SoniControl 2.0

Zwischenbericht | Call 13 | Projekt ID 3480

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1 Introduction

The goal of the project SoniControl (http://sonicontrol.fhstp.ac.at) is the development of a first ultrasonic firewall to protect users against ultrasonic tracking by companies like Silverpush. We have published the app developed in a first netidee project (project no. 1701) beginning of 2018 on Google PlayStore in a German and English version. Since then it was downloaded more than 40.000 times and the project was reported in more than 70 national and international press articles on platforms like heise.de and theregister.co.uk.
We continuously get requests from users for new functionality. Most important features needed to make the firewall applicable to a broader target group are (i) more diagnostic features (visualizing and sonifying detections for a more tangible user experience), (ii) providing metadata about the detections (e.g. the type of detected message), (iii) sharing detections with other users, and (iv) extending the firewall to iOS. The goal of the current project "SoniControl 2.0" is to realize large parts of this functionality. This report summarizes the status of the follow-up project SoniControl 2.0.

2 State of the Work Packages

2.1 Work Package 1 – *Project Management & Dissemination*

Brief description of the main activities

- Financial planning (controlling sheet)
- Finalizing contract, signing, sending to netidee
- Update project website, create monthly blogs on netidee website
- Request first funding rate
- Organizing regular meetings
- Controlling project hours
- Dissemination of the project
- Writing intermediate report

Insights into the procedure

The project is progressing as planned. All deliverables could be achieved in time.

Brief description of the results achieved

- Contract signed,
- Project plan and list of project results finished and approved
- First funding rate requested
- Intermediate report finalized and sent
- Second funding rate requested

- Project dissemination at several events (see Section 5 for details)

Special successes/ problems

The project progress is satisfactory. Many of the critical questions and difficult parts of the implementation could already be solved.

Were there major deviations from the plan? Why?

Due to a higher workload during the first months of the project due to projects running in parallel at our institute, fewer resources were consumed as planned. For this reason, we would like to request a cost-neutral extension of the project by three months (see also Section 4)

2.2 Work Package 2 – *Advanced Diagnostics*

Brief description of the main activities

In WP 2 there were three major modules which have been implemented:

- the message recognition module
- the visualization module
- the sonification module

Message recognition module:

The recognition module builds upon the existing detection module of SoniControl and enables to determine the actual type or protocol of an ultrasound message. For a detected signal it can, for example determine if the signal is a Silverpush signal (which is most suspicious for ultrasonic tracking) or a GoogleNearby signal (which may be used, e.g. for pairing the user's phone with Google Chromecast and thus shall pass the firewall). The recognizer thereby provides important meta-information about what type of communication is currently going on and enables the user to better assess the type of threat she may be exposed to. It further enables to filter messages by type and protocol automatically, which leads to a higher user convenience.

To realize this module, we have implemented a frequency-based algorithm that recognizes the type of ultrasonic message and the protocol behind. By knowing which frequencies are used by a certain protocol, a detector can be built by analyzing the sound spectrogram in the Fourier frequency space. For each protocol to which we have access, we have determined the frequencies manually in advance. The recognition algorithm then matches the spectral signature of the message with our protocol definitions and reports the type of message found. If an unknown message is detected (i.e. a message that does not match any definition), the algorithm returns that an unknown message type was detected.

Visualization and sonification modules:
In the first version of SoniControl, detections were reported to the user without additional information about the actual message. To improve user experience, we have developed a visualization and sonification module to make the detected messages visible and hearable. The visualization module computes a short-time Fourier transform (STFT) to generate a spectrogram. The spectrogram is then normalized, mapped to an image and shown to the user directly in the alert dialog of the firewall. The spectrogram reveals the temporal and spectral properties of the message and helps to identify whether a real message was detected or (less likely) some unusual noise in the ultrasonic band. It does not reveal the actual content of the message, which would raise privacy concerns.
The sonification module allows the user to playback the message in the hearable range. This module provides acoustic feedback to the user about a detection and makes it more tangible for the user that something has happened which could not be perceived in a natural way. To make the detections hearable, we perform a pitch-shifting on the detected message (only on the part above 17kHz). Pitch shifting reduces the pitch frequencies of the message and brings them into the hearable range without distorting the temporal dimension (i.e. the duration of the message stays the same). The result is a hearable message that the user can listen to.

We expect that visualizer and sonifyer will significantly contribute to raising awareness to ultrasonic tracking by providing more tangible feedback to the users. Numerous users already requested this feature. Thus, it was given highest priority in the project.

Insights into the procedure
Initial tests have shown that visualization and sonification significantly improve the touch and feel of the app. The feedback is now much more tangible and false detections can easily be identified (i.e. when there is no structure in the spectrogram the likelihood of a false detection is high).

Brief description of the results achieved
All three modules (the message recognizer, the sonifyer and the visualization module) were finished in a first version. First test were performed successfully. A second larger test setup is planned for WP 5.

Special successes/ problems
The employed pitch-shifting algorithm from the “superpowered” library (https://superpowered.com/) supports only a pitch-shifting of up to one octave. This has shown to be sufficient to make the sounds well hearable. The quality of the visualization depends on the signal to noise ratio (SNR) and varies between different smartphone models. A proper contrast normalization method is thus necessary to improve the visual appearance of the spectrogram. We have already implemented such a normalization method. The fine-tuning of the method is planned for WP 5.

Were there major deviations from the plan? Why?
There were no deviations

2.3 Work Package 3 – *Sharing Functionality*

Brief description of the main activities
To leverage the power of the user community, users should have the opportunity to share their detections with other users. For this purpose, we have implemented a web-service to which detections can be uploaded. The server hosts the collection of anonymously uploaded detections and shows their location on a map. In this way, the users can inform themselves about potential ultrasonic tracking in places they, e.g., plan to go to or where they frequently stay. Users can also share false alarms on the server to enable us to further improve the detector.
The sharing functionality consists of two modules: the sharing *server* and the sharing *client*. The sharing server is a web-service with a MongoDB database as storage backend where the data is stored in the form of JSON objects. The sharing client is a software service integrated into SoniControl that enables the user to upload a detection to the server together with metadata such as location, time and the type of message.

Insights into the procedure
The sharing functionality could be implemented as planned.

Brief description of the results achieved
- SoniControl Web-backend, accessible via: http://sonicontrol-server.herokuapp.com/
- SoniControl Client module that enables sharing of detections

Special successes/ problems
A major challenge that we had to solve was the pre-processing of the captured audio before sending it to the webserver. This was mainly because the Android platform uses pulse code modulation (PCM) as audio format, which is difficult to handle. To solve this issue we implemented a file exporter that converts the PCM format into a standard WAV format.

Were there major deviations from the plan? Why?
There were no deviations.

2.4 Work Package 4 – *iOS Conceptualization*

Brief description of the main activities

For the planned implementation of SoniControl on the iOS platform (the implementation is beyond this project), different implementation-specific aspects need to be investigated in detail to assess the feasibility of an implementation of the SoniControl features on iOS. The reason to perform this feasibility study is that the iOS platform is stricter in some regards than the Android platform, e.g. when it comes to continuous background operation, continuous recording, and the availability of required signal processing algorithms. For this purpose, we have performed a literature research and analyzed for each component of the SoniControl app possible ways to implement them on the iOS platform.

Insights into the procedure

The main insights from the performed research is (i) that most of the components can be implemented in a straight-forward manner on the iOS platform and (ii) that the background audio recording represents the main obstacle in the implementation. It cannot be guaranteed if the app would pass the review from the Apple Store and unfortunately, this question cannot be answered in advance. Especially the permission to resume audio capturing while the app is in the background seems to be difficult to obtain from the reviewers but necessary for the proper operation of the firewall.

Brief description of the results achieved

The result of the WP is a report that describes a first concept for porting SoniControl to the iOS platform together with possible limitations and solution strategies.

Special successes/ problems

See “Insights into the procedure” above.

Were there major deviations from the plan? Why?

There were no deviations to the project plan.

2.5 Work Package 5 – *Integration and Release*

Brief description of the main activities

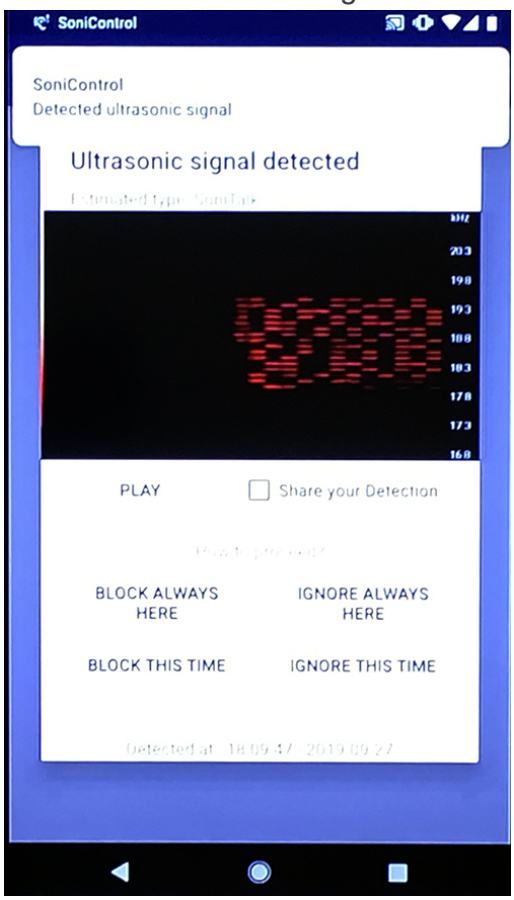
In this WP, we are currently integrating the individual modules (visualization, sonification, sharing and recognition of the message type) into the SoniControl 2.0 application.

Insights into the procedure

The integration so far runs as planned. Due to the additional complexity of the resulting application, the efforts for adequate testing of the individual components and their mutual interactions will be higher than for the initial SoniControl app.

Brief description of the results achieved

The visualization and the sonification could already be integrated (beta version). A screenshot of the new detection dialog showing a visualization of the detected message and the “Play”-Button is shown in the figure below.



Special successes/ problems

Currently everything is running according to our plan.

Were there major deviations from the plan? Why?

No deviations to the plan so far.

2.6 Work Package 6 – *Documentation*

Brief description of the main activities

In WP6 we are extending the user documentation and developer documentation of SoniControl.

Insights into the procedure

Work is still in progress.

Brief description of the results achieved

Work is still in progress.

Special successes/ problems
None.

Were there major deviations from the plan? Why?
No deviations to the plan so far.

2.7 Work Package 7 – *External Communication & Dissemination*

Brief description of the main activities
The goal of the WP is the dissemination of the project on different channels, i.e. to the scientific community and to the public, in the form of interviews in Radio / TV and in magazines as well as the presentation of news items on the projet website and the netidee website. Furthermore, the project has been presented at several events.

Insights into the procedure
The dissemination clearly exceeds our expectations. The topic of ultrasonic tracking is still of large importance to the media and we regularly get requests from the media or from companies on the topic.

Brief description of the results achieved
Dissemination activities included so far (sorted chronologically, containing only the dissemination starting with January 2018):

- Presentation of SoniControl at the 22th **Netzpolitischer Abend** in the Meta Lab in Vienna (January 29, 2018)
- Exhibition of SoniControl at the **Lange Nacht der Forschung** (April 13, 2018) in St. Pölten
- Presentation of SoniControl in a **Keynote** held by Matthias Zeppelzauer at the "Digital Livestyle Preview" event in Munich (June 28, 2018) for a selected group of international journalists from different IT-related media and magazines.
- Exhibition of SoniControl at the ARS Electronica Festival (September 6-10, 2018) in Linz where around 300 visitors could try out ultrasonic communication and see how this technology works.
- Presentation of SoniControl together with SoniTalk at the ACM Multimedia Conference in Seoul, South Korea, 22 - 26 October 2018 (http://www.acmmm.org/2018/), which is the premier conference for multimedia experts and practitioners across academia and industry.
- Presentation of SoniControl at the **DeepSec Conference 2018** in Vienna on November 30, 2018 in the course of the *Reversing and Offensive-oriented Trends Symposium* (ROOTS).
- Presentation of SoniControl at **Lower Austrian Innovation Award** Event including an interview with Landesrätin Bohuslav: https://www.netidee.at/sonicontrol-20/sonicontrol-noe-innovationspreis

- Selection of SoniControl as a showcase project for the initiative "**Haus der Digitalisierung**": https://www.virtuell-haus.at/digigalerie/details/59402083-a775-49a5-83d6-3f26a6f91734
- Article about SoniControl and SoniTalk with the title "Data over Sound" in **KES Magazine** on information security: https://www.kes.info/archiv/heft-archiv/jahrgang-2019/ausgabe-20194/
- Demonstration of SoniControl and SoniTalk at the **Lower Austrian Forschungsfest** in a stage performance in front of an audience of more than one hundred people ("*Wie werden Handys ausspioniert und was kann man dagegen tun?*", http://www.noe.gv.at/noe/Wissenschaft-Forschung/Forschungsfest_Noe.html).
- A **television feature** about ultrasonic communication in the ORF series: "Digital Leben - Vernetzt, verstehen, profitieren", Tuesday September 17, 2019, 7:20pm, ORF Niederösterreich
- Further dissemination activities (e.g. mentions of the project in newspaper articles) can be found on our project website: https://sonicontrol.fhstp.ac.at/#dissemination

Special successes/ problems

none

Were there major deviations from the plan? Why?

There were no deviations from the project plan.

3 Implementation of funding requirements

Dieses Kapitel ist nur relevant, wenn in der Fördervereinbarung spezielle Förderauflagen festgelegt wurden. In diesem Fall soll in diesem Kapitel dargestellt werden, wie diese berücksichtigt werden.

No special requirements.

4 Summary Plan Update

Alle Anpassungen des Plan-Excels kurz zusammengefasst

The work is progressing as planned. All deliverables could be reached in time. Due to a higher workload during the first months of the project due to projects running in parallel at our institute, fewer resources were consumed as planned. For this reason, we would like to request a cost-neutral extension of the project by three months, until end of March 2020 (see also the controlling Excel sheet for an adapted time plan). This would enable us to extend the development and testing time of the app and to more sustainably improve the quality and robustness of the app.

5 Dissemination / Networking

Beschreibung der bereits erfolgten Öffentlichkeitsarbeit oder Vernetzung, bzw. Beschreibung des Plans künftiger Aktivitäten

See Section 2.7 for a summary of all dissemination activities.

6 Project Website

Wird zusätzlich zur netidee-Projektwebsite noch eine eigene Website betrieben, so ist hier die Adresse anzugeben.

The project website can be found here: https://sonicontrol.fhstp.ac.at