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Listen-In Project Plan
Group Cardio (Dec13-12)
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Problem Statement

Many times, doctors are working away from their office and have a need for analyzing stethoscope data. In other cases, they are working with patients as a telepresence, which may require a nurse to listen with a stethoscope. Lastly, doctors often need to train medical students and provide guidance on how to accurately diagnose conditions.

In all of these cases, doctors and other medical professionals need a way to capture data with a phonocardiograph and a way to analyze it, possibly from a remote location. There is also a need for the playback of educational sound files so that students or other individuals being trained can hear what certain conditions sound like to accurately diagnose them.

Project Summary

The Listen-In project will create an Android tablet application to interface with the Littmann 3200 stethoscope that can run data analysis on captured sounds and create a phonocardiogram. The stethoscope will pair with a Bluetooth-enabled Android device running version 4.0 (Ice Cream Sandwich) and above and stream sounds to the application.

Our program will allow doctors to diagnose patients on the go without the need to bring bulky equipment. The sounds can also be saved to the device where they can be accessed for further analysis and sharing, allowing for more input from more doctors. This will help prevent incorrect interpretation of results by having the input from several doctors easily available.

3M has designed the Littmann 3200 Bluetooth stethoscope. The goal of this project is to create an Android tablet application that can provide an interface with their stethoscope. The application will provide an array of data analysis on recorded and streaming sounds captured from the stethoscope. This will allow doctors to work more remotely with their patients and give real time diagnosis of the readings. With the increased prevalence of remote examinations, our application will help bridge the gap between patient and doctor.

Moreover, this application is designed to assist in healthcare education. By providing tools such as a phonocardiogram, stethoscope recording, and playback of educational sound files, educators can more effectively teach in a hands-on way. The application will make use of social media, such as Facebook and Google+, to enable medical professionals and educators to share non-confidential data to the healthcare community and facilitate academic discussion.

Terminology

Phonocardiogram (PCG)	Plot of the sounds and murmurs made by the heart produced by a phonocardiograph
Phonocardiograph	A device consisting of microphones and recording equipment used to monitor and record heart sounds and murmurs
Littman 3200 Bluetooth Stethoscope	An electronic stethoscope, manufactured by 3M, which uses Bluetooth technology for transmitting sounds in real-time to a PC or other device

Table 1: Terminology and definitions

System Description

This project consists of implementing an application targeting Android devices, specifically mobile phones and tablets. The system is geared towards healthcare educators as well as healthcare providers who would like to make it easier to analyze and diagnose patients on the go.

The application must be able to receive data from a Littmann 3200 Bluetooth stethoscope in a manner that minimizes ambient noise. With the data transmitted from the Bluetooth stethoscope, the application will render a phonocardiogram. Additionally, it will come with educational sound files so that users of various backgrounds can learn to better diagnose a patient's conditions. There is also a need for some integration with social media so that healthcare providers can share sound files with other professionals and students in their network.

Concept Diagram

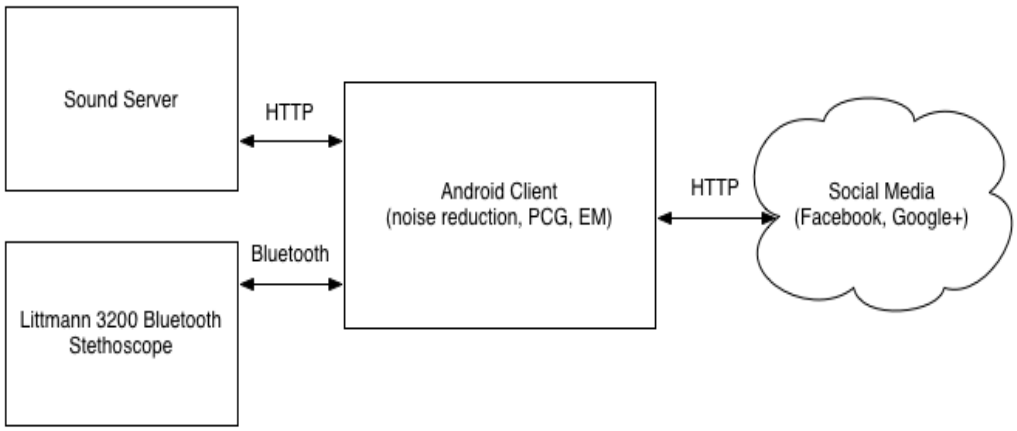

Figure 1: Listen-In concept diagram

Technology

This section outlines the technologies that will be leveraged in the Listen-In project, including the Android client and server module.

Android Client

- **Java 1.6:** The Android client will be run on the Dalvik Virtual Machine, so the program will be written in Java, which is compiled to Dalvik bytecode.
- **Android SDK (API level 14):** The Android client will be built against API level 14 (Ice Cream Sandwich) of the Android SDK.
- **OpenGL ES:** The phonocardiogram will be rendered using the graphics API provided by OpenGL ES.
- **3M Stethoscope SDK:** A proprietary API for interfacing with the Littmann Bluetooth stethoscope provided by 3M.
- **Infinitum Framework:** An open source application framework for Android which provides facilities for dependency injection, aspect-oriented programming, and object-relational mapping.
- **JUnit:** A unit testing framework for Java.
- **Robolectric:** An open source unit testing framework that integrates with JUnit to enable test-driven development for Android.

- **Mockito:** An open source mocking framework that allows software components to be unit tested in isolation.
- **Apache Maven:** A software comprehension tool for managing builds and dependencies.

Resources

This section outlines the resources for Listen-In project. Resources denoted by "*" are provided by 3M.

- Littmann 3200 Bluetooth Stethoscopes (x6)*
- Google Nexus 7 tablets (x3)*
- Android virtual devices
- Apache HTTP server

Operating Environment

The operating environment for our software will be an Android 4.0+ environment running on an internet and Bluetooth enabled tablet. The software will be sending and receiving audio data from a nearby Littmann 3200 stethoscope using a Bluetooth protocol, as well as communicating with a sound server and uploading to social media such as Google+ and Facebook using HTTP.

Specification

This section outlines the specification for the Listen-In project, including use cases, functional, and non-functional requirements. Use cases are presented as user stories since the project will be developed in an Agile environment.

Use Cases

- As a healthcare professional, I want to pair a stethoscope to the tablet
- As a healthcare professional, I want to see a phonocardiogram so that I can better diagnose the patient with a condition
- As a healthcare provider, I want to play sound files, both audio recordings and educational sound files, from the tablet to stethoscope
- As a healthcare provider, I want to see a phonocardiogram displayed when I play sound files, both audio recordings and educational sound files

- As a healthcare professional, I want to share non-confidential sound files on Google+, Facebook, or other social media for academic purposes.
- As a marketer, I want to change sound files via a server rather than through an application update

Functional Requirements

1. Can pair a stethoscope to android device
    a. Establishes a Bluetooth connection with Android Tablets
2. Can plot a phonocardiogram
    a. Graphical representation of the sound data with axes, timestamps, guidelines
    b. Rendered during real-time streaming from stethoscope and during playback of audio files
3. Can record stethoscope audio data
4. Can playback sound files from tablet to stethoscope
    a. Transmits data from the Tablet to the Stethoscope via Bluetooth
    b. Renders phonocardiogram identical to when it was rendered when the audio was captured
5. Can share sound files on social media
    a. Can access Google+, Facebook profiles
    b. Ability to upload/post information

Non-functional Requirements

1. Reduces noise
2. Gracefully disconnects the stethoscope
3. Indicates when the stethoscope encountered error
4. Indicates when stethoscope encounter too much background noise
5. Works on Android 4.0 or greater

Constraints

1. Technological

a. OpenGL - The customer has requested that the phonocardiogram be implemented using OpenGL. This is a foreign technology to us so we will have to learn how to use it to implement this feature.

b. Android Bluetooth API - The Android Bluetooth API is incomplete as parts of it are not public. As a result, we have to call the non-public API methods through reflection, which is volatile because the API is not stable.

c. Legacy Code - The project was provided with some code already implemented. Some of it needs to be debugged, and other needs to be rewritten or removed.

d. Stethoscope SDK - The customer did not provide us with the source code or documentation for the low level implementation of the stethoscope API.

2. Resource

   a. We were only given three Nexus 7 devices to work with in a group of 6 people, so we either need to work together or find separate devices.

3. Physical

   a. We aren't in the same location as our client, which can lead to latency issues when attempting to show our fluid phonocardiogram display through screen sharing.

User Interface Description

The user interface will provide the user with various functions and details of the stethoscope readings. The user will be able to view the plot of a phonocardiogram, which will be rendered by using the OpenGL API. The ability of recording and saving sounds locally will be provided. Social media such as Facebook, Google+, and Twitter will be integrated into the application and allow for easy sharing of educational and non-confidential data.

The Android application will follow Google's Android user interface guidelines, specified at the following URL: http://developer.android.com/guide/practices/ui_guidelines/index.html. This is in order to provide the user with a consistent, intuitive, and rich experience.

Verification and Validation

This section outlines the procedures we will take to perform verification and validation for Listen-In. Using an Agile process, we will receive constant feedback from our client

to ensure all aspects of the project are fully satisfied. The verification and validation process will include reviews of requirements, design, and code, as well as white-box and black-box testing.

Requirements Reviews

Requirements reviews will be performed by both the development team and the customer to ensure the project's functional and non-functional requirements are being met. These reviews will be completed at the end of each iteration to validate the work completed during the sprint.

Design Reviews

Design reviews will be performed by the customer to ensure the project meets the specifications for the GUI and phonocardiogram aspects. These reviews will be completed at the end of each iteration to validate the work completed during the sprint.

Code Reviews

Code reviews will be performed by developers when code is being committed to ensure that best practices are being implemented and that the code is of a high standard. The development team will be following a code convention set forth by 3M to maintain consistency with their projects.

Quality Assurance

White-box unit tests will be written for all major components by the developers of said components. Black-box testing will be performed manually by all developers using an emulator or Android device.

Risks and Mitigations

This section outlines some potential risks that should be considered during the planning and development of this project, as well as mitigation strategies for them.

1. **Risk:** A bad phonocardiogram could be plotted due to a loss of connection between the stethoscope and mobile device.

   Mitigation: We can detect when a loss of connection occurs, stop the plotting of the phonocardiogram, and gracefully notify the user.

2. **Risk:** The raw data coming into the application could contain good audio data mixed in with noise data, which would cause an incorrect phonocardiogram to be displayed.

   Mitigation: We can make a series of software filters available to eliminate the excessive noise and keep the good data.

3. **Risk:** It proves too difficult to use OpenGL when rendering the phonocardiogram.

Mitigation: Use a different (possibly Android's native) 2D graphics drawing API.

4. **Risk:** Facebook may not provide easy support for sharing sound files.

   Mitigation: Allow users to upload recordings to a server and share a hyperlink to the file

Assumptions

This section outlines some of the assumptions we are making during the planning and development of this project.

1. The Littmann 3200 Bluetooth Stethoscope has a quality, built in ambient noise filter.
2. Our development of this application will be a proof of concept for experimental purposes.
3. We will not need to go through the FDA approval process.
4. The user of the application has received permission from the patient or other individual to share recorded audio data.

Deliverables

Our final expected product is a working Android application that will be used for mobile phones and tablets. The 3M Littmann Stethoscope will need to pair up with the user's device of choice. Once they are successfully paired, the user, such as a doctor, should be able to view the patient's vital signs via the user interface and give the proper diagnosis based on this information.

Project Tracking Procedures

To ensure that our team stays on schedule, we meet twice per week. Our first meeting is with our project adviser, where we discuss any potential problems we are dealing with. In the second meeting, we discuss our goals and how we are going to accomplish them.

Because it is also important for us to keep in touch with the client, we have frequent discussions with 3M. We log our progress each week in a progress report, which reflects what we accomplish each week and how many hours each team member contributes.

Since we are using an Agile process with iterative development cycles, we are leveraging Team Foundation Service to track our product backlog of user stories. This also enables us to monitor who is working on what tasks.