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NFC for Public

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Abstract:
One of the largest IT challenges in the health and medical fields is the ability to track large numbers of patients and materials. As mobile phone availability becomes ubiquitous around the world, the use of Near Field Communication (NFC) with mobile phones is emerging as a promising solution to this challenge. The decreasing price and increasing availability of mobile phones and NFC allows us to apply these to developing countries in order to overcome patient identification and disease surveillance limitations, and permit improvements in data quality, patient referral and emergency response. In this paper, we present a generalizable system using NFC-enabled mobile phones which has been designed to address the needs of a project that tracks and cares for patients.

1. Introduction

There are several challenges, including the absence of a reliable method for patient identification or capturing illness. The inability to record visits or a brief medical history precludes continuity of care, not only as patients move across providers but frequently at the same clinic or hospital. Patients can be observed carrying old prescriptions, laboratory test results, and radiographs, and the information in these is not easily accessible and is often ignored. Additionally, since health care centers are understaffed, providers often see a large number of patients in a short period of time, and may not have the time to counsel or refer patients appropriately.

We have developed tools which utilize NFC-capable mobile phones to allow electronic patient identification and tracking across multiple providers.

These tools allow patients to be identified by a unique RFID tag on their person when they visit a clinic. By using a cell phone to send a patient ID and diagnosis to a central server, the physician will be able to report disease in real time. If disease is diagnosed, a mobile team is alerted to pick up the sick patient for further evaluation and treatment. In presenting these tools, we note that although we focus on a particular application for this paper, the general system architecture design can be extended to many other applications in public health and other areas.

2. How NFC Can Be Used To Solve The Problem

Our paper proposes to create a fully electronic system to reduce the tracking system's current dependence on humans and expedite the overall surveillance process. We propose a mobile phone- and NFC-based patient presence alert system which identifies infants participating in the study. 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. Consequently, the study participant will be identified and the physician will be prompted to select the patient's diagnosis on the cell phone. The selection of a positive diagnosis by the physician will then alert a specialized mobile team to dispatch to the patient's location for further study and treatment.

3. Goals of the Technical Implementation

The ultimate goal of our technical solution is to provide 100% accurate automatic identification of a participating infant once that infant enters a clinic.There are several cost and design constraints that bar us from initially implementing this goal by means of automatic identification, and our initial design goal is to provide 100% accurate identification that is not automatic, but requires minimal physician and patient interaction.

Our initial solution is modular in how the participant is identified to allow for several identification methods to be added in the future. We have built a low-cost option, which will use an RFID reader that is embedded in the phone to identify the patient. Passive RFID technology will require human initiative to identify study participants, but will allow us to test the remainder of the system and stay within the cost constraints of the design.

4. System Design

The system architecture can be seen in Figure 1. It features two components: a cell phone and a centralized web server. For the cellphone component, we use the NFC running a J2ME midlet. The implementation allows the user to scan a passive NFC tag that has previously had a patient ID written to it by a process that will be described later. The NFC tags that we use have the form factor of a business card. The tags themselves are small enough to fit on a bracelet for the eventual implementation.

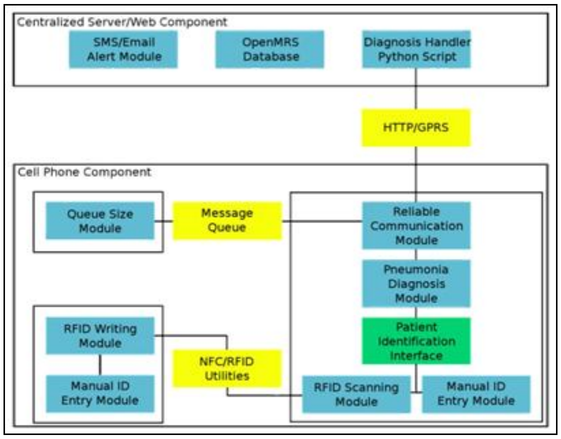

Figure 1

5. User Interface

Figure 2: The physician is presented with the option to scan an NFC tag or enter a patient ID manually

We now present a walkthrough of the user interface presented to the physician diagnosing a patient in the study.

The first the phone asks the doctor to scan an NFC tag using the NFC module on the phone. Note that if a new patient enters the study, the doctor has the option of writing a new card for the patient using the phone. There is also an option to enter the patient's ID manually, which is prone to human error, but required since a patient may lose their tag, or have a broken tag.

If the doctor elects to scan a card, he or she is prompted to place the phone to the card.The diagnosis interface allows the doctor to select the diagnosis of a patient. This is step 2 of the architecture diagram. Once the doctor enters the diagnosis, he or she is prompted to send the diagnosis over a GPRS connection by way of the HTTP protocol. The system sends a request to the web server which takes the patient ID, diagnosis, and the location of the phone. The communication with the HTTP server may be encrypted over SSL to protect sensitive patient information (although in reality, an adversary spying on the communication would only receive the patient's integer identifier and diagnosis with no other identifying information). In order to ensure that the entry is legitimate, further protection can be provided with public/private key encryption, so that the doctor's identity can be verified at the central server.

One implementation hurdle of the system is that HTTP over GPRS is unreliable, and we have seen diagnosis messages hang or be dropped. To ensure reliable delivery, and to avoid locking the doctor's screen while the transmission (which may take several seconds) is processed, we instead utilize the J2ME records system to create a record for each diagnosis, which is safely and transparently written to the local file system of the phone. A background thread will be woken up when a new record is added to the file system, and will loop continuously until a successful response is confirmed by the HTTP GET.

In this way, all messages will be sent as soon as a connection allows, and the doctor will not be forced to wait while transmitting the message. We also have a version of the midlet which uses SMS to send the data from the phone to the central server.

Figure 3: A bracelet with an NFC tag

6. Discussion: Metrics, Limitations, Foreseeable Problems, And The Future

6.1. Metrics for Success

The following outcome measurements would be interesting to pursue in order to assess the utility of this technology.

- **Accuracy:** Use a special team of health workers along a specific and limited geographic area for some time todetermine how many false positives and negatives exist. Moreover, we can compare the accuracy of this study to that of previous studies (pre-test vs. post-test).
- **Speed**. Did the time employed to report sick patients, assist sick patients, and the time of the study as a whole improve with the use of the technology?
- **Human Resources**. Did the usage of the technology decrease the need of human resources for tracking and assessing patients, as compared to previous methods?
- **Cell phone breakdowns**. Diagnosis would be stalled any time the cell phone fails to operate, so keeping track of the total number of instances of when the cell phone breaks down (measured by the number of times the physician calls for help) would help measure the robustness of the technology.
- **NFC tag breakdowns**. How often do bracelets need to be replaced? The number of times NFC tags get damaged, measured by the number of times bracelets need to be replaced, would be another measurement of the technology's durability.
- **Medical issues with bracelets**. How many clinic visits are due to bracelet-related concerns? The introduction of any extraneous medical issues (e.g. rashes) by the NFC bracelets would call for the need to rethink the use of the NFC system or the form factor of the bracelet.

6.2. Other uses of the technology

Aside from tracking patients more efficiently, this tech-nology could and should also be used for the collection of statistics that show how often disease occurs, which in turn helps to identify disease trends, track disease outbreaks, and help control future outbreaks. Similarly, the same platform could be used to report outbreaks of any other reportable diseases with public health importance.

Additionally, the technology could be used for other epidemiological studies or clinical trials that need to keep track of participants using an inexpensive but efficient method.There are many other areas in healthcare where this technology could be useful. RFID could be used for safer blood transfusions. This high-risk procedure requires healthcare staff to read blood and patient labels several times in order to check that the correct blood is given to a patient. As distraction and errors are common in stressful situations, frequent automated ID checks would be useful.

Similarly, administering medications to pediatric or adult patients during surgery or in intensive care units (where patients are usually sedated and/or intubated and cannot respond to questions) could be much safer if patients had RFID bracelets. They can help alert the nurse in case the wrong medication is administered.

Surgical intervention is another area where this technology could be utilized. It could help reduce the unfortunate but common problem of wrong-site surgery. Finally, RFID bracelets could be used to avoid newborns being abducted or switched during their hospital stay.

7 . Conclusion

We have presented an NFC-based mobile medical patient tracking and diagnosis system. While each of the components have been presented individually before, we feel that the combination of these technologies, and its being designed for use within a developing nation. As prices for mobile phones equipped with NFC readers and writers come down, more such applications will come to light, reducing medical spending, avoiding human error, increasing medical team response times, and improving information flow in previously information-poor environments.

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