Active RFID-Based Smart Interruption Handling and Information Retrieval

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Problem

Hospital physicians are frequently interrupted in their work. Current interruption methods are unintelligent because they don't take into account the status of the physician. Methods are needed for routing phone calls, lab test results, and other interruptions based on the availability of the physician and her priorities.

Research Goal

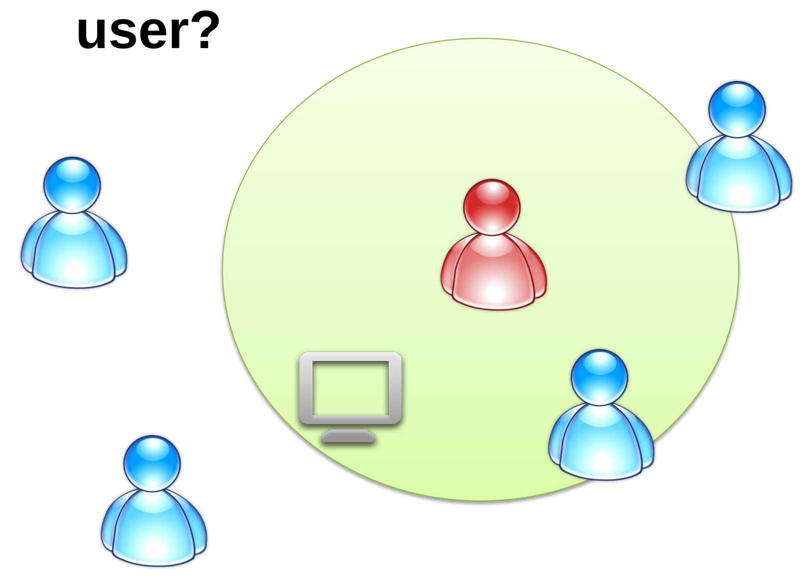
How to help users retrieve information and handle interruptions based on their current activities which are inferred from proximity information detected using Active-RFID equipped smartphones?

Approach

Active-RFID equipped smartphones are able to provide proximity information of a user and other objects in the surrounding environment.

The proximity information can then be analyzed to infer a user's current activity. For instance, if a user has been close to a workstation for a period of time, it might indicate that the user is performing some task on the workstation.

Who and what are around the user?



Our Solution

We proposed a context-aware solution based on a proximity detection system built from an Android smartphone and a simple Active-RFID system. With the proximity information detected from the RFID sensor, the smartphone is able to carry out some context-aware applications to help physicians handle interruptions as well retrieve information more intelligently.

Nexus One android smartphone.

Ananiah Electronics's RF8315R Active RFID reader

Ananiah Electronics's RF8315T tags.

Solution Overview

In our solution, a user will carry the smartphone with a Active-RFID sensor connected. Objects of high interests such as patients, other hospital workers, workstations and etc. will have the RFID tags attached.

We choose Nexus One Android smartphones for our project as the openness of the platform allows us to customize Linux kernel to enable serial port on Nexus One. A RFID reader is connected to the phone via serial connection (TTL level). Of course, it's also possible to use a bluetooth connection.

Active-RFID tags and readers from Ananiah Electronics are chosen for our system. The tags can emit their unique IDs at 2/3 of a second. The readers can report up to 160 IDs along with their RSS values at a time and have a maximum reading distance of 14 meters.

To smooth the raw RSS data, we implemented two RSS filters: a low pass filter and a median filter. at software level and tested both of them. The result shows that the low pass filter provides much better noise reduction, which produces more stable RSS values. The comparison between the two filters is presented in figure 1.

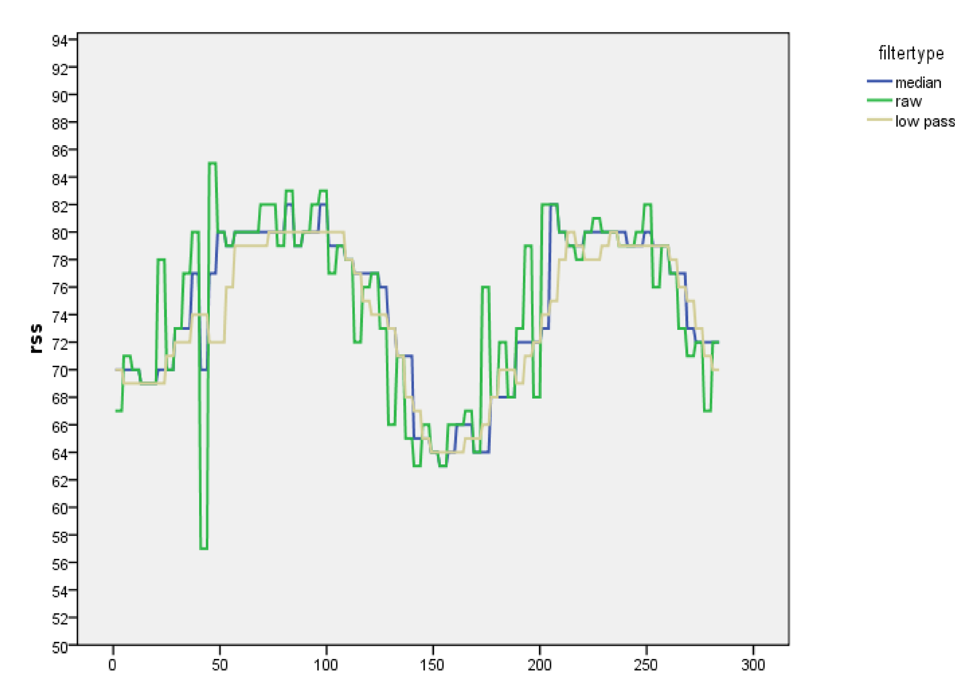


Figure 1

Hardware Performance

Two benchmark tests have been conducted to verify that the system we built can provide reliable proximity information of a user.

The first test is to verify that our system is able to reliably detect changes in RSS values resulted from the changes in distance between tags and readers (figure 2). This is essential to proximity detection.

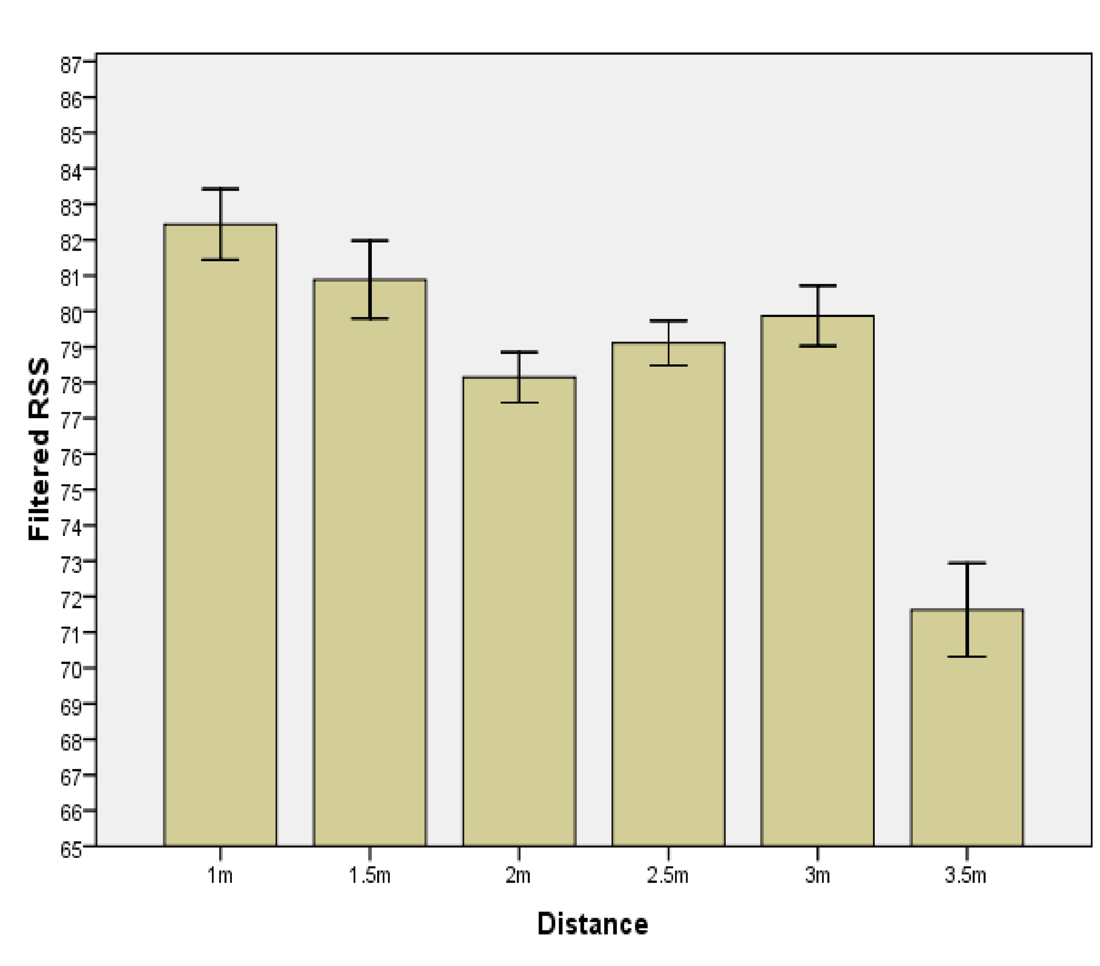


Figure 2

Our system is able to show that weaker RSS is related to increased distance between the tags and the reader. Although RSS values at 2.5m and 3m are higher than the values at 2m due to possible radio bouncing, multi-path issues, the system is able to report accurately for distance below 2m, which is good enough for our application.

The second test is to verify that our system is able to reliably detect RSS values when a user is moving around in a small, multi-tag (4 tags in a 3mx4m room) environment. As the user visit each tag one after another, the system managed to detect the tag that is being visited each time. (figure 3)

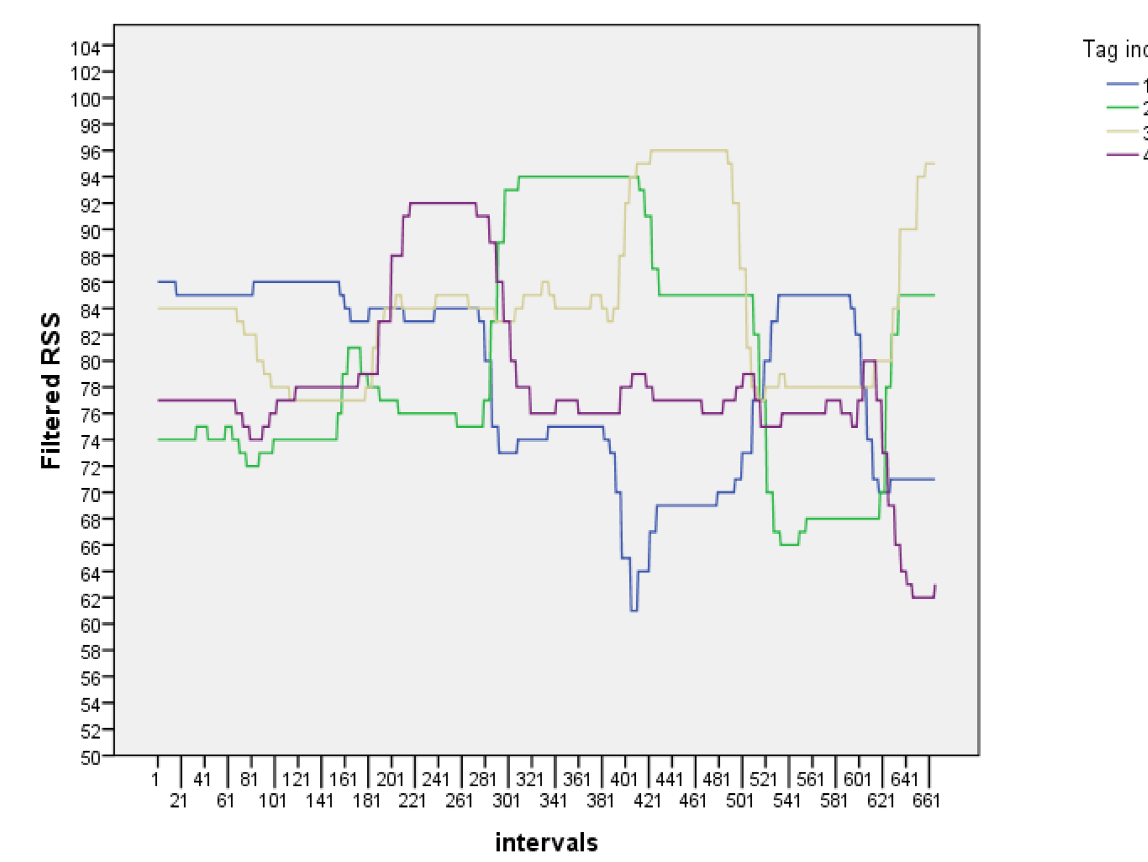
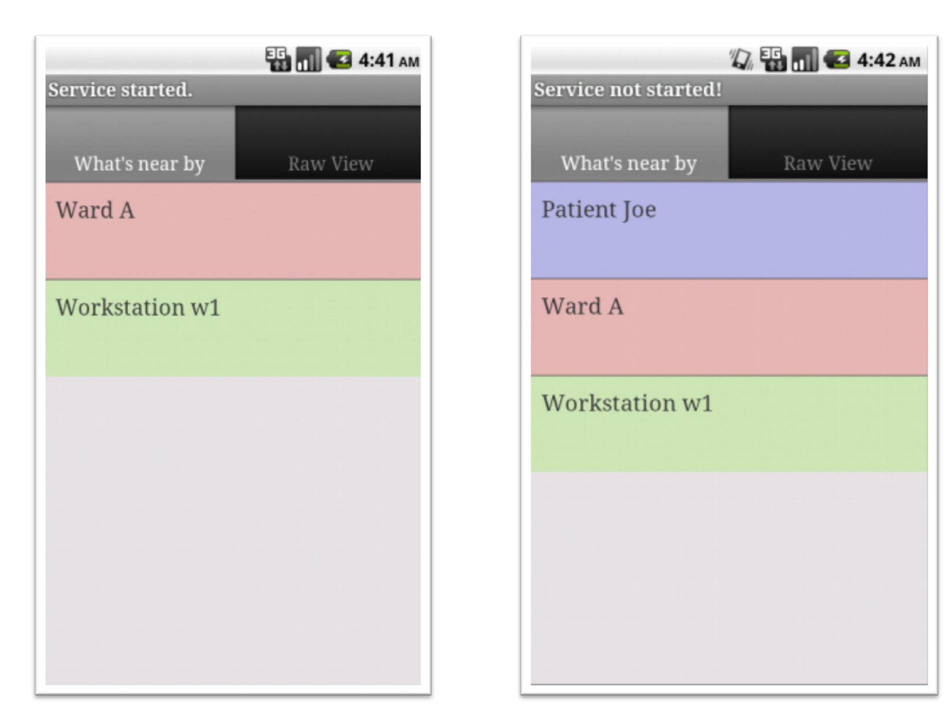


Figure 3

Software Overview

We wrote a simple context-aware application that runs in the background on Nexus One. Thus, the user can run other applications on the smartphone in parallel to our application. The application reads tag IDs from the surrounding area and ranks tags based on their RSS values. The ID of each tag will then be translated to meaningful objects by querying a local database via wireless network. Since tags of higher RSS values should be of more interests to the user, they will be displayed at the top of the list.



Two snapshots show the interface of the application. A click at a listed item will bring the user to a corresponding view to such as a view displaying patients' EPRs.

Summary

Our system is able to distinguish tags that are closest to the user from other tags in a typical working environment where objects such as human bodies, walls, windows etc. can influence radio signal emitted from the tags. This shows the practicality of our proposed system in real-life situation. We plan to improve the context recognition function in the future.

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