' temperature again by scanning the RFID-wristlet.

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Corresponding Author
Mark Bittermann
University of Applied Sciences Technikum Wien, Department of Biomedical Engineering
Höchstädtplatz 5, A- 1200 Vienna
Email: mark.bittermann@chello.at