Laermometer – A Mobile Noise Mapping Application

Mark Bilandzic◆, Michael Banholzer✶, Deyan Peev✶, Vesko Georgiev✶,

Florence Balagtas-Fernandez✶, Alexander De Luca✶

◆Technische Universität München, Department of Informatics, Chair of Information Systems

Boltzmannstr. 3, 85748 Garching b. München, Germany

✶Media Informatics Group, University of Munich, Amalienstr. 17, 80333 Munich, Germany

mark.bilandzic@in.tum.de

{banholzer, peevd, georgiev}@cip.ifi.lmu.de,
{florence.balagtas, alexander.de.luca}@ifi.lmu.de

ABSTRACT

Creating noise maps is a complex task. They can be created using modeling approaches that take into account different data such as traffic conditions and the like. Another approach is to use stationary recording stations which provide better results but are costly to maintain. Nevertheless, the benefits of noise maps are worth the effort. Laermometer has been developed to solve the problems of creating noise maps by utilizing mobile phones and their built-in microphones. The main functionality is to provide noise information for any place in the world.

Users can add further information like a noise description or comments about the location and its sound level. Every user can view the noise maps and comments, anywhere using their mobile devices. In addition Laermometer brings along a small web interface. With this web interface users can view/edit their profiles, comments and noise descriptions.

Categories and Subject Descriptors

H.5.0 [**INFORMATION INTERFACES AND PRESENTATION**]: General: information interface for a mobile and a web platform.

General Terms

Measurement, Design, Human Factors, Standardization.

Keywords

Noise maps mobile devices, geotagging, location based services.

1. INTRODUCTION

Nowadays, cities can be very noisy places. For its citizens it might be difficult to find some quiet places to spend their time off. Traffic, student parties, noisy neighbors and the like are the most common sources of noise. When looking at usual maps, no matter whether online or analog, only green spaces like gardens and gray

areas are distinguishable. Noise information cannot be found on them.

Nevertheless, for different situations it can be inalienable to have this kind of information, for instance when renting or buying a house.

As stated in the EU directive 2002/49/EC [2], action plans have to be designed to manage noise issues and effects. Noise reduction proposals have to be included within these action plans. As an effect of this directive, Defra [3] provides noise maps for 23 big cities in England. Those maps have been created using computer modeling techniques, based on information such as traffic flow data, road/rail data, and vehicle information. Another approach to collect data for noise maps is to use stationary and costly microphones. For instance, Cho et al. [1] designed a system that draws sound levels to maps using stationary microphones. Manvell performed additional work [5] about the measurement of noise levels combined with GPS data. For their work they used a standard sound level meter to analyze the levels. Even though it might be possible to surmise the level through past experiences, it cannot be ensured. Fabjan et al. [4] tried to define the sound levels on a street. Therefore, they looked at the traffic of streets and defined the sound levels with these values.

In this work, Laermometer, a community-based mobile noise mapping application, will be introduced. It exploits the built-in microphones of mobile phones to create noise maps on-the-go. The idea is to have a large community to create high quality noise maps. Users of the system install software on their mobile phone, which automatically records sounds and sends them to the server at appropriate time. That is, the users do not have to use the application actively as it can simply run in the background.

This paper firstly outlines the concept of Laermometer and explains the prototype in detail. The paper concludes with an outlook of what will be done in future work of this project and finishes with a wrap-up of the work.

2. BASICS

The basic idea of Laermometer is to use mobile phones to create so-called noise maps. Noise maps visualize differences in noise levels of different areas. Usually, gradients and the like are used for visualization.

The Laermometer concept of creating noise maps is based on using the built-in microphones of mobile phones to collect the

required data to create noise maps. First of all, the current position of the device is required. In order to achieve this GPS modules of the mobile phone (either built-in or external) are used. Therewith it is possible to get an exact position of the device.

The next step is to analyze the sound level of the environment. Therefore, the microphone of the mobile phone is used. The advantage of this approach is that every mobile phone is already equipped with a microphone and thus there are no costs for additional equipment.

Now, with these two types of information, so-called sound level points are created. To combine sound levels with GPS-coordinates Laermometer utilizes geotagging [6]. Geotagging is commonly used to enhance maps with additional useful information as for example done by Google earth[1]. It enables its users to place their photos on maps and combine them with GPS-coordinates where they have been made.

The Laermometer concept has two main advantages compared to the usual approaches: Firstly, it is based on real recorded sound levels and thus more precise than modeling based systems (the drawbacks of mobile phone sound recording like the quality of microphones and placement issues will be discussed in a later section). Second, no extra costs (despite the internet connection) are generated, because already existing hardware (the users' mobile phones) is used.

3. PROTOTYPE

Laermometer consists of two main parts. The first one is a mobile phone application, which is responsible for the sound recording and provides functionality like different visualization of sound points, administrating comments, viewing the noise maps at different points of time via the timeline etc. The second one is the server that is used to store, upload and retrieve sound points. Additionally, it offers a web interface to view and edit the data, make comments and add bookmarks.

3.1 Mobile application

Since Laermometer is a mobile application, users should not have to be bothered a lot to make Laermometer working. Therefore, it automatically does everything to analyze the sound level and upload it to the server. Only comments have to be uploaded actively by the users. Comments are a very powerful tool to provide readers information about the kind of noise that has been tagged. For instance, it might be possible that someone does not mind the noise of playing kids whereas traffic noise completely annoys that person.

The major problem of the Laermometer software is that it has no means to find out where the mobile device is currently placed. It is possible that the users run the application and put it into their pocket. This can lead to uploading a wrong noise level, because the level is damped. Additionally, the quality of the recordings can be bad or diverse due to different qualities of different microphones. To balance such misreading, it is necessary to have a bigger amount of sound level values of the current GPS-location to get a more significant mean value. Thus, Laermometer does this for the user and cyclically uploads the new measured level. Generally speaking, it can be mentioned that the quality of the measurements increases with the number of uploaded sound

points and therefore with the number of active community members.

Information between the database and the mobile application is transmitted using an XML format, which will be explained in more detail in the following sections.

The mobile software is designed to provide the full set of functionality that Laermometer supports, so that users do not necessarily have to access the web platform to use a specific feature. After a one-time registration during which the users choose their username and password, they can log in and start using the system. After a successful login the user will automatically upload the sound level from the current position without an interaction on the part of the user. Additionally, an automatic upload interval is used defining the time after which the collected sound information is analyzed and uploaded to the server.
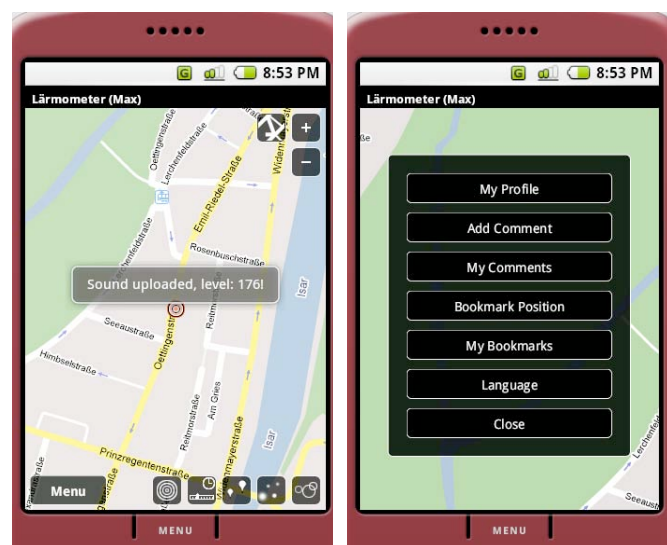

Figure 1: Uploading sound level notification and the menu

The interaction with the software works as follows:

The first screen after a login is shown on Figure 1 (left). There are several buttons on this screen. The buttons at the bottom of the screen represent the main functions of the Laermometer. The upper buttons are used to navigate the map view, zoom in and out and to change between the satellite and map view.

The first button at the bottom of the screen shows the main menu which is depicted in Figure 1 (right). It can be used to submit comments for the current position and the sound level, to make bookmarks, to navigate easily back to this position and some more functions being self-explanatory.

The next button is "current position". By clicking this, the map will navigate to the current coordinates of the users.

The button with the clock is the timeline button. Pressing it displays the timeline as seen in Figure 2. Moving the timeline pointer shows the sound levels of the current screen for a specific time of the day. When the timeline is deactivated every sound level that was uploaded to this place will be taken and the average level will be calculated from them.
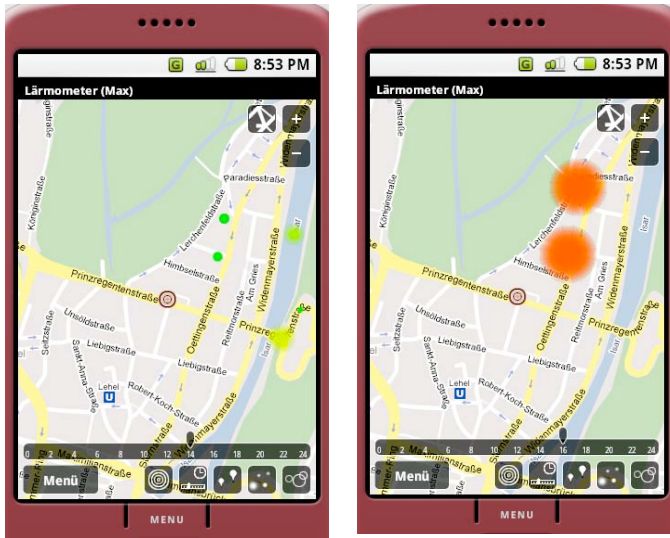
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[1] http://earth.google.com/

Figure 2: Using the timeline to show the difference in the sound levels at 2pm and 4pm
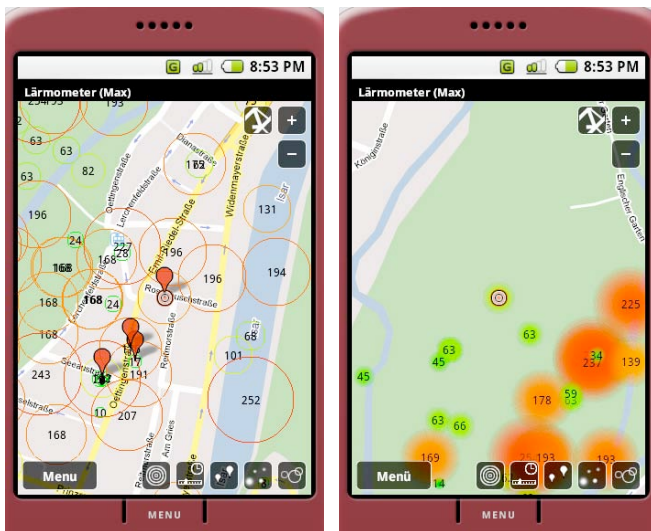

Figure 3: The two different Laermometer visualizations: Stroked circle view with comment markers (left) and gradient view (right)

Figure 2 shows the timeline slider and some sound level changes between 2pm and 4pm.

To fourth button is used to enable/ disable comments on the map.

The last two buttons are the two different visualization options that have been implemented. Users can switch between these two views. The left button switches to the gradient mode as shown in Figure 3 (right) and the right one switches to the stroke circles visualization as shown in Figure 3 (left). The color (green to red) and the size of the circles are determined by the sound levels.

3.2 Web interface

In addition to the mobile application, Laermometer provides a web interface which only provides the edit/view functionality. Users can easily modify their comments, user profile, noise descriptions and bookmarks. The following screen shows the web

interface with the navigation on the left and the edit user profile content on the right side.

3.3 Database

All the user data and sound information are stored in a MySQL database. For the communication between the mobile device and the server an apache server had been used. To read information from the server, the server generates XML files that the mobile application parses.

An exemplary request could be:

".php?fct=getNoise&latitude=48.141691&longitude=11.589243& zoomFactor=17"..

The result of this request would be an xml file like the following one:

```
<request action="getNoise">
    <noise idnoises="1" idusers="6">
      <mappoint idpoint="1">
        <latitude>48.134591</latitude>
        <longitude>11.557543</longitude>
      </mappoint>
      <volume>135</volume>
      <timestamp>2008-06-25 11:00:13</timestamp>
    </noise>
    <noise idnoises="2" idusers="6">
…
```

It contains the sound levels in a specific area which is dependent on the zoom factor, the GPS coordinate, the volume value and the uploaded timestamp. For the first version of the prototype the sound level used a parametric value with a range between 0 and 255. In the next version it will be replaced with the actual decibel values.

Figure 4: Web interface to edit user profiles

4. USE CASE

The following outlines two examples of how standard interactions with Laermometer could look like:

Alice and Bob love traveling around the world. Because every now and then they had bad experiences with noisy hotels and the like, they started to use Laermometer to check locations for noise in advance. Last week they traveled to Munich with Tom and Anna - their 27 and 22 years old son and daughter. The four went to the English Garden. It is a big park in Munich where citizens go

to relax. When they checked their Laermometer application, they found a quite loud spot between all the quietness of the park. Curious what causes the high noise levels they check the comments marked for this spot. The most interesting one is labeled "Chinese Tower" and describes the location as "a place in the middle of Munich where the Bavarian people drink beer under the shadow of the Chinese Tower" - a comment that another user of Laermometer has uploaded to the database. Encouraged by comment, Tom and Anna went to the place leaving their parents by the quiet park lake and discovered that it was really nice. So they enjoyed the special Bavarian atmosphere of that amazing place.

While drinking their beer, Anna made a comment with the Laermometer "add comment" function and uploaded it to the server, so everybody can read by now about her experience in that park. All the time her mobile phone automatically collects new sound information, which will increase the quality of the visualization even more once it is uploaded.

Soon after that holiday, Bob and his wife are traveling to Sydney alone. Last year they were there and have added that place to their Laermometer bookmarks.

On their way Bob loads the map of the area of their hotel. He uses the timeline functionality to see how the noise map of the area looks like during the night. It looks normally, but a little bit louder as he thought it should be. He reads some comments: "Awesome concert!", "The best rock concert ever! See you next year." and on the Internet he finds out when: just that week. Having this information, Alice calls the travel agency and asks' to change to a new hotel situated in a quieter place.

5. CONCLUSIONS AND FUTURE WORK

In this paper, we presented Laermometer, a mobile community-based system to create noise maps and assist its users to find quiet places to spend their time off or just to get an impression about the sound levels in a specific area.

A prototype has been created consisting of a mobile application and a web-based interface. While the web-based interface is mainly used for informational purpose, the mobile application provides additional functionality by using the mobile phones' built-in microphones to record sound levels.

Laermometer has been created on a communication basis to cope with a task of updating the information every day to keep the information most accurate. A major task for the near future is to extend the web interface with more functions from the mobile application like map navigation. This is planned because the screens of desktop computers provide a better overview of the maps. The prototype uses noise levels between 0 and 255 for ease of visualization. For the next prototype, sound levels should be stored the specific unit dB (decibel)

The biggest challenge that is yet to be handled is to evaluate the system in real-world usage. For this, a user study is planned. Participants will be equipped with Laermometer enabled devices and given some specific tasks over a period of several days (or weeks). This is done to gather qualitative information about the system and to find further enhancements. It will also be used to gain data on the quality of sound-levels in the application's everyday usage. That is, if sound levels will be highly influenced by the usage (e.g. kept in pockets, bags and the like) and to find out how to avoid these problems.

6. REFERENCES

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