Current Near Field Communication (NFC) Trends in Medical Sector

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Abstract

NFC (Near Field Communication) is a recently growing technology for communications to be done in short range aimed to augment existing near field technologies such as RFID (Radio Frequency Identification).This paper covers the important details of this technology, its advantages and the feasibility of its usability in this highly-regulated area. Using a NFC enabled mobile phone; the user interacts with different tags to get the required services in a very easy way. The physical closeness that NFC requires guarantees the reduced chance of a human error and, by the ease of instructions, allows doctors, nurses and even patients to monitor the health conditions as well as up to date corrected data acquisition. This paper explains that how NFC has become an important and effective technology in medical applications with the help of recent work that has been done by various researchers.

1. Introduction

Near field communication (NFC) is a wireless technology operating in the short range of four to ten centimeters for communication. It is based on radio frequency identification (RFID) technology. For a communication, an NFC device generates a radio frequency in 13.56 MHz spectrum. A receiver could receive the data through the principle of magnetic inductive coupling if it lies in a close proximity. Transmitter and receiver are small chipsets which are able to be embedded in devices such as mobile phones, POS (Point Of Sale).

NFC has evolved from the earlier near-field RFID contactless identification and interconnection technologies such as ISO14443, MIFARE and FeliCa. An NFC device can communicate with another NFC enabled device or communicate with an RFID/NFC tag. All tags have a 4 to 10 byte-long unique ID number within a range of manufacturer and technology that can effectively be used to identify the tag when used. Collisions may occur with multiple manufacturers. NFC-enabled devices are capable of bidirectional communication with each other, as defined in the NFC-IP1 standard

The communication is based on magnetic inductive coupling. A reader creates alternating current through a coil, which is incorporated in a smaller tag. An alternating magnetic field is created and a voltage will appear across the tag.

In March 2004, a new interconnection technology, Near Field Communication (NFC), was launched by Sony, Philips and Nokia, by the establishment of the NFC Forum [3a]. The NFC Forum is a non-profit industry association for advancing the use of NFC short-range wireless interaction in consumer electronics, mobile devices and PCs. The NFC Forum will promote the implementation and standardization of NFC technology to ensure interoperability between devices and services. The total number of NFC enabled devices is increasing rapidly worldwide as shown in figure 1.

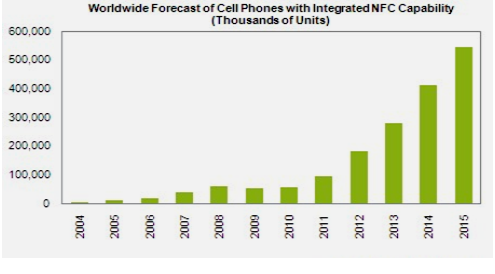

Fig.1. Worldwide forecast of mobile phones with integrated NFC

The Three Modes of NFC

- **Card Emulation mode:** An NFC device in card emulation mode can replace a contactless card or tag. This will enable NFC devices to be used with existing contactless card infrastructure in applications such as ticketing, access control and payments.
- **Reader/Writer mode:** NFC enabled devices are able to read and write to NFC and many contactless cards. For example, if a NFC tag is attached to a poster, the NFC Smartphone can "tap" the tag to access the information stored in the tag (e.g. coupons, maps, product information, etc) easy and conveniently.
- **Peer to Peer mode:** Peer to peer mode enables two NFC devices to share data between them. In this case, the NFC is used to negotiate the optimal communication protocol and transfer authentication data for the secondary protocol. The file or data is then sent over the high capacity protocol (i.e. Bluetooth, Wi-Fi, etc).

Medication errors lead to significant clinical and financial consequences. Recent literature in health care quality and safety reveals a crucial statistic regarding preventable medication errors. The U.S. Institute of Medicine reported an estimated 44,000 to 98,000 hospital deaths per year are caused by preventable medication errors. Similarly, the Canadian Adverse Events Study reported an estimated 70,000 preventable medication errors, causing 9,250 to 23,750 deaths annually [24]. Medication care includes several stages where misidentification can be fatal.

Types of errors

Following types of errors were identified in their study: [5]

1) Giving inappropriate dose of medicine;
2) Wrong time of supervision of medication;
3) If IV rate is very fast;
4) Incorrect route of administration;
5) Wrong medication administered;
6) Wrong medications given because of misidentifying a patient

2. NFC IN MEDICAL

NFC has become the prior choice for wireless communicating between two medical devices taking consideration of security also. The data size output by medical devices is normally within the capability of NFC to transmit without any undue delay, so it can easily suit the profile for a wireless channel for medical devices. Even if there is a need for data transmission rates going over its limits, the NFC protocol can be used as a validation procedure. There are many medical use cases, like implanted devices which remain in the body for number of years, and have to be highly energy efficient and save as much power as possible.

Healthcare is experiencing a growth of mobile to mobile interaction and linkage in its medical devices. As these devices become smart and interconnected, there will be an increasing demand for data transfer between devices which are present outside the body and inside the body.

NFC brings mobility and adaptability to a variety of medical devices and is perfectly suited for home-based disease monitoring systems. NFC is very easy to understand for older patients, making it easier for acceptance and usage.

Since NFC in its passive form acts RFID tag, it can be used to keep tabs on pill boxes, blisters and other drug dispensing solutions. This property has good scope for compliance monitoring, and anti counterfeiting measures especially for the elderly and for pharmaceutical companies doing clinical trials.

The benefits of NFC are not limited to implantable devices only but also for large devices which are used for In Vitro Diagnostics (IVD), imaging, molecular diagnostics and other applications.

NFC services in medical environments

There are two kinds of applications of NFC in medical environments [10]

a) External applications to the human body: NFC device is used to management of HER (Electronic Health Record), to set up medical devices, to query the medicines that patient needs, taking patient's vital signs and checking that diets and medicines are provided as indicated in the patient's ERR So hospital staffs tasks can be speeded up.

b) Internal applications to the human body (implants): NFC as passive RFID to communicate with implanted devices wireless, and in addition to avoid the use of internal battery power and can be used the properties of electromagnetic induction of passive RFID to recharge batteries without surgery. NFC communication with implanted devices can be for collecting data, setting up parameters and Power supply and recharge batteries.

Potential applications of implanted NFC for stimulation include: [2]

- Direct improvement of chronic pain through the use of spinal chord stimulus
- Reduction of Parkinson's disease symptoms through the use of deep brain stimulation
- The prevention of too much eating by gastric stimulation that creates a feeling of satiation
- Improvement of diabetic gastro paresis through the use of high frequency stimulation

Figure 2 below is showing some medical applications like Diabetes check up, temperature sensor and other health monitoring parameters.

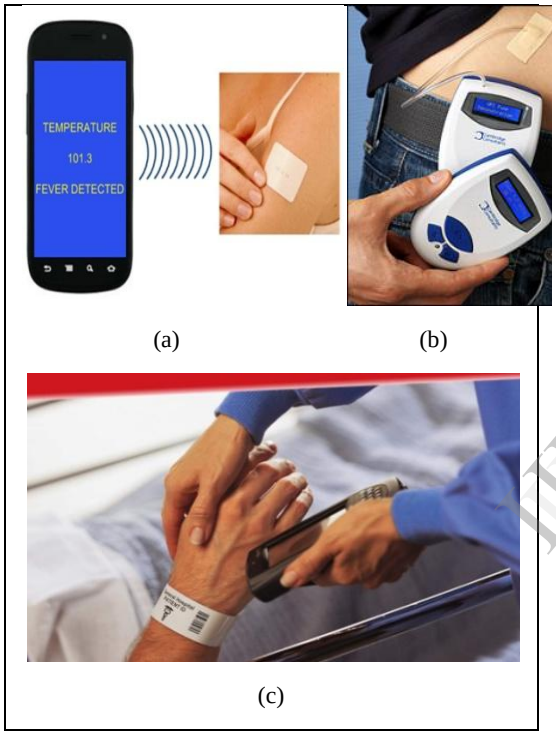

Fig.2. Some medical applications using NF

3. RELATED RESEARCH

In [1], Practices are proposed to apply NFC to some health monitoring applications and study the benefits that are attainable with NFC and also comparison is done between NFC and other short-range communication technologies such as Bluetooth and IrDA. The potential of the emerging infrastructure external computers that potentially have larger power budgets to provide convenient and low cost power distribution is considered [2]. An EDC system featuring mobile phone-based data acquisition was developed and utilized to assess the feasibility of using a new IMD in a clinical environment. The EDC system was in use for a period of 77 days at the Department of Internal Medicine - Division of Cardiology of the Medical University of Graz [3]. The telemetry assists a smart pill swallowed by human being to trigger an actuator for drug delivery, record temperature, or perform diagnostic task inside the body [4]. The smart pill includes 32bit processor, 16 Kbyte memory, temperature sensor, telemetry unit, and additional external peripheries. Figure 3 shows how RFID could be used in medication care combined with the electronic patient record and a data system**.** Today there are greater and greater expectations about technological adaptability in health care scenarios. The patient's wrist tag contains information about patient identification, along with treatments, diets, and dates of blood and/or urine tests, patient monitoring and the contraindications of the medication. Here Tagging for Nursing Care is proposed. [5] .

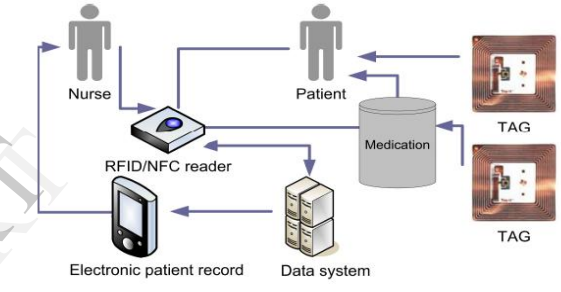

Fig. 3. Using RFID/NFC in medicine care combined with electronic patient record

In [6], a novel system using NFC is presented to increase support and encouragement of outdoor physical activity, or 'Green Exercise'. The main aim of the project is to help population which is leading to increasing health problems. A navigation system is developed that supports the independent walking of the visually impaired in the indoor space [7]. To provide physicians, nurses and clinical researchers with an adequate solution for acquiring research data within a clinical environment an ICT system was developed in [8]. Various security problems in NFC and some solutions for them are shown in [9]. Desirable characteristics of safety are defined that must be accomplished with cryptographic SIM cards and other technologies, to make this a safe and suitable technology for the medical world. A system is presented in [11] using NFC-enabled mobile phones for facilitating the tracking and care of patients in a low-resource environment. Patients enrolled in the study will wear or carry an NFC bracelet or anklet (in the form of a traditional amulet) or an NFC card, which the physician will scan with a cell phone during a medical encounter. A drugs checker based on Internet of things

and a knowledge-based system is proposed to detect ADRs and allergy interactions [12] because The incidence of serious and fatal Adverse Drugs Reaction (ADR) and harmful effects of pharmaceutical cases in worldwide hospitals is extremely high. An algorithm is presented in which small operating distance inherently introduces a close coupling between a node's physical presence and its logical certificate. Important advantage is drawn from the hierarchical architecture of typical MSNs[13].In [14], A system is developed based on NFC technology and touching interaction (as a complement) to help nursing students to perform patient care tasks with simple interactions, including medication administration, clinical tests, and vital signs supervision among other. Typical tasks of a hospital routine are:

- *Medication management*. A nurse has to administer some medicaments to patients.
- *Medical tests and samples*. For example an X-ray test, blood test and others.
- *Taking essential signs*. For example, taking blood pressure or temperature, among others.

A solution to the problem of tedious and time consuming task in data collection from patients by using NFC is proposed along with wireless sensors and android applications. Medical assistants would simply use NFC enabled devices to collect the data from patients only touching or getting it closer to patient's NFC enabled device[15]. Electronic data capture prototype called inSERT has been designed that allows quick and easy self-reporting for patients in [16]. The work presents the integration of a clinical device with continuous data transmission requirements in NFC technology [17]. A parametric modeling technique for a fast polynomial extraction (FPE) of the physically relevant network parameters of inductively coupled radio frequency identification / near field communication (RFID/NFC) antennas is presented [18]. An innovative wearable, partially self-powered, health monitoring and indoor localization shoe-mounted sensor module is presented in [19]. A mobile ward round system based on open EHR for the use on smartphones and tablet computers using the Android platform which integrates and uses NFC to explore new ways of computer interaction, data processing and workflows in the medical world [20].Like in figure 4, Smart phone is receiving data from ECG directly using NFC technology.

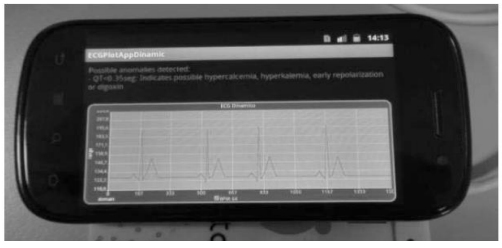

Fig.4. Google Nexas S receiving data from ECG via NFC

A novel solution using a smartphone integrated with an NFC reader and an NFC application is given in [21] to detect and update drug allergies and drug interactions for people with multi morbidity during medication administration like in figure 5. Another technical concept is presented to develop innovative medication services for patients based on NFC enabled smart mobile devices [22].

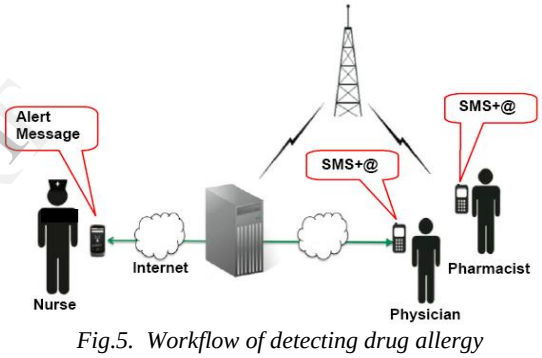

Fig.5. Workflow of detecting drug allergy

A proposal is given to enable patients getting prescriptions from home, avoiding going to the health-care center. With the aim of achieving a natural user interaction, something necessary because of the physical and mental limitations of care-dependent people [23].

SOME MEDICAL USE CASES

The possible areas include monitoring and management of home-based care. Monitoring systems can be applied for a variety of chronic diseases like diabetes, hypertension, cardiac diseases (infarctions, heart failure, arrhythmias and other rhythm abnormalities), pulmonary diseases like asthma and COPD, and neurological abnormalities like seizures, chronic renal failure, etc.

Ergonomi design : A biometric device called "MiniME" developed by Ergonomi design monitors various vital parameters like ECG, blood pressure, heart rate, pulse oximetry, body temperature, blood

glucose, cholesterol, hemoglobin and prothrombin time, and transmits the data using NFC to the cloud. [26]

Impak Health: Another company working in this area which is involved in home-based cardiac, pulmonary and sleep monitoring. They have incorporated NFC in devices such as "RhythmTrack" that tracks a person‟s ECG, and "SleepTrack," which tracks the sleep cycle and duration. Similarly, FITBIT – a fitness monitoring company – has incorporporated NFC for transferring details like calories burned, number of steps taken and other details from a wristband to the user‟s smartphone which houses a user-friendly application. [27]

Gentag: a company specializing in mobile health, is using NFC to transfer data from devices ranging from diagnostic assays to skin patches. [28]

Nedap: a Netherlands-based security and identification specialist has rolled out 50,000 NFC phones for nurses. They are used for recording home visits for the elderly [29]. A similar phenomenon is seen in France too [30].

The Sony Corporation: Made an NFC Healthcare Library which makes possible the communication between healthcare products embedded with the NFC Dynamic Tag and healthcare applications installed on smartphones.[31]

Other companies: like Qolpac and Identive WPG have brought NFC into the mainstream with uses ranging from medication compliance to X-ray image sharing [32,33].

CONCLUSION

NFC is a capable technology. There are many features of NFC which give it a different advantage for use in medical device applications. NFC is essentially more secure and consumes less battery than other comparable wireless technologies. Therefore, NFC is becoming more accepted and is being largely used in the medical device domain. Accelerated adoption of NFC in medical sector is predicted where this technology will help enhancing the security levels and simplicity and easiness of data transmission between medical devices.

10. References

[1] NFC Forum web site. http://www.nfc-forum.org/
[2] E.Strömmer et al. "Application of Near Field Communication for Health Monitoring in Daily Life" Proceedings of the 28th IEEE EMBS Annual International Conferenc New York City, USA, Aug 30-Sept 3, 2006, pp-3246-3249
[3] E. Freudenthal et al. "Suitability of NFC for Medical Device Communication and Power Delivery", Engineering in Medicine and Biology Workshop, 2007 IEEE Dallas , pp. 51 - 54 , 2007
[4] J.Morak et al. "Electronic Data Capture Platform for Clinical Research based on Mobile Phones and Near Field Communication Technology", 30th Annual International IEEE EMBS Conference Vancouver, British Columbia, Canada, , 2008,pp-5334-5337, August
[5] N.Fawaz and D.Jansen," Enhanced Telemetry System using CP-QPSK Band Pass Modulation Technique Suitable for Smart Pill Medical Application", Wireless Days, 2008. WD '08. 1st IFIP , pp. 1 – 5, 2008
[6] A.Lahtela et al. "RFID and NFC in Healthcare: Safety of Hospitals Medication Care", Pervasive Computing Technologies for Healthcare, 2008. Pervasive Health 2008. Second International Conference, pp. 241 - 244 , 2008, Finland
[7] J. Bravo, R. Hervás et al. "Tagging for Nursing Care", Pervasive Computing Technologies for Healthcare, 2008. PervasiveHealth. Second International Conference, 2008 , pp. 305 - 307 , 2008
[8] O.Rashid et al, "Using NFC to Support and Encourage Green Exercise", Pervasive Computing Technologies for Healthcare, 2008. PervasiveHealth 2008. Second International Conference , pp. 214 – 217, 2008
[9] T. Seto and K. Magatani," A navigation system for the visually impaired using colored navigation lines and RFID tags", 31st Annual International Conference of the IEEE EMBS Minneapolis, Minnesota, USA, pp.2-6, September 2009
[10]]J. Morak et al. , "Near Field Communication technology as the key for data acquisition in clinical research", 2009 First International Workshop on Near Field Communication, pp. 15 - 19 , 2009
[11] A.J. Jara et al. "Secure use of NFC in medical environments" RFID Systems and Technologies (RFID SysTech), 2009 5th European Workshop, pp. 1 – 8, 2009
[12] A.Marcus et al.," Using NFC-enabled Mobile Phones for Public Health in Developing

Countries", Near Field Communication, 2009. NFC '09. First International Workshop, pp. 30 – 35, 2009

[13] A.J. Jara et al. "A Pharmaceutical Intelligent Information System to Detect Allergies and Adverse Drugs Reactions based on Internet of Things", Pervasive Computing and Communications Workshops (PERCOM Workshops), 2010 8th IEEE International Conference , Ypp. 809 – 812, 2010

[14] J.Fontecha et al.," An NFC Approach for Nursing Care Training", Near Field Communication (NFC), 2011 3rd International Workshop, pp. 38 - 43 , 2011

[15] H.Zhang and J. Li," NFC in Medical Applications with Wireless Sensors", Electrical and Control Engineering (ICECE), 2011 International Conference, pp. 718 – 721, 2011

[16] A. Prinz et al. ," inSERT – An NFC-based Self Reporting Questionnaire for Patients with impaired fine motor skills", Near Field Communication (NFC), 2011 3rd International Workshop, pp. 26 – 31, 2011

[17] J. Jara et al. ," Interaction of patients with breathing problems through NFC in Ambient Assisted Living environments", Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), 2012 Sixth International Conference, pp. 892 – 897, 2012

[18] R.Kazemzadeh1 et al. ," Efficient Network Modeling of Inductively Coupled NFC Antennas in Medical Wireless Sensor Applications", Signals, Systems, and Electronics (ISSSE), 2012 International Symposium, pp. 1 – 6, 2012

[19] A. Mariotti et al. "An IPv6-enabled Wireless Shoe-Mounted Platform for Health-monitoring", Wireless Sensors and Sensor Networks (WiSNet), 2013 IEEE Topical Conference, pp. 46 – 48, 2013

[20] H.Köstinger et al. "D,eveloping a NFC Based Patient Identification and Ward Round System for Mobile Devices Using the Android Platform", Point-of-Care Healthcare Technologies (PHT), 2013 IEEE, pp. 176 – 179, 2013

[21] M. Alabdulhafith, Raghav V. Sampangi, Srinivas Sampalli, "NFC-Enabled Smartphone Application for Drug Interaction and Drug Allergy Detection", Near Field Communication (NFC), 2013 5th International Workshop, pp. 1 – 6, 2013

[22] T.Engel et al. "A NFC-based Concept for Medication Related Patient Services", Smart Objects, Systems and Technologies (SmartSysTech), Proceedings of 2013 European Conference, pp. 1 – 10, 2013

[23] M. Vergara et al. "Mobile Prescription: an NFC-based proposal for AAL", Near Field Communication (NFC), 2010 Second International Workshop, pp. 27 - 32 , 2010

[24] A. Kollmann, P. Kastner, G. Schreier. "Utilizing mobile phones as patient terminal in managing chronic diseases, " In: LA. Hakim, editors. Web Mobile-Based Application for Healthcare Management. Idea Group Inc, pp. 227-257, 2007

[25] J. Morak, A. Kollmann, G. Schreier. "Feasibility and Usability of a Home Monitoring Concept based on Mobile Phones and Near Field Communication (NFC) Technology, In: Kuhn K et al. (Ed). Proceedings of Medinfo. IOS Press, pp. 112-116, 2007

[26] The World‟s Most Personalised Medical Device" Ergonomidesign. Retrieved on 15th March 2013 from http://www.ergonomidesign.se/CASES/InteractionDesign/miniMe-Personalised-Medical-Device-of-the-Future.aspx

[27] FitBit Flex. Retrieved on 15th March 2013 from http://www.fitbit.com/flex

[28] Gentag Applications. Retrieved on 15th March 2013 from http://www.gentag.com/applications.html

[29] "50,000 Dutch nurses now using NFC phones". By Sarah Clark. Publsihed in the NFC World. Retrieved on 15th March 2013 from http://www.nfcworld.com/2011/09/06/39716/50000-dutch-nurses-now-using-nfc-phones/

[30] "French carers to use NFC". By Mike Clark. Published in the NFC World. Retrieved on 15th March 2013 from http://www.nfcworld.com/2012/11/12/321066/french-carers-to-use-nfc/

[31] Sony Felica in Use in Healthcare Devices Retrieved on 15th March 2013 from http://www.sony.net/Products/felica/casestudy/healthcare.html

[32] Qolpac Products. Retrieved on 15th March 2013 from http://www.qolpac.com/what-we-do.html

[33] Identive and WPG Americas Team to Deliver NFC Pairing Solution for Transferring Medical X-Rays". Retrieved on 15th March 2013 from http://www.identive-group.com/en/updates-and-news