Diploma Thesis

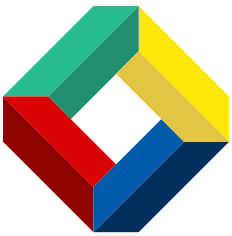
AudioAnt

An assistant tool for hearing impaired persons

By

Benjamin Hackstock
Florian Langer
Daniel Sparber

Höhere Technische Bundeslehr- und Versuchsanstalt
6020 Innsbruck, Anichstraße 26-28
Höhere Lehranstalt für Wirtschaftsingenieurwesen,
Ausbildungsschwerpunkt Betriebsinformatik



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Supervisors:

DI Benedikt Frischmann
Mag. Dr. DI Albert Greinöcker
Mag.[a] Sylvia Mayr

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Benjamin Hackstock	Florian Langer	Daniel Sparber

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Innsbruck, 08.04.2016

Benjamin Hackstock	Florian Langer	Daniel Sparber

Project team

Benjamin Hackstock
Reschweg 12
A-6068 Mils

Tel.: +43 650 9403243
Email: benni.hack@hotmail.com

Florian Langer
Schützenstraße 58
A-6020 Innsbruck

Tel.: +43 664 3563300
Email: florian.langer2@gmail.com

Daniel Sparber
Spitz 18/1
A-6406 Oberhofen im Inntal

Tel.: +43 664 2432067
Email: sparber.daniel@gmail.com

Supervisors

Mag. Dr. DI Albert Greinöcker
HTL Anichstraße

Email: greinoecker@htlinn.ac.at

DI Benedikt Frischmann
HTL Anichstraße

Email: frischmann@htlinn.ac.at

Mag.[a] Sylvia Mayr
HTL Anichstraße

Email: mayrs@htlinn.ac.at

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Apart from being responsible for the initial project idea, Mr. Frischmann helped us by advising us in the areas of hardware, project-management, and technical research, as well as motivating and encouraging us in the harder phases of the project. Mr. Greinoecker was our contact partner for software based questions and was a big help to us because of his rich amount of knowledge and his always positive and optimistic mindset. Ms. Mayr helped us face the challenge of a diploma thesis written in English and guided us during the process of writing a diploma thesis in a foreign language.

We also want to thank Mr. Werner Pfeiffer from the self-help association for deaf and tinnitus affected "PRO.ject.EAR". He helped us get in contact with people affected by hardness of hearing and enabled us to do the survey in the extent we did, questioning over 100 people that were affected by either tinnitus, hardness of hearing or hearing loss.

Abstract

According to a study, conducted by the "Deutscher Schwerhörigenbund (DSB)", the number of hearing impaired people (hearing performance reduced by more than 20dB) is at about 20 percent with a rising tendency. One common problem of these people is missing sounds in their own home. This could be an alarm clock, the doorbell or the alert sound of the microwave. With our project we want to conquer these problems by developing a device that can help the user reduce the amount of missed sounds in their own home.

The auxilary device, the AudioAnt, was implemented in the form of a prototype. First, we planned the construction, made production drawings and created a circuit diagram. During the course of the project, we constructed the housing of the AudioAnt, ordered and built in all the necessary components.

To analyse if a sound appears, an audio analysis software was implemented. During the analysis process a series of steps, based on each other, are executed. The three main steps are gaining the data by recording the ambient noise, extracting important features from the data, and comparing the obtained information.

In order to get all the important information out of the audio signal, the so called *Feature Extraction* is used. This is an umbrella term for many mathematical functions used to obtain characteristics based on waveform and spectrum. The most useful functions turned out to be the extraction of dominant frequencies and the *Mel Frequency Cepstral Coefficients (MFCC)*, as well the calculation of the *RMS-Energy* and the *Spectral-Rolloff-Points(SRP)*.

In addition to these core tasks of our diploma project, we conducted a usability research with focus on elderly users, an environmental analysis, a patent search and a competitor analysis. The findings we were able to get through these tasks were used to optimise the goals and priorities of our project. The prototype and the Android application, for example, were heavily influenced by the results of of our studies. Another research finding is that not only older people suffer from hardness of hearing and that our target group therefore also includes younger people.

The final result of our project is a fully functioning prototype and a working Android application used for configuring the AudioAnt. Using the inbuilt microphone, the ambient noise is constantly being recorded and analysed. Multiple tests have proven the ability of the AudioAnt to recognise almost every learned sound, provided its audio pattern is similar to a standard ringtone, meaning that it is the same every time it occurs, is artificially made and has characteristic frequencies.

Zusammenfassung (Abstract)

Laut einer Statistik des Deutschen Schwerhörigenbundes (DSB) aus dem Jahre 2011 liegt die Zahl an schwerhörigen Menschen (Hörleistung mehr als 20dB vermindert) mit steigender Tendenz bei über 20%. Ein gängiges Problem dieser Menschen ist das Überhören von Geräuschen in den eigenen vier Wänden. Dies kann zum Beispiel ein Wecker, der Signalton einer Mikrowelle oder die Haustürklingel sein. Bei diesem Problem setzten wir mit unserem Projekt an und entwickelten ein Hilfsgerät zur Minimierung der Anzahl der überhörten Geräusche im eigenen Haushalt.

Das Hilfsgerät, die AudioAnt, wurde in Form eines Prototypen realisiert. Für die Umsetzung des Gerätes wurde zuerst eine komplette Planung vorangestellt, welche Fertigungszeichnungen und einen Stromlaufplan beinhaltet. Im Laufe des Projektes wurde das Gehäuse gefertigt, die benötigten Komponenten bestellt und verbaut.

Um zu analysieren, ob ein gewisser Ton auftritt, wurde eine Audioanalyse implementiert. Hierbei wurden nach einem strikten Vorgang aufeinander aufbauende Schritte durchgeführt. Die drei essentiellen Aufgaben hierbei sind die Gewinnung der Daten durch Aufnehmen der Umgebungsgeräusche, das Extrahieren der wesentlichen Informationen und der abschließende Vergleich dieser.

Um die wesentlichen Informationen eines Audiosignals zu gewinnen, wird die sogenannte *Feature Extraktion* verwendet. Hierbei handelt es sich um den Überbegriff für eine Vielzahl mathematische Funktionen zur Gewinnung von Merkmalen basierend auf Wellenform und Spektrum. Wie sich durch zahlreiche Versuche herausstellte, sind das Extrahieren der dominanten Frequenzen und *Mel-Koeffizienten (MFCC)*, sowie die Berechnung der *RMS-Energie* und des *Spectral-Rolloff-Points (SRP)*, die hilfreichsten Funktionen.

Zusätzlich zu den Kernaufgaben wurden die Grundlagen der Benutzerfreundlichkeit ausgearbeitet und eine Umfeldanalyse, sowie eine Patentrecherche und Konkurrenzanalyse durchgeführt. Die Erkenntnisse dieser Aufgaben flossen direkt in die Arbeiten ein. So wurde speziell bei der Konzipierung des Hilfsgerätes und der Applikation auf eine leichte Bedienung Wert gelegt. Besonders die Umfeldanalyse zeigte, dass entgegen unserer Annahme auch viel jüngere Personen zur Zielgruppe gehören.

Das konkrete Ergebnis dieser Arbeit ist ein voll funktionsfähiger Prototyp inklusive Android-Applikation zur Bedienung und Konfiguration des Gerätes. Über das Mikrofon des Hilfsgerätes werden permanent die Umgebungsgeräusche aufgezeichnet und analysiert. Wie diverse Testszenarien ergaben, war die AudioAnt in der Lage, nahezu jedes gelernte Geräusch wiederzuerkennen, sofern es eine klingeltonähnlichen Charakter hat, sprich, wenn es sich um einen immer gleich auftretenden, künstlich erzeugten Ton mit charakteristischen Frequenzen handelt.

Contents

Part I.

Preface

1. Introduction

1.1. Initial Situation

According to a study, conducted by the "Deutscher Schwerhörigenbund (DSB)", the number of hearing impaired people (hearing performance reduced by more than 20dB) is at about 20 percent with a rising tendency.[1] Roughly half of these 20 percent are badly enough influenced by loss of hearing, so that the use of an assistance device would be of great help to the user.

One of the most common problems for people who are hard of hearing is missing noises and sounds in their own home. These sounds include for example the doorbell, an alarm clock or the alert sound of the microwave. We want to face this problem by building a personal assistance device that can recognise these sounds and inform the user, therefore reducing the amount of missed sounds of a person at their home.

1.2. Project Idea

The initial idea for our project came from our teacher Mr. DI Benedikt Frischmann. Personal experiences had led him to the idea of developing a hearing assistance device that could conquer the challenges in these areas.

The idea was to create a stationary device that constantly monitors its surrounding using a built-in microphone. The characteristics of this audio stream are then constantly compared to previously learned signals. If a sound has been recognised, the software triggers multiple methods of alerting the user.

The device, the "AudioAnt", can be configured using a mobile application for Android smartphones. We chose this way of configuring it, because it provides good user experience and can be handled by technically inexperienced users without having to use complicated command line entries. This is especially important for us, since hardness of hearing becomes more and more common as people age and the majority of our target group will therefore consist of people that might not be as used to handling modern technology as younger generations are.

Once a signal is recognised, the user should be alerted in the following ways:

[1] Statistische Angabenn zur Hörschädigung in Deutschland zwischen 2005 und 2011, http://www.oesb-dachverband.at/uploads/media/DSB_SH_Statistik2011.pdf, 23.1.2016

- **Visual Signals**
  The device can emit flashes of light using an LED-light and thereby alert the user in a silent way.

- **Acoustic Signals**
  A loud acoustic alert can be triggered by the AudioAnt, whereby the alarm tone for each learned signal can be individually set.

- **Haptic Signals**
  If a local Wifi network exists and both, the AudioAnt and the smartphone are connected to it, the permanent connection can be used by the AudioAnt to trigger vibrations on the smartphone. However, it is also possible to play acoustic signals and use the built-in LED-flash of the phone for alerting the user.

1.3. Description

1.3.1. Hardware

The computing unit of the AudioAnt is a Raspberry Pi 2, that is used together with multiple external gadgets in order to enable sound to be recorded and replayed. The establishment of wireless connections is executed by using Bluetooth and Wifi. In addition, the smartphone can be charged wirelessly, if it is placed on the provided space on top of the AudioAnt.

We chose the Raspberry Pi 2 because of the computing power it offers, combined with the support of all common coding languages such as Java, Python and R which we had to use in order to achieve our goals in a realistic and effective way.

1.3.2. Audio Analysis

The audio analysis we use to identify if an important sound has occurred, happens on the Raspberry Pi. The coding language R is used to extract audio features out of the audio stream coming in from the microphone. Additionally, Python is used to control the external hardware. The whole process is managed by an underlining Java program.

1.3.3. Android Application

The mobile application for configuring the Raspberry via Bluetooth or Wifi was written for Google's Android platform. Apart from configuring the Raspberry, it also enables the smartphone to alert the user in case of an occuring sound and therefore increases the usability of the AudioAnt System.

1.3.4. Background work

In order to evaluate the needs of our potential users, we conducted a survey that helped us to decide which features to prioritise during the development process, how to implement certain features and which ones are unimportant to the user and can therefore be abandoned.

To ensure our project would not collide with any existing products, we conducted a patent search, both by ourselves as well as by experts of the Austrian patent office ("Österreichisches Patentamt" - ÖPA).

We also conducted a research on mobile usability with a special focus on elderly people. We did this, although not all of our users will be elderly people. Nonetheless, the elderly need to be taken into account the most, since they are very likely to be least familiar with modern technology.

In order to evaluate if our product has a chance on the global market, we developed a calculation scheme. With this scheme we evaluated the production costs of the AudioAnt.

1.4. Goals

The goal of our diploma project is the development of a fully functioning prototype that is able to recognise previously learned sounds and react to them. The Android application should be fully implemented and allow complete configuration wirelessly.

Part II.

State of the Art

2. Competitor analysis

The competitor analysis is a major part of a project, when started by a business. Not only shows the result which products from competitors are similar to the products you want to produce and are on a competitive basis, but also which companies are in competition with you.[1]

Finding direct competition is not always easy. After an extensive market research, most of the competitors should be clear. An important aspect is which businesses or products the company is able to compete with. This depends on the size of the company and the quality of a product. For example, handmade noodles produced by a local store cannot compete with pasta produced by an international company.

Competitive rivalry will be high if

- competitors sell the same or very similar products,
- the size of the businesses are approximately identical or
- fellow campaigners have similar sales strategies.

2.1. Comparison of the competitors and products[2]

Concerning products, the first conspicuousness is the price difference between the same products from various sellers. Moreover, features of the product or services can be compared to the product or service you want to produce or rather offer. The analysis may also show possible improvements of your product due to failure or faulty products of other companies.

To get a good overview of the competitors, the following issues have to be elaborated.

2.1.1. Distribution channel

There are a few strategies a business can use when selling products. Not only can they sell their products in stores, but also in online shops, on exhibition stands or door-to-door. To become a worthy competitor, it would be good to compete in more than one of these markets. The more distribution channels a business has, the better. Nonetheless, more money has to be invested to run a bigger distribution network.

[1] Competitor analysis https://www.fuer-gruender.de/businessplan-vorlage/konkurrenzanalyse/, 2016-02-14

[2] Learnmarketing: Competitor analysis - http://www.learnmarketing.net/competitoranalysis.htm, 2016-02-14

2.1.2. Quality and price-performance ratio of the products

The quality and the price of a product often lets the buyer decide if a product is bought or not. Unfortunately, most cheap products do not show very high quality. When you want to produce a high-quality product, you can either produce a high quantity to get a lower price when purchasing raw materials or raise the price of the final good.

2.1.3. Customer base

A firm only becomes a competitor when they are aiming at the same customer base as your business. If the competitor has great success with this customer base, you can either change your customer base (e.g. sell other products) or directly compete with the competitor.

2.1.4. Weaknesses and strengths of the competitor

To evaluate strengths and weaknesses of the competitor, the business has to be examined from different angles. Therefore, a strength-weakness profile can be created to visualize the competitor's advantages and disadvantages. Ideally, it is noticeable which disadvantages your product has so they can perhaps be compensated before producing. Within this profile, many different characteristics have to be rated. Once you know their strengths and weaknesses, you can compensate them by for example, buying raw materials with higher quality.

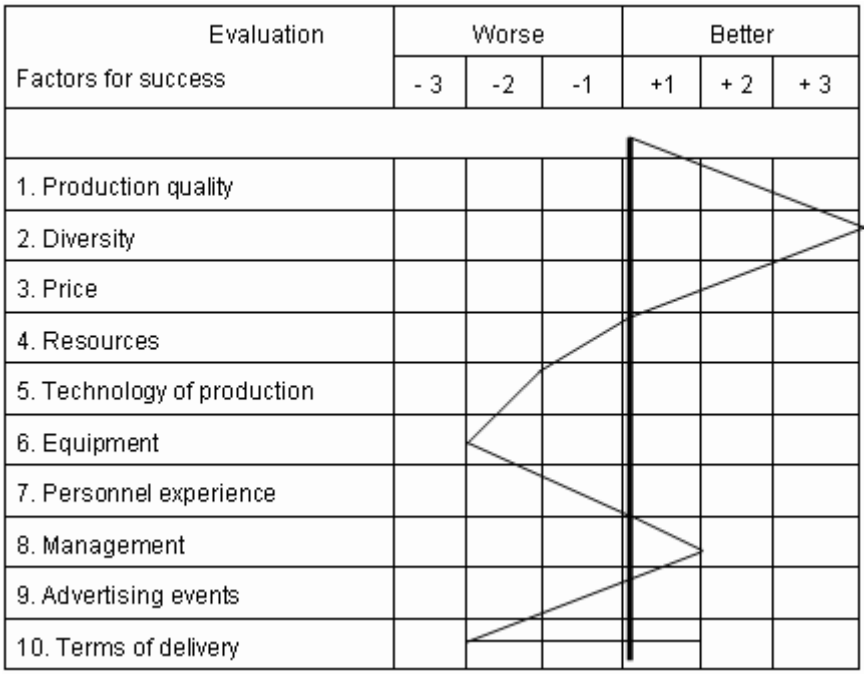


Figure 2.1.: Example for a strength-weakness profile
Source: http://www.innosupport.net/index.php?id=2189, 2016-02-23 16:16

2.2. Performed competitor analysis

Due to the fact that our diploma project is very technology-dependent, the competitor analysis only played a minor role in this project. For this reason, the extent of the analysis is rather small and not all theoretical processes were implemented. There are a few products available which provide diverse amplification of different signals or sounds. Only four of them are similar enough to our product to describe them more exactly.

2.2.1. Doorbell amplification

This tool provides emergency paging and doorbell intensification, which helps people to ring for help or hear their doorbell loud enough, also in their cellar or backyard. The intensifier is portable and you can choose between eight different doorbell sounds. The volume is infinitely variable and the receiver additionally disposes of a light source to optically alert the user when the doorbell is ringing. The receiver is powered by a 3V lithium battery and the sender has to be plugged into an socket. According to the producer, the tool can receive signals up to 100 metres in the open. The tool costs 59.90 € and can be bought online at www.senioren-onlineshop.de. The button to ring for help can only be bought on request. The scope of delivery includes a transmitter, a receiver and an instruction manual.

Figure 2.2.: Emergency paging and doorbell intensification tool

Source: http://www.senioren-onlineshop.de/Funk-Personenruf-bis-ca-100-m-mobil-und-erweiterbar, 2016-02-23 17:01

2.2.2. Ring tone intensifier

This tool provides ring tone intensification with flash light to hearing impaired or elderly people. It is only usable for landline phones and provides three ringtones to choose from. Its volume is infinitely variable and can be up to 95dB. The tool has to be integrated into the phone line to notice an incoming phonecall. The scope of delivery includes the intensifier, a telephone line, a power supply and an instruction manual. The tool can be bought on different websites and costs between 29.95 € (www.senioren-onlineshop.de) and 36.33 € (www.amazon.de).

Figure 2.3.: Ring tone intensifier

Source: http://www.senioren-onlineshop.de/Anrufverstaerker-Ring-Flash-100-Telefon-Zusatzklingel-Blitz, 2016-02-23 17:17

2.2.3. Ring tone intensifier with doorbell adapter

The ring tone intensifier is the same tool as above but contains an additional small wireless receiver. The tool receives signals from a wireless adapter unit which observes the doorbell. The wireless doorbell adapter unit has to be attached next to the doorbell. The tool provides three ringtones and two doorbell sounds to choose from. Furthermore, the tool has an interface to notice an additional occurring sound. Therefore, a second wireless adapter unit has to be installed next to the tool which causes the sound that needs to be intensified. As mentioned above, the tool has a flash light to optically alert the user when it receives a signal. The tool is available on different websites and costs between 69.95 € (www.senioren-onlineshop.de) and 72.00 € (www.amazon.de), the second wireless adapter unit costing extra. The scope of delivery contains the intensifier, the wireless doorbell adapter unit, a telephone line, a power supply and an instruction manual.

2.2.4. Amplicomms

Amplicomms is a special brand from Audioline GmbH. According to their website (www.amplicomms.com), the business produces a wide variety of specialized products for hearing impaired and elderly people. *"Under the amplicom brand name we offer a range of extremely specialised phones for users with impaired hearing and sight and for elderly people. The functions of these phones are totally oriented to the needs of persons with audiovisual handicaps, but can naturally also be used at home and in the office by users with and without hearing impairments.*

Figure 2.4.: Ring tone intensifier with a wireless doorbell adapter unit

Source: http://www.senioren-onlineshop.de/Anrufverstaerker-Ring-Flash-250-Tuerklingelverstaerker-Blitz, 2016-02-23 17:43

All of the models in this range optimally combine functionality, technology and design, and offer features such as compatibility with hearing aids, extremely high reception volume and extra-loud ringing tones." http://www.amplicomms.com/index.php?en_amplicomms2016-02-25 13.52

It can be assumed that Amplicomms is aiming at the same customer base (except visually impaired people) as we do. Mainly, Audioline produces mobile phones for elderly people. As per their website, more than 10 million Audioline devices have been sold in Germany. It can be expected, that their market share in the range of hearing impaired people is rather high. They distribute their products online on a wide range of websites in Germany and Austria.

2.2.5. Summary

The competitor analysis revealed that tools for hearing impaired people already exist. However, none of the tools seemed to be as developed as ours. The tools are only applicable for a certain scope but none of them is as flexible concerning sound recognition as our product.

Amplicomms seems to be the greatest seller concerning assistance tools for hearing impaired people in Germany and Austria.

3. Patent search

During the patent search, we looked for existing patents in order to inform ourselves about existing tools and technologies that might be useful to us, furthermore, we performed it to avoid violating legal protections.

3.1. Intellectual property

In general, intellectual property refers to creations of the mind, for instance inventions, literary and artistic pieces of work and names used in commerce.

Intellectual property is a fundamental principle of capitalism, protected by law, in order to earn recognition and financial benefits from what a person has created. The goal of the system of intellectual property is to the keep balance between interests of innovators and the public interests.

There are many different forms of intellectual property rights, the most important which are listed below.

- Copyright: It gives the creator of the original work exclusive rights, but is limited to a certain time span.
- Patent and Utility model: a right given to an inventor, which excludes others from achieving profit with the invention
- Trademark: a recognisable sign, design or expression to distinguish products or services
- Industrial design right: protects the visual design of objects that are not purely utilitarian

3.1.1. Patent

When you have for example accomplished new insights in an area and you do not want anyone other than you to profit from these insights, you have two options: concealment or protection by patenting.

A patent is an exclusive right for an inventor or assignee granted by a sovereign state. Therefore patents are bound to a certain region, additionally they are limited to a specified period of time (usually between 10 and 20 years maximum, in Europe 20 years).[1]

[1] Patent - Wikipedia, https://en.wikipedia.org/wiki/Patent, 2015-10-14

The exclusive right prevents others from commercially making, selling, using, importing, or distributing a patented invention without permission of the patent's owner.

3.1.2. Utility model

The utility model is also an intellectual right to protect inventions. It is similar to the patent, but it has a shorter term (about 6 to 15 years, in Europe 10 years) and less stringent patentability requirements.[2]

Although most countries determine that inventions, protected by a utility model, have to be new, there are mostly no substantive examinations needed. Utility models are usually granted by just checking the application formalities.

The most famous example of the utility model is the German and Austrian "Gebrauchsmuster", which influenced some other countries such as Japan or Indonesia. Contrary to the European patent, processes and methods cannot be protected. Additionally, the maximum lifetime is only half as long (10 instead of 20 years). Some further interesting characteristics of a "Gebrauchsmuster" are:[3]

- Prior art considered for examining novelty and inventive step is more limited, since oral disclosures and prior art outside of Germany are not taken into account.
- There is a six month grace period provided for prior art. For example you are allowed to apply for a "Gebrauchsmuster", even if there was a written disclosure three months ago.
- "Gebrauchsmuster" are, like most utility models, not substantially examined before being granted.
- The Austrian "Gebrauchsmuster" also includes protection for logic algorithms for computer software, processes and therapy methods for animals.

[2] Utility model - Wikipedia, https://en.wikipedia.org/wiki/Utility_model, 2015-10-14

[3] Gebrauchsmuster - Wikipedia, https://en.wikipedia.org/wiki/Gebrauchsmuster, 2015-10-14

3.2. Patent law

3.2.1. Requirements for assigning a patent

When applying for a patent, you have to disclose your discovery. Therefore, the work is made public for everyone once you submit the proposal.

In order to patent an invention, it must fulfil nationally given guidelines which are nearly the same in the whole western world. The European patent office (EPO) defines a patentable invention according to the European patent convention (EPC 15th edition, September 2013), article 52:

1. *European patents shall be granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application.*
2. *The following in particular shall not be regarded as inventions within the meaning of paragraph 1:*
   a) *discoveries, scientific theories and mathematical methods*
   b) *aesthetic creations*
   c) *schemes, rules and methods for performing mental acts, playing games or doing business and computer programs*
   d) *presentations of information*
3. *Paragraph 2 shall exclude the patentability of the subject-matter or activities referred to therein only to the extent to which a European patent application or European patent relates to such subject-matter or activities as such.*

Therefore, novelty, usefulness and non-obviousness are essential for an invention being patented. Without these factors it is almost impossible to acquire exclusive rights in the meaning of patents.

3.2.1.1. Novelty

Novelty is probably the most important requirement for patentability. Hence, an invention can not be declared new if it has been known to the public before the date of submitting the patent application (EPC 2013, article 54).

The main concept behind this requirement is to prevent prior intellectual work from being patented. Thus, it is not possible to limit someone who has done it before by claiming it to be an invention of yours.

Usually, for assessing the novelty of an invention, a search through 'prior art' is performed that helps to assure that your invention is actually new. Therefore, it is obligatory to search

large patent databases for publications by matching keywords. Nonetheless, it is impossible to guarantee the novelty of an invention, since one might not be able to take account of every single existing publication.

3.2.1.2. Inventive step and non-obviousness

According to most patent laws, inventions have to be sufficiently inventive (non-obvious) in order to be patented (EPC 2013, article 56). Therefore, an invention which is obvious for an expert can no be patented.

The underlying purpose of the inventive step (used in Europe), or non-obviousness (used in the US) principle, is to avoid protections for inventions which only follow from normal product design and development.

3.2.1.3. Industrial applicability

Apart from the previous criteria, a patent can only be granted when it is susceptible of industrial application (EPC 2013, article 57).

Therefore it is only possible to claim a patent right, when the applicant actually uses the invention. This measure aims to save inventions without the goal of profitable use from being patented.

3.2.1.4. Exclusions from patentability

In order to enable a well functioning patent law it is needed to exclude certain subjects from patentability.

Examples for exclusions (EPC 2013, article 53):

- inventions contrary to law and order or morality
- discoveries ($\neq$ inventions)
- scientific theories
- mathematical methods
- aesthetic creations
- schemes, rules and methods for performing mental acts
- playing games or doing business
- computer software

- presentations of information
- plant or animal varieties
- methods for treatment of the human or animal body by surgery or therapy
- diagnostic methods practised on the human or animal body
- etc.

3.2.2. Patent specification

The patent specification is needed when applying for a patent. It describes the invention and sets out the scope of protection. Due to the complexity of a specification which protects an invention in the best way, the application is commonly written by a legal expert.

3.2.2.1. Contents of a patent specification

In order to describe the invention with all needed details, most patent offices require the following contents:[4]

- description of the background and overview of the invention
- representation of the current state of the art
- claims of the patent
- representation of the problem
- solution for the existing problem
- representation of advantages
- figures (optional)

3.2.2.2. Structure of a patent specification

By setting a uniform structure for patent specifications, working with them is simplified. The following structure is commonly used by many patent offices:[5]

- cover sheet with title, summary and bibliographic data
- name of the invention, with the problem representation, examples, etc.

[4]Patent Applications, http://inventors.about.com/od/patentsbasics/a/Specifications.htm, 2015-10-14

[5]Patent specification - Wikipedia, https://en.wikipedia.org/wiki/Patent_application, 2015-10-14

- patent claims (main claim and sub claims)
- figures
- search reports

3.2.2.3. IPC and CPC Codes

The IPC and CPC codes are patent classification systems. When a patent office publishes a patent application or grants one, it classifies the invention using IPC or CPC codes. Therefore these categorisation classes are an essential aid for people who want to search patent databases.

The International Patent Classification (IPC) divides all kinds of technologies into over 70000 categories. Theses classes are hierarchically structured according to the technical field of the invention.[6]

The newer system, the Cooperative Patent Classification (CPC), extends the IPC. This categorisation is jointly managed by the European and the US patent office and is constantly expanded whenever new technical fields emerge. The CPC is divided into nine sections, which contain hierarchical sub divisions, namely classes, sub-classes, groups and sub-groups. Estimated, there is a total of 250000 categories.[7]

3.2.2.4. Patent Kind Codes[8]

The Patent Kind Code is a system for patents and patent applications which simplifies expressing the status of a patent specification. A typical patent nomination consists of the following three parts: the region code for the applied area, a unique patent number and the Patent Kind Code.

Example: US 6453500 B1

The most important Patent Kind Code examples are:

- A: publication of the patent application
- B: granted patent (e.g. in Austria)
- C: granted patent (e.g. in Germany)
- T: translation
- U: granted utility model

[6] EPO - IPC (International Patent Classification), http://www.epo.org/searching/essentials/classification/ipc-reform.html, 2015-10-14

[7] EPO - Cooperative Patent Classification (CPC), http://www.epo.org/searching/essentials/classification/cpc.html, 2015-10-14

[8] Patent Kind Codes, http://www.cas.org/content/references/patkind, 2015-09-24

3.2.3. Patent offices

A patent office is an organization, governed by a state, which controls everything concerning patents. These offices may grant or reject the patent application based on whether or not the requirements for patentability are fulfilled.

3.2.3.1. National patent offices

National patent offices are able to grant patents for the specific country which they represent. For instance, if a person wants to apply for a patent being valid in Austria, Germany and Italy, three applications need to be submitted, one for every country.

Since it would become a lot of effort when applying for a patent in more than just a few countries, international patent offices were established.

3.2.3.2. International patent offices

An international patent office is able to release a patent in all its member organizations. The largest patent office worldwide is the World Intellectual Property Organization (WIPO) with 142 member countries. Applying for a patent for all these countries can therefore be done by submitting only one single application. However, the granting processes duration can last up to three years.[9]

Apart from the WIPO, there are other international patent offices, like the European Patent Office (EPO), which includes all members of the European Patent Convention (EPC). Due to the smaller amount of members, the granting process for European patents is much faster than for international ones.

3.2.4. Patent search

Performing a patent search can be exhausting, since extracting the relevant pieces of information is often strenuous. Nonetheless, performing a prior art search is one of the most important tasks during product development.

3.2.4.1. Advantages of performing a patent search

At some point inventors want to make use of their developed product by distribution. Since distribution is only allowed if there are no existing patents restricting the technologies used by the product, it becomes essential to know about similar products and according patents. If

[9] World Intellectual Property Organization - Wikipedia, https://en.wikipedia.org/wiki/World_Intellectual_Property_Organization, 2015-10-14

the product is released without caring about possible patent infringements, the distributor can easily get into serious trouble.

Apart form avoiding conflicts with existing patents, a prior art search also helps to get ideas for one's own product. When searching for patents one may stumble upon solutions to current problems, already solved by others, or find out about important features never even thought of. With this additional inspiration it becomes a lot easier to develop the best product possible.

3.2.4.2. Patent search procedure

A patent search requires accurate working. To ease the process of a patent search, the following steps should be respected:

1. Figuring out characteristics of the invention:
    - key words
    - synonyms
    - abstraction level
    - etc.
2. Starting the patent search:
    - analysing patent specifications
    - analysing citations
    - analysing categories
3. Refining the search:
    - using refined keywords
    - trying out new combinations
    - using different data sources

3.2.4.3. Patent search platforms

The easiest way to search for patents is using the internet. Apart from common search platforms, like Google, Wikipedia or internet forums, there are websites especially made for patent searches. These platforms are databases, accessible via the internet, provided by patent offices. These databases are free of charge and enable an easy way to search by oneself.

The most relevant patent databases for our case are the following two:

- **Espacenet:** Database of the European patent office (https://ep.espacenet.com/)
- **DEPATISnet:** Database of the German patent office (https://depatisnet.dpma.de)

3.2.4.4. Professional patent search

Most patent offices provide a commercial and professional patent search. The advantage of this search is not needing to perform a search by oneself, as the only thing needed is to submit a detailed description of one's invention. Due to experienced employees the patent search is more accurate compared to a search performed by oneself.

The Austrian patent office (Österreichisches Patentamt - ÖPA) offers a professional prior art and novelty search for every specific technical problem. Exclusively for diploma, bachelor or master theses, they offer a free patent search.

3.3. Performed patent search

During the patent search, we looked for existing patents. Firstly, we searched on our own to get the results. We mostly used the patent search engine provided by Google (https://patents.google.com), since Google's patent platform allows easy content based keyword searching, considering the most important patent offices (US, EP, DE,...). After we found a matching result, we looked it up on the European patent office database (Espacenet).

Afterwards, we requested the professional search offered by the ÖPA to ensure the correctness and completeness of our own search.

3.3.1. Our search

All in all, we found about five patents, but only two of relevance. The patents only cover a bell system for the elderly, where it is possible to notify them via optical alerts or GSM transmitters.

3.3.1.1. CN 202551174 U

Source:
http://worldwide.espacenet.com/publicationDetails/biblio?CC=CN&NR=202551174U&KC=U
2015-10-06 20.28

Overview
The utility model, granted in 2012, describes a ring recognition device, aiming to identify if a specific chime or alarm signal has been sent. The utility model protection only covers China, since there is no patent family.

The device
This device comprises the following components, as seen at figure 3.1:

(1) a microphone

(2) an amplifying filtering circuit

(3) an analogue digital conversion circuit

(4) a ring tone recognition module

(5) and a GSM transmission module

With these components combined within a single device, the inventor is able to perform a bell recognition literally out of the box. Our concept is very similar to this strategy, since all components are also placed within a single device.

Nevertheless, our tool differs as regards patent invention in some ways, for instance, not having a GSM transmitter or an amplifying circuit. With these missing components, the sound processing flow is different from the invention.

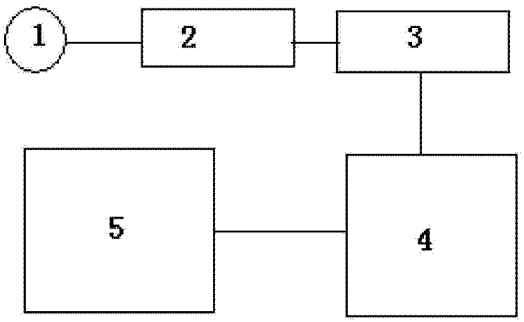


Figure 3.1.: Schematic view of the bell recognition device

Source: http://worldwide.espacenet.com/publicationDetails/originalDocument?CC=CN&NR=202551174U&KC=U (Page 5 - Drawings), 2015-10-06 19.22

Claims

The utility model describes three claims:

0001 *One kind of a bell recognition apparatus, characterised by comprising a microphone (1), an amplifying filter circuit (2), an analogue digital conversion circuit (3), a bell recognition module (4) and a GSM transmitter module (5). The bell (1) is connected to the amplifying filter circuit (2), this circuit is connected to the conversion circuit (3). The conversion circuit is connected to an microcontroller (4) port and the GSM transmitter (5) to the microcontroller.*

0002 *A bell recognition apparatus according to claim 1, characterised by the recognition module being a single chip*

0003 *A bell recognition apparatus according to claim 1, characterised by the GSM chip transmitting a network alarm message when receiving a signal from the microcontroller.*

Resulting form the declared claims, violating the patent is only possible by building a device with exactly the same parts in the same order (claim 1).

Since the second and third claim references to the first, constructing a bell recognition device, where the analysis is performed by just one chip or using a GSM module, is legitimate if you do not use the same-structured elements.

Summarisation

Although the invention has some similarities to our device, there are still differences. According to the formulated claims, the patent does not conflict with our work.

Even if the claims collided with our aspects of the invention, it would not matter, since there are no legal protections outside of China, since the inventor only applied for a patent registration protecting the device there.

3.3.1.2. CN 201556267 U

Source:
http://worldwide.espacenet.com/publicationDetails/biblio?CC=CN&NR=201556267U&KC=U
2015-10-06 19.46

Overview
This utility model, granted in 2010, describes a twinkling doorbell system for people with hearing difficulties. The protection ended on January 25th 2012.

Description of the invention
Often, the elderly with hearing impairments cannot hear the doorbell ringing. Therefore, they have to be reminded by an optical signal.

This invention describes a system, where the doorbell is connected to various light bulbs positioned at well-marked places inside a room. These lamps go on when the doorbell rings. The main advantage of this structure is its simplicity.

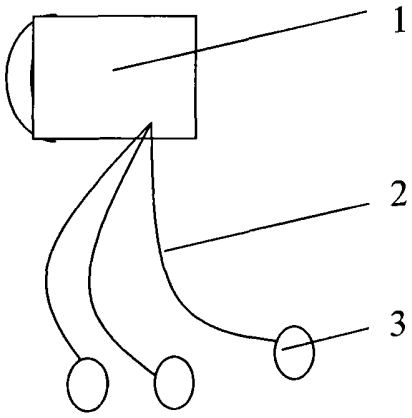


Figure 3.2.: Schematic view of the shiny belt doorbell: The system consists of the bell (1), connecting wires (2) and light bulbs (3).

Source: http://worldwide.espacenet.com/publicationDetails/originalDocument?CC=CN&NR=201556267U&KC=U (Page 4 - Drawings), 2015-10-06 19.22

Claims
The utility model claims the following characteristics:

0001 A shiny doorbell, which is characterised by comprising the doorbell, wires and light bulbs. The wires connect the bell with a series of light bulbs, located at obvious indoor places. When the doorbell rings, the light bulbs go on.

The claim will not conflict with our product, since we have the light source directly installed within the device. Furthermore, our device has no doorbell built in and hence only recognises the sound of an existing one.

The only thing which is identical to our invention is that a light source illuminates when the bell rings in order to notify people with hearing difficulties.

Summarisation
In short, this invention shares the same idea as ours but the execution has almost nothing in common. Concerning the claim, there is no conflict, and even if there was one, it would not influence our project, since the whole utility model already expired.

3.3.1.3. WO 2008067638 A1

Source:
http://worldwide.espacenet.com/publicationDetails/description?CC=WO&NR=2008067638A1&KC=A1&FT=D 2015-12-30 12:17

Overview
This world wide application describes a personal unit for hearing impaired users which notifies them of a sound event detected in its surrounding environment.

Since this is only an application, it would not forbid any commercial actions with our product. Nevertheless, it would not be possible to patent a similar invention, since the inventive step would not be fulfilled thereby.

Description
This patent describes a system, which consists of various detection units. These units are installed around the house. The detection units may comprise a door bell detector, a fire alarm detector, a phone ring detector, etc. Additionally, each detection unit has a wireless transmitter for transmitting a signal to the portable receiver worn by the user, close to the body.

When the portable receiver receives a signal from one of the detection units, it warns the user with a vibration. The receiver typically has light indicators with a symbol or a word underneath for indicating which detection unit generated the signal (e.g. four lights for "door", "fire", "phone" and "sound").

Claims
The application has multiple claims, the main claim is listed below:

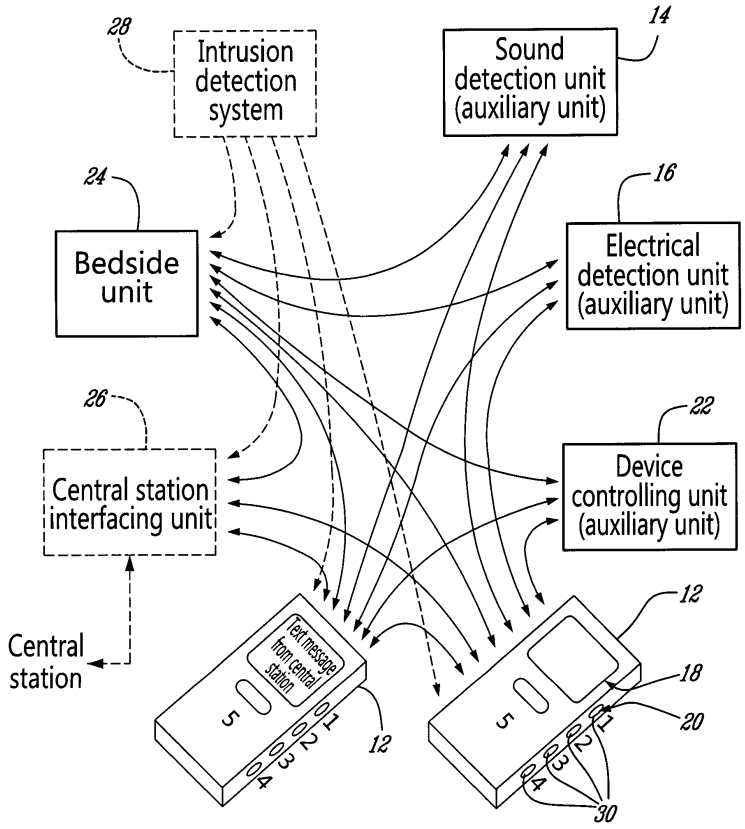


Figure 3.3.: Schematic view of the sensing system: The system consists of various detection units, a central unit (26) and a portable receiver (12)

Source: http://worldwide.espacenet.com/publicationDetails/originalDocument?CC=WO&NR=2008067638A1&KC=A1&FT=D (Page 35 - Drawings), 2015-12-30 12:30

0001 A personal unit for notifying a deaf/hearing-impaired user of a sound event in its surrounding environment and for communicating an immediate assistance request to a central station, said personal unit comprising:

- *a transceiver for receiving a sound event message representative of said sound event detected in said environment,*
- *an output module for notifying said user of said sound event message, and*
- *an input module for inputting said immediate assistance request, said request to be communicated to said central station using said transceiver;*
- *said transceiver being further for receiving an inquiry message initiated by said central station in response to said request,*
- *said output module being further for displaying said inquiry message, and*
- *said input module being further for inputting an answer to said inquiry message, said answer to be communicated to said central station using said transceiver.*

Summarisation
Even though this application describes a helping device for hearing impaired people, the approach is different to ours. The main distinction is that this systems consists of multiple detection units. Therefore, this application (if granted) would not restrict our work.

3.3.2. ÖPA search

In addition to our search, the Austrian Patent Office (ÖPA) found multiple patents related to our product. Most of these patents cover recognition and alarming systems.

In order to get results form the ÖPA, we had to describe the main aspects of our invention. The search request and the results are contained within the appendix.

3.3.2.1. US 8269625 B2

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=US&NR=8269625B2&KC=B2&FT=D 2015-12-30 17:31

Overview
This patent, granted in the Untied States (2012) describes a signal processing and detecting system for audible alarms generated by smoke detectors, carbon monoxide detectors, and other types of detectors.

Description
Due to the lack of reliable warning systems, the inventor created a system which can reliably detect audible alert signals generated by commercially available smoke, fire, and carbon monoxide detectors, including audible alert signals of different intensities. The disclosed system and process can also reliably detect audible alert signals in the presence of background noise of varying intensity.

Claims
This patent also has multiple claims, the main claim is listed as following:

0001 A method for detecting audible alert signals implemented in signal processing circuitry, the method comprising: generating a digital representation of a received audio signal; for each of a plurality of templates, comparing the digital representation of the received audio signal to the respective template, and generating a matching score representing a degree of match between the digital representation of the received audio signal and the respective template, wherein each template corresponds to an acceptable audible alert signal timing pattern, and the plurality of templates encompass an acceptable range of variation in a timing pattern of a standard audible alert signal; and determining, based at least partly on the matching scores corresponding to the plurality of templates, whether an audible alert signal is present.

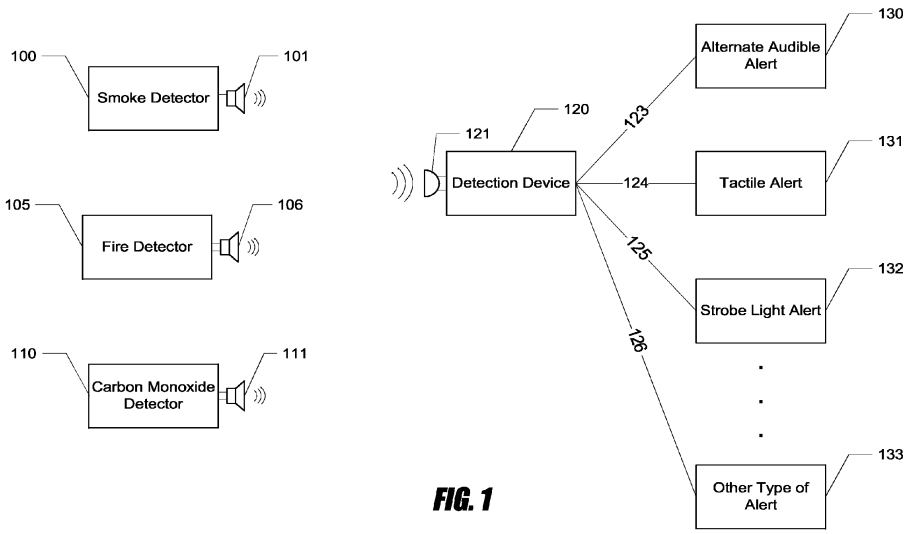


Figure 3.4.: Schematic view of signal processing system: Multiple detectors (100, 105 and 110) emit a warning signal; the detection device (120) detects them and alerts the user (130 - 133)

Source: http://worldwide.espacenet.com/publicationDetails/originalDocument?CC=US&NR=8269625B2&KC=B2&FT=D (Page 3 - Drawings), 2015-12-30 17:46

Summarisation

This patent specifically aims to detect standardised (US) fire related alarms. The detection approach is similar to ours. Therefore we would not be able to patent our product, since the inventive step can not be fulfilled.

3.3.2.2. WO 2011000113 A1

Source:
http://worldwide.espacenet.com/publicationDetails/description?CC=WO&NR=2011000113A1&KC=A1&FT=D 2015-12-31 13:37

Overview

This world wide patent application, submitted in 2011, describes a sound and voice detector for hearing impaired or deaf persons.

Description

This warning device for hearing impaired persons provides the possibility of detecting sound events in the immediate environment. The detection units used can include phone, door bell, fire alarm or other type of sound detector.

The device continuously compares the digital information to ambient sound information which is converted into ambient digital information and alerts the individual with an alerting signal when the pre-recorded digital information matches the ambient digital information corresponding to the warning signal.

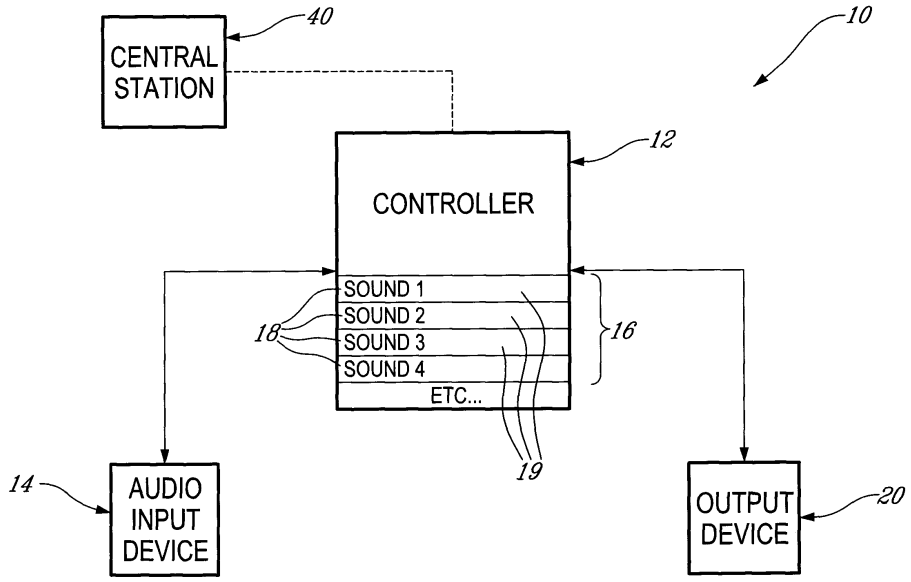


Figure 3.5.: Schematic view of the sound and voice detector: The central station (40) consists of an audio input device (14), an output device (20) and a controller (12) which compares the input signal to the previously saved sounds

Source: http://worldwide.espacenet.com/publicationDetails/originalDocument?CC=WO&NR=2011000113A1&KC=A1&FT=D (Page 39 - Drawings), 2015-12-30 13:49

Claims

This patent claims almost one hundred aspects. The first (and main) claim is listed as following:

0001 A system for notifying a deaf/hearing impaired user of a sound event and/or a word spoken by the human voice produced in the ambient environment, said system comprising:

- *a controller providing for recording and storing a plurality of target sound events and target words;*
- *at least one audio input device for continuously capturing in realtime sound events and spoken words in the ambient environment and transmitting in real-time the captured sound events and captured spoken words to said controller; and*
- *at least one output device for receiving a signal from said controller that a given sound event or a given spoken word has been captured and for producing a notification signal thereby [...]*

Summarisation

The detector, capable of recognising a plurality of sounds including words produced by the human voice and notifying a hearing impaired person, is also very similar to ours. Hence we would not be able to patent our product, since the inventive step can not be fulfilled.

3.3.2.3. Further results

Additionally, the ÖPA search result listed further patents related to our description. Nonetheless, these publications do not exactly match.

WO 0074013 A1
An analysis station which analyses sounds recorded by the microphone. If the sound, for example, is a fire alarm, the station turns on a signal light.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=WO&NR=0074013A1&KC=A1&FT=D

DE 19816752 C2
A spectral analysis unit distinguishes between different audible signals. When the unit detects for instance a doorbell a vibration and light emitter alerts the user.

Source: https://register.dpma.de/DPMAregister/pat/PatSchrifteneinsicht?docId=DE19816752C2

KR 20110092479 A
A series of microphones that enables filtering sounds form background noise. When the system detects something, lamps will be turned on.

Source:
http://worldwide.espacenet.com/publicationDetails/description?CC=KR&NR=20110092479A&KC=A&FT=D&ND=3

US 4237449 A
Sounds like car horns, police sirens or fire alarms are detected by an analysis unit which lights up LEDs to inform the user.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?NR=4237449A&KC=A&FT=D&CC=US

JP 2004073417 A
A microphone records sounds in order to detect signals produced by kitchen appliances. A speaker amplifies the sound for hearing impaired persons.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=JP&NR=2004073417A&KC=A&FT=D

WO 2014168594 A1
A warning system comprising a wristband embodiment alerts a user when a warning signal occurred.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=WO&NR=2014168594A1&KC=A1&FT=D

US 2009154744 A1

Audible signals are recorded by multiple microphones. Depending on the recognised signal an according symbol will be displayed on a monitor.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=US&NR=2009154744A1&KC=A1&FT=D

JP 3043730 B1

A comparison unit is able to differentiate between known and unknown (e.g. surrounding noise) audible signals.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=JP&NR=3043730B1&KC=B1&FT=D

DE 4033673 A1

A small device (which fits into a pocket) alerts hearing impaired persons when an audible signal (baby alarm, bell, alarm clock, etc.) occurred.

Source: http://worldwide.espacenet.com/publicationDetails/biblio?CC=DE&NR=4033673A1&KC=A1&FT=D

3.3.3. Summary

The prior art search revealed that there are many existing publications in this technical area. Hence, our invention cannot be declared as entirely new. Due to this reason we are not able to patent this project, since the novelty can not be fulfilled.

Nonetheless, we are able to commercially use (selling, using, importing or distributing) our product, since we would not violate any existing patents or utility models. This could be relevant, if we continue this project after graduating.

4. Usability

4.1. Usability in general

4.1.1. What is usability?

The point of usability is to describe how easy and intuitive it is to use something, how uncomplicated the learning process and how satisfying the user experience is. Usability does not only deal with software or technical devices, but with all human-made objects that involve human interaction, for example, a computer program, a milling machine, a door handle, or the process of how to change a bike's tire. [1]

Figure 4.1.: Examples for bad usability

Source: http://www.gruenderszene.de/allgemein/veranstaltungstipp-sie-mussen-nur-den-nippel-durch-die-lasche-ziehn-usability-in-der-praxis, 2016-01-02 20:00

According to the International Organisation for Standardisation (ISO), usability can be described as *"The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use."*

Jakob Nielsen, a usability consultant and author divides usability as a part of usefulness into five elements:[2]

1. *Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?*

2. *Efficiency: Once users have learned the design, how quickly can they perform tasks?*

[1] Wikipedia - Usability, https://en.wikipedia.org/wiki/Usability, 2015-10-26

[2] Jakob Nielsen - Usability, http://www.nngroup.com/articles/usability-101-introduction-to-usability/, 2015-10-26

3. *Memorability: When users return to the design after a period of not using it, how easily can they re-establish proficiency?*

4. *Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?*

5. *Satisfaction: How pleasant is it to use the design?*

4.1.2. Why is usability important?

Good usability is crucial for every product to survive on the market, whether it is a website, a computer program or a physical entity like a bike or a watering can. If something is not easy to use, people are likely to not use it at all.

If looked at from a business perspective, improving the internal usability of used tools, software or processes helps saving money on training employees and improves the efficiency of your business.

A study by Jakob Nielsen in 2003 about the return on investment for usability showed very clearly how design projects are positively influenced by involving usability as a main part of the project.("*Return on investment (ROI) is the benefit to the investor resulting from an investment of some resource*"[3])

For the study, he collected data from 863 projects and analysed the benefits gained by improved usability. Based on his results, he found out that the best practice for usability in a project is to dedicate 10 percent of the total financial budget to usability.
By doing so, desired metrics for websites like visitor count, user productivity, or conversion rates increased by over 130 percent. ("*The conversion rate is the percentage of users who take a desired action*"[4])

While it may be more obvious to improve the usability of products sold by the company, one must not oversee the benefits gained by improving the internal usability. By doing so, it is possible to simultaneously reduce costs, avoid errors and have a higher working efficiency.[5]

In 2008, a second study concerning the ROI for usability conducted by Nielsen indicated that the improvement of key performance indicators decreased to just over 80 percent compared to over 130 percent in 2003. The reason for this are the decreasing benefits of usability paired with the almost constant costs. While a few years back it was possible to really stand out of the mass when having good usability on, for example, an online-shop, nowadays, as usability is much more present and a lot more companies invest in it, the positive effects of usability are a

[3] Wikipedia - Return on investment: https://en.wikipedia.org/wiki/Return_on_investment, 2015-10-27

[4] Jakob Nielsen - Conversion Rates: http://www.nngroup.com/articles/conversion-rates/, 2015-10-26

[5] Jakob Nielsen - ROI for Usability:
http://www.nngroup.com/articles/return-on-investment-for-usability/, 2015-10-26

lot smaller. However, this also means that not having good usability will have a much bigger negative impact than it would have years ago.[6]

4.1.3. Methods to improve usability

4.1.3.1. User Testing

This is an easy and frequently used method that consists of three components:

- Find representative users.
  In order to simulate a realistic use-case, the user testing has to be performed by users who fall in the target group of the project. An experienced IT-specialist cannot test, for example, a computer program and give representative insight on usability needs of other, less knowledgeable people.

- Perform representative tasks.
  Not only do the performed tasks have to be realistic, but they also have to take place in a realistic environment to be able to give useful information. Users in lab tests will, for instance, run into issues with lower contrast text or pictures much less frequent than actual real-life users.

- Observe the user.
  The last step is to observe the user behaviour, protocol what they do, where errors appear and in which areas they are successful. It is crucial not to interfere with the user in any way (for example by giving them hints, drawing their attention to certain elements) or otherwise the test will not represent a realistic use-case and the results will be meaningless.

To maximise the efficiency of this method, small tests between adaptations are a much better way to go than fewer big tests, since flaws can be identified and fixed faster, using less resources.[7]

4.1.3.2. Eye Tracking

The method of "eye tracking" uses sensors to monitor the motion of the users' eyes while they are using, for example, a web page.[8]

It can help answer a few basic questions concerning usability:

- Where are the users most likely looking?

- How long are users looking at specific elements?

[6] Jakob Nielsen - ROI decreasing:
http://www.nngroup.com/articles/usability-roi-declining-but-still-strong/, 2015-10-27

[7] Jakob Nielsen - Usability: http://www.nngroup.com/articles/usability-101-introduction-to-usability/, 2015-10-26

[8] Blickverlaufsmessung:
http://www.onlinemarketing-praxis.de/glossar/eye-tracking-blickverlaufsmessung , 2016-02-02

4. Usability

- How well can users orient themselves?
- Are there any elements users frequently miss?
- What are the "eye-catchers" on the website and which elements should be more visible to the user?
- How do users navigate through the website? Is the existing eye-movement equal to the desired eye-movement of the user? [9]

With the collected data, heat maps and saccade pathways can be created to visualise what users were most commonly looking at and how their eyes moved across the screen.

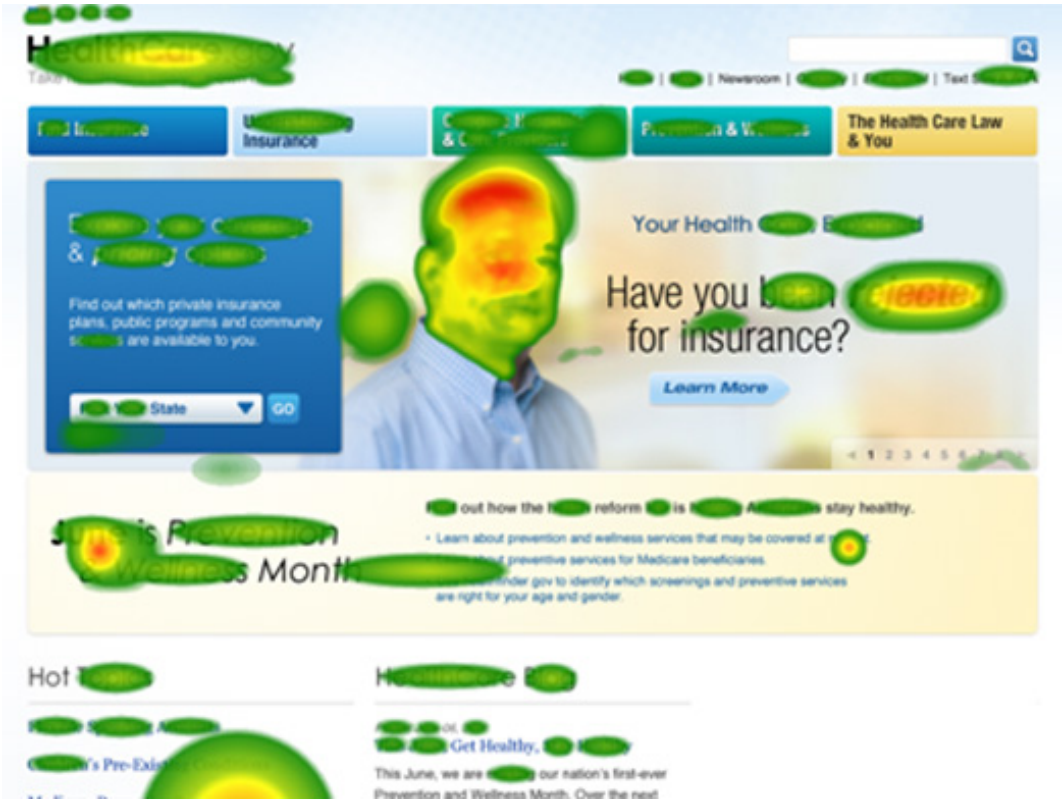


Figure 4.2.: A heat map showing what users look at most on this website

Source: http://www.usability.gov/how-to-and-tools/methods/eye-tracking.html, 2016-01-02

In addition to tracking the movement of the eyes, users can also be asked to "think aloud" when using the website to provide better information on why certain elements attract them more than others or what they think when looking at them.

[9] Eye Tracking Method: http://www.usability.gov/how-to-and-tools/methods/eye-tracking.html , 2016-01-02

4.1.3.3. Focus groups

Focus groups consist of multiple participants (usually between 5 and 10) and a moderator who leads the discussion. The participants should ideally resemble the target audience of your project, so the results are representative and can be used to get the right impulses for your project.[10]

The group talks about and discusses possible concepts, ideas and, for instance, existing designs, often with the help of creative techniques.

It is most commonly used during the planning phase of a project to determine the users' needs and preferences concerning a specific product such as a website or a mobile application.

Focus groups are a great way for:

- finding out how the users feel about your product, if it is what you want them to associate it with.
- finding our how users react to certain elements/ideas of your project.
- getting new ideas inspired by the participants input.

4.1.3.4. Other testing methods

Some other of the countless testing methods: [11]

- Ethnographic Field Studies
  Users are studied in their natural environment to gain realistic results.
- Interviews
  Researcher meets with user to question and discuss the users opinion on the topic.
- Diary Studies
  Users document their thoughts, feelings, etc. about a topic or product in regular intervals.
- Clickstream Analysis
  The screen inputs are recorded to gain knowledge about how users use and navigate the, for example, website.
- Email Survey
  Users are questioned about the program or topic via email.

[10] Focus groups method: http://www.usability.gov/how-to-and-tools/methods/focus-groups.html , 2016-02-02

[11] UX research Methods, https://www.nngroup.com/articles/which-ux-research-methods/, 2016-02-11

4.2. Usability for Mobile Apps

When it comes to mobile applications, usability and a consistent design are extremely important in order to create a well received product.

Usability guidelines help to keep functionality and design consistent across different applications and ensure that the user quickly gets accustomed to new applications. This, however is not easy, especially on mobile devices where the screen size is small and the application is often used in user-unfriendly situations such as bright daylight or stressful situations.

4.2.1. General usability and design principles

- Keep it sweet and simple.
  People don't like reading a lot of text, in fact, many people will skip over texts if they seem to take too much time to read. Using simple language and short sentences helps keeping the users attention.

- Use of images and icons.
  In many situations, using images and icons to illustrate the meaning or role of certain elements of your app is much more efficient than merely using text. They deliver a more pleasant user experience and a more beautiful application overall.

- Visibility and accessibility.
  All the content of an application should be displayed in a big and clear enough manner for the user to easily distinguish it from other elements inside your app. Furthermore, all the widgets of your app not only have to be easy to detect and identify as what they are but also easy to access, since touch control is not the most precise way to navigate and falsely selecting the wrong item can be really frustrating.

Figure 4.3.: Items have to be easily identifiable as what they are

Source: http://www.peachpit.com/articles/article.aspx?p=2209309, 2016-02-11

- Keep it consistent.
  In order to make that sure users don't get confused when navigating through your application, the look and operation of the different screens have to be consistent. Not only do menus and often occurring options have to be in the same place all the time, but it is also important that everything acts like it looks. For example, a basic button the user already

knows from various other applications must not be without any function, just present for aesthetic reasons.

- Leaving space for customization
  The design principle of android aims at giving users the best possible options to adjust settings, looks and functions. To support that mindset, choose for the user but give them options to change things if they want to.[12]

- Placement of clickable content
  Especially when using smartphones with a big screen, it can be problematic to reach every corner of it when using the smartphone with only one hand. Therefore, buttons, links, etc. ideally should be placed so the user can easily reach them.

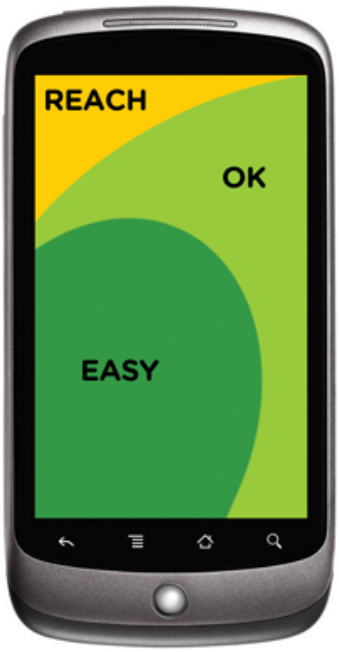


Figure 4.4.: Important elements should always be in reach of the user when using the application one-handed

Source: https://www.smashingmagazine.com/2012/07/elements-mobile-user-experience/, 2016-02-11

- Consider usage in different conditions
  This includes, for example, outdoor-use where high contrast is important to ensure the readability of the content or the use of the application in landscape mode where it still has to look and function beautifully. [13]

[12] Android - Design: http://developer.android.com/design/get-started/principles.html, 2016-02-10

[13] Mobile User Experience:
https://www.smashingmagazine.com/2012/07/elements-mobile-user-experience/, 2016-02-11

4.3. Usability for the elderly

4.3.1. Why it matters to us

Our mobile application will target users with hardness of hearing or reduced hearing ability. According to the online survey we conducted, about 20 percent of the questioned persons were older than 66 years and about 60 percent were older than 45 years. Since especially older users of smartphones are often not very confident when it comes to using applications, the design of our application has to support them in using it and make the experience as free from potential frustration as possible.

4.3.2. Existing studies and conducted research

While good usability has become a standard for every aspect of user-orientated technology and there are huge studies and a lot of resources about it, the aspect of the elderly-orientated usability, considering their habits and needs gets a lot less attention. In order to collect enough information, we not only looked at studies concerning mobile usability for elderly people but also at studies about web-usability or general usability of computer programs. We then tried to apply the gained knowledge to the circumstances of mobile applications.

4.3.3. Difference between older and younger users

Just as one would presume, users of different age groups act and react differently when using websites (the study concerns websites but is also applicable to mobile applications).

The study, conducted by Jakob Nielsen in May 2013 shows the differences between older and younger users and the hindrances that should be avoided.[14]

4.3.3.1. Physical differences

When growing older, a lot of things about the human body and its abilities tend to change:

- Visual ability
  The older a person gets, the harder they typically find it to read and identify text or graphics, also the ability to differentiate between colours decreases.
- Fine motor skills
  It gets continuously more difficult to precisely click or select what the user wants to.
- Hearing ability
  Hardness of hearing is very common amongst elderly people, but most of the time has no impact on using a website or an application.

[14]Mobile User Experience: https://www.nngroup.com/articles/usability-for-senior-citizens/, 2016-02-11

4.3.3.2. Behavioural differences

Not only do the physical abilities of a person change as they age, but the general mindset is also heavily affected by this process and leads to behavioural differences between users of different age:

- Hesitation and lack of confidence
  Elderly people tend to be much less likely to explore and try out things they have never done before when it comes to using websites or applications.

- Resilience
  According to the study, older users were more likely to give up on a task a while before younger users did.

- Blaming oneself
  When facing problems, a large portion of elderly users blamed themselves for it while only fewer younger users did so. This constitutes a big source of frustration older users can run into.

4.3.4. Usability rules for the elderly

Source: Linh (2013)

Quite often, usability guidelines for elderly people are the same as the ones for regular users. However, they might have a much bigger impact on the user experience when not or falsely implemented into the application. Here are a few guidelines that are especially important for app-design for an older target group: [15]

- Making them feel save
  As it is with the normal design of websites or apps, users must never be able to do something irreversible by accident. For seniors, this is especially important because they tend to be more hesitant and sometimes afraid to do things they don't already know.

- Arrangement of items
  To ensure users do not get puzzled when navigating through your application, the number and arrangement of items has to be well controlled. It is always better to have fewer elements that the user can actually perceive than to have tons of super important information for the user all displayed at once, causing frustration and confusion.

- Compensating for errors or misunderstandings
  During the design and developing process, things that could be done wrong have to be taken into account and ideally stopped from happening at all. This could be something like a hyphen in a place where you don't want it, something that can be fixed by giving an example of how the input should look like.

[15] Mobile User Experience: https://www.nngroup.com/articles/usability-for-senior-citizens/, 2016-02-11

- Avoiding drastic changes
  Most users don't like it when things change because it always triggers a process of reorientating and rethinking, something that especially older people don't like that much.

- Size of things
  While some elderly users might not mind smaller font sizes or pictures, the vast majority will. Therefore, all readable elements of your application should be bigger than usual. This however leads to less displayable content on the screen, so what will be displayed has to be really well thought out. Moreover, the buttons displayed have to be big enough to be easily pressed without accidentally touching something else.

- Language
  The content of the application should always be in the native language of the user, since language barriers can be especially frustrating for older users. Moreover, the kind of language used also has to be well chosen. Not everybody might know what, for example, the „WIFI SSID" is, so the application must contain as little misunderstandable vocabulary as possible.

- Input Methods
  Since older people often have a hard time typing on the tiny keyboard of smartphones, other input methods such as voice commands or the ability to choose between different keyboard-types should be considered.

- Icons with Text
  While it is good and necessary to use icons in your application instead of just plain text, the use of icons without any explanation can lead to a lot of confusion. Not everyone associates the same things with a certain picture. This can be seen in figure 4.5, where some users might think of a sketching program or a dictionary (because of the „A" formed by pencil, brush and ruler), instead of a place to download new applications.

Figure 4.5.: Icon of the App Store in IOS9

Source: http://www.appleibite.com/2014/11/22/app-store-free-button-replaces-get/, 2016-02-13

- Gestures
  Complex or hidden gestures should be avoided at all costs, since many people will not even know about their existence and will therefore never use them and maybe miss very important features of the application. This not only includes gestures like swiping from the side of the screen to bring up a menu, but also long presses for more options or the common „pinch to zoom" feature.

Part III.

Theoretical foundations

5. Hardware

5.1. Raspberry Pi

A Raspberry Pi is a small computer, based on a single board. It was brought to the market in 2012 with the aim to teach people software and hardware skills easily. Furthermore, it should help developing countries to computerize their everyday life due to the Raspberry Pi's low price.[1]

5.1.1. Hardware

Since the first release of the Raspberry Pi there have been multiple models launched. When purchasing a Raspberry Pi, the following models can be chosen from:

- A-Series:
  - Raspberry Pi 1 Model A
  - Raspberry Pi 1 Model A+
  - Raspberry Pi 3 Model A (to be released)[2]
- B-Series:
  - Raspberry Pi 1 Model B
  - Raspberry Pi 1 Model B+
  - Raspberry Pi 2 Model B
  - Raspberry Pi 3 Model B
- Raspberry Pi Zero
- Raspberry Pi Compute Module

Although all of the models are more or less armed with the same components, the hardware differs in some areas such as performance, connectivity options, size or use case.

[1] https://de.wikipedia.org/wiki/Raspberry_Pi

[2] According to the official Raspberry Pi blog, the Raspberry Pi 3 Model A is expected to be produced during 2016 - https://www.raspberrypi.org/blog/raspberry-pi-3-on-sale/, 2016-03-23 11:54

Processor

Except Raspberry Pi 2 and 3, who have a quad-core processor, all the other models have a single-core processor. The clock speed (without over-clocking) starts at 700 MHz (all Raspberry Pi 1 models) and goes up to 1200 MHz (Raspberry Pi 3).

RAM

The A-models and the first B-Model have a RAM-capacity of 256 MB, the following B-Models and the Raspberry Pi Zero have 512 MB RAM. With 1024MB, the Raspberry Pi 2 and 3 have the highest RAM-capacity of all so far produced models. Although the RAM seems to be pretty small, it is enough for such a tiny computer.

Pins

Every model has a certain number of pins for various purposes. Not only has a Raspberry Pi ground and voltage pins, but also GPIO-pins for general usages. The first Model A and Model B Raspberry Pi have 26 Pins, from which 17 are GPIO-pins (general purpose input/output). All the other models have 40 pins, whereof 26 are GPIO-pins. The only exception is the Compute Module, which aims to be used within a professional surrounding and has 200 pins (DDR2 layout). Furthermore, there are many different additional modules which can be attached to almost every Raspberry Pi to upgrade their hardware.

Network connectivity

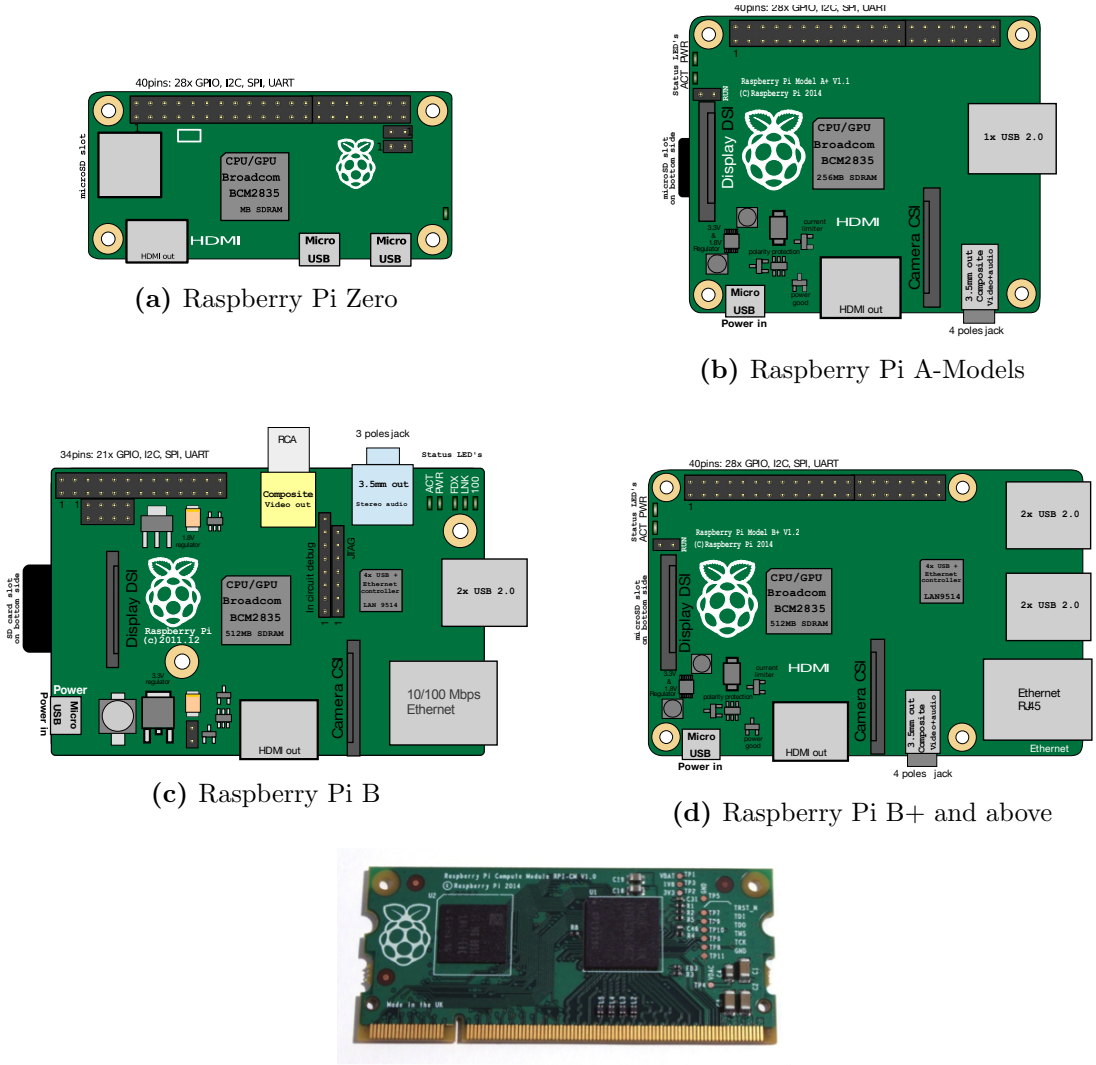
The main difference between model A and B is the network connectivity. Whereas model B has an ethernet port, model A does not support a network connection without using a WLAN stick or any other network components.

Use case

Depending on the use case, different Raspberry Pi models can be applied. When the Raspberry Pi has to be small and modest, the Raspberry Pi Zero can be used. For low power consumption, model A has to be used. Model B represents the allrounder of the Raspberry Pi family and can be used for small projects such as a media server or a weather station. The compute module is used for professional applications and services.

Board layout

The Raspberry Pis do not only differ in hardware characteristics but also in the arrangement of the connectors and ICs on the boards. The following figures show the different layouts used by the corresponding Raspberry Pi Models. Model Zero is the smallest one and has therefore not as many components as the other ones. Contrary to the A-Models, where the layout is the same for all revisions, the B-Models had a layout change between Version B and B+ which arranged the components in a better way.



(a) Raspberry Pi Zero

(b) Raspberry Pi A-Models

(c) Raspberry Pi B

(d) Raspberry Pi B+ and above

(e) Raspberry Pi Compute Module

Figure 5.1.: Layout of the different Raspberry Pi Models

Source: https://en.wikipedia.org/wiki/Raspberry_Pi#Connectors, 2016-03-28 15:59

5.1.2. Software

Nowadays, there are several open-source operating systems available for the Raspberry Pi. The installation can either be carried out by cloning the image of an operating system onto a SD-card or by the NOOBS-installer (new out of the box software). When using the NOOBS-installer, the software has to be downloaded and dragged onto the SD-card. When booting the Raspberry Pi, NOOBS will offer a range of operating systems to choose from. The chosen operating system gets installed automatically.

Raspian

Raspian is a Linux-distribution based on Debian. The image is approximately 3GB in size and has a graphical user interface. After booting the Raspberry Pi, the partition size can be

extended in order to use the full memory space for saving data. As the Raspberry Pi Foundation optimizes the image for every individual Raspberry Pi, it is recommended to always download the images from the official website.

Other operating systems[3]

Apart from the Raspian operating system, Linux offers several operating systems which seem to be running on the Raspberry Pi.

Pidora, a slimmed down version of Fedora, was only developed for the Raspberry Pi. In the beginning of Pidora, is was full of bugs and seemed to be unsuitable from a user's perspective. Although most of the teething troubles have been eliminated, Pidora is still not usable on certain Pi models with a RAM of 256MB.

Arch Linux is, compared to the other operating systems, clearly not for Raspberry beginners. It is very quick in booting but does not have a graphical user interface so the user must work with the command line. Arch Linux is mostly used by advanced users.

[3]Source: http://www.raspberry-pi-geek.de/Magazin/2013/05/Distributionen-fuer-den-Raspberry-Pi-im-Ueberblick/, 2016-03-24 13:40

5.2. Relay[4]

A relay is an electromagnetic switch in order to react to a small control current. The relay works with both electrical and mechanical components. When current starts flowing through a coil, an electromagnetic field is produced in order to pull a contact arm towards the coil. The contact arm closes the main circuit. When the control current stops flowing through the coil, the contact arm backs off the coil and the main circuit is opened.

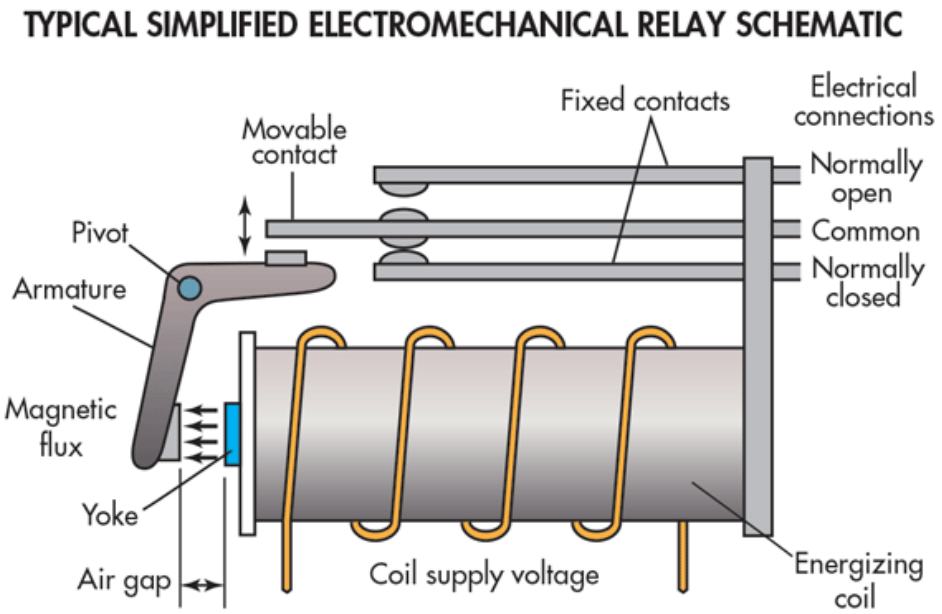


Figure 5.2.: Operating mode of a relay

Source: http://machinedesign.com/site-files/machinedesign.com/files/uploads/2014/07/relay_diagram.gif, 2016-03-24 16:43

As seen in the figure, there are 3 different contacts, between which can be switched:

- Normally Open Contact (NO)
  When the control current flows, the contact is closed in order to close the main circuit. When the relay is inactive, the contact is open.

- Normally Closed Contact (NC)
  The NC-contact represents the opposite of the NO-contact and is closed, when the relay is inactive. The NC-contact is used when the relay should work the other way round. The main circuit is not closed when the relay is active.

- Change-over Contact (CO)
  The change-over contact is used to connect the main circuit with the relay. The main circuit can either be connected between the CO and the NO-contact when the relay should close the main circuit when active or between the CO and the NC-contact to achieve the opposite effect .

[4]http://www.circuitstoday.com/working-of-relays, 2016-03-24 17:46

5.3. Qi[5]

Qi is a newly developed standard to transfer power without using any physical components between the transmitter and the receiver. Both the transmitter and the receiver contain a induction coil. The coil in the transmitter gets powered and creates an electromagnetic field, which can be received by a second induction coil. If the second coil gets close enough, the power will be transferred automatically. After receiving the power over the coil, the energy gets converted into electrical current in order to charge for example a battery. Until now, wireless charging has still some disadvantages in usage.

- Efficiency
  Due to losing most of the energy in heat, the efficiency of Qi wireless charging is about 40%. This results in higher electricity costs per charge and it takes much longer to fully charge a device. A decent cable has an approximate efficiency of 80%.

- Handling
  Whereas a phone can be used while charging by cable, the wireless charging only functions when the phone and the Qi transmitter are in direct contact, which complicates the usage of the phone.

Wireless charging has become more and more popular since big manufacturers like Samsung have built Qi-receivers into their newest smartphones. In addition, some furniture companies have started to produce pieces of furniture which already have Qi-transmitters built-in. Experts are looking forward to developing a wireless charging system where the electromagnetic field is so powerful that users only have to be at home to charge their devices.

[5] http://mentalfloss.com/uk/physics/26648/how-does-wireless-charging-work-and-is-it-actually-safe, 2016-03-26 17:27

6. Android

Figure 6.1.: Android logo and lettering

Source: https://en.wikipedia.org/wiki/Android(operating_system), 2016-02-13 14:00

6.1. What is Android?

Source: https://en.wikipedia.org/wiki/Android(operating_system), 2016-02-13 13:00

Android is an open source operating system for mobile devices, developed by Google Inc. Those devices are mainly smartphones and tablets, however Android also supports smartwatches using "Android wear" (announced March 2014) and cars using "Android auto" (announced June 2014).

It is mainly controlled via touch input, but can also be controlled via physical buttons or Google's voice control feature "Google Now", depending on the hardware it runs on.

As of February 2016, Android has by far the biggest market share amongst mobile operating systems. According to a survey by *Strategy Analytics*, Android had a market share of 84.6% during the second quater of 2014, topping out above Apple's iOS with 11.9% and Microsoft's Windows Phone with 2.7%.[1] The currently latest version of Android is Version 6.0 - "Marshmallow" and was released on October 5, 2015.

[1] Golem - Android läuft auf fast 85 Prozent aller Smartphones: http://www.golem.de/news/mobile-betriebssysteme-android-laeuft-auf-fast-85-prozent-aller-smartphones-1408-108290.html, 2016-02-14

6.2. Interface Elements and Usage

6.2.1. Homescreen

The homescreen is what the user sees when the device boots up or closes applications and is comparable to the desktop of Windows. It can contain the icons of the users' favourite apps and widgets that can display auto updating content like the weather forecast. The homescreen can contain several different pages (switched between by swiping left or right) and can keep the user from going through all the installed applications by providing the possibility to arrange the most used ones as liked.[2]

6.2.2. Taskbar

The taskbar is another defining feature of the Android operating system. It can show important information like battery status or network connectivity and also be used to toggle quick settings such as WIFI on-off, airplane mode or using the inbuilt LED-flash as a flashlight.

6.2.3. Navigation buttons

Android by default has three main buttons at the bottom of the screen: home, back and open-apps-overview. Depending on the manufacturer, these can be either on-screen where they can change place according to the device's orientation, or off-screen (mostly below). Some manufacturers also choose to modify Android, so that e.g.: the off-screen softkey for showing all open apps now opens an "options" dialogue and all open apps can be seen by long pressing the home button.

6.2.4. Menu

In Android, the menu, opened via an icon on the homescreen, is a collection of all installed apps, however, it isn't the go-to-place when wanting to do something. Instead, this is done almost completely by the homescreen (depending on the users' preferences and the manufacturers' integration of the homescreen). The menu is something manufacturers tend to modify very heavily, changing the look and feel of it, as well as adding functions like rearranging apps, having a separate page of favourite apps, allowing the user to uninstall apps directly and a lot more.

6.2.5. Applications

Applications or "apps" are one of the most important and success defining features of mobile operating systems and represent the parallel to pc programs. Virtually everything the user does

[2]Wikipedia - Android: https://de.wikipedia.org/wiki/Android_(Betriebssystem), 2016-02-16

on an Android device happens through an application, whether it is tweaking the settings of the smartphone using the "Settings" application, taking photos, installing new apps, playing games, checking social media sites or something else. Applications are stored on the Android device (contrary to computers, the exact location of the program can not be specified, although some modified versions offer the choice to install apps on the inserted SD card). Once installed, the icon of the app appears in the menu and can be put on the homescreen if requested by the user.

6.2.6. Widgets

Widgets could be best described as "a window inside an application". They vary in size and can be placed on the homescreen. The benefit of using widgets is the instant information of what is going on without the need to actually enter the application. A very commonly used widget for example is an e-mail widget that shows the last received message automatically.

6.2.7. Play Store

The Google Play Store (formerly "Android Market") is the default application to find and install new applications onto the Android device. However, contrary to iOS and Windows Phone[3], Android allows apps to be installed from external, uninvestigated sources if the related option is ticked in the settings application.

[3]Wikipedia - Windows Phone: https://de.wikipedia.org/wiki/Microsoft_Windows_Phone, 2016-02-15

6.3. Android Studio

Android Studio is Google's official integrated development environment and is based on JetBrains' "IntelliJ IDEA" development environment. It is specifically designed to develop Android apps and has replaced eclipse Android development tools as the official IDE for Android since its first stable release in December 2014. It is available for Windows, MacOS, and Linux Users.

6.3.1. Features

Android studio is a solid IDE with some of its key features being:

- Text editor
  Android studio's editor is based on the IntelliJ IDEA Editor and important features such as code completion and syntax highlighting.

- Support for all Android versions
  With Android Studio, the user can code apps for all Android versions and all types of end devices like smartphones, smartwatches and even cars.

- XML Editor
  XML files can be configured either via the graphical UI by dragging elements onto the screen of the, for example, phone, via the standard code editor.

- Monitoring features
  When running a coded application (either on a real device connected via USB or an emulated device), Android Studio can monitor the CPU and network usage of the application and provide helpful graphical feedback to the user. In Android Studio 2.0 which is currently (2016-02-17) in canary (preview) state, a GPU profiler was added, which can be used to investigate rendering outcomes and get a better understanding of possible causes of errors.

- ProGuard
  ProGuard is an open-source software that compresses, optimises and impedes the decompilation of Java bytecode and makes files smaller and more stable when running.[4]

- Gradle
  Gradle is the build automation system Android Studio uses to convert the written Java and XML code into bytecode. It was designed to be able to build big projects and supports incremental building where only changed parts of the code are rebuilt, which helps reducing build times. It also supports custom build logic that can be added via plugins.[5]

[4] Wikipedia - ProGuard: https://de.wikipedia.org/wiki/ProGuard, 2016-02-17

[5] Gradle Plugin User Guide:
https://sites.google.com/a/android.com/tools/tech-docs/new-build-system/user-guide, 2016-02-18

6.4. Coding Android Applications

6.4.1. Differences in comparison to regular Java coding

While Android programs are written in Java, the "Android Java" doesn't function exactly the same as the "regular" one does.

6.4.1.1. Libraries and Methods

While the source code of Android uses the standard Java-syntax, not all libraries available for Java are available for Android as well. Therefore, not everything that can be done in Java using one of the numerous libraries can be done in Android the same way. Apart from this, Android doesn't use a "main()" method that is executed as Java does, but methods like "onCreate()" or "onResume()" that are invoked depending on certain events or the users actions.[6] For more information, see Figure 6.2.

6.4.1.2. Program structure

A typical Java project can consist of various different files with different possible filetypes such as ".java", ".xml" or ".csv". Much more than Java however, Android relies on various different files in order to get to the finished application.

These files include:

- JAVA-Files
  They contain the program logic of the application, define how the app reacts to events/ user inputs, defines the apps' functionality.

- Android Manifest
  It provides essential information such as required permissions, app icon, app theme or launching activity to the Android system and is preconditional for a working app. [7]

- Default resources
  Static resources are used regardless of the device's hardware or if no other resource is available. This includes layout files, animations, drawables, color state lists, etc. [8]

- Alternative resources
  These kind of resources may vary, depending on which hardware the application is run

[6] Wikipedia - Comparison Java and Android:
https://en.wikipedia.org/wiki/Comparison_of_Java_and_Android_API, 2016-02-18

[7] Developers - App Manifest:
https://developer.android.com/guide/topics/manifest/manifest-intro.html, 2016-02-18

[8] Developers - Resource Types:
https://developer.android.com/guide/topics/resources/available-resources.html, 2016-02-18

on. The most important example are different layout files that are chosen according to the screen size of the device. [9]

- Gradle config files
  These files specify things like the target Android version or which build tools/plugins should be used.

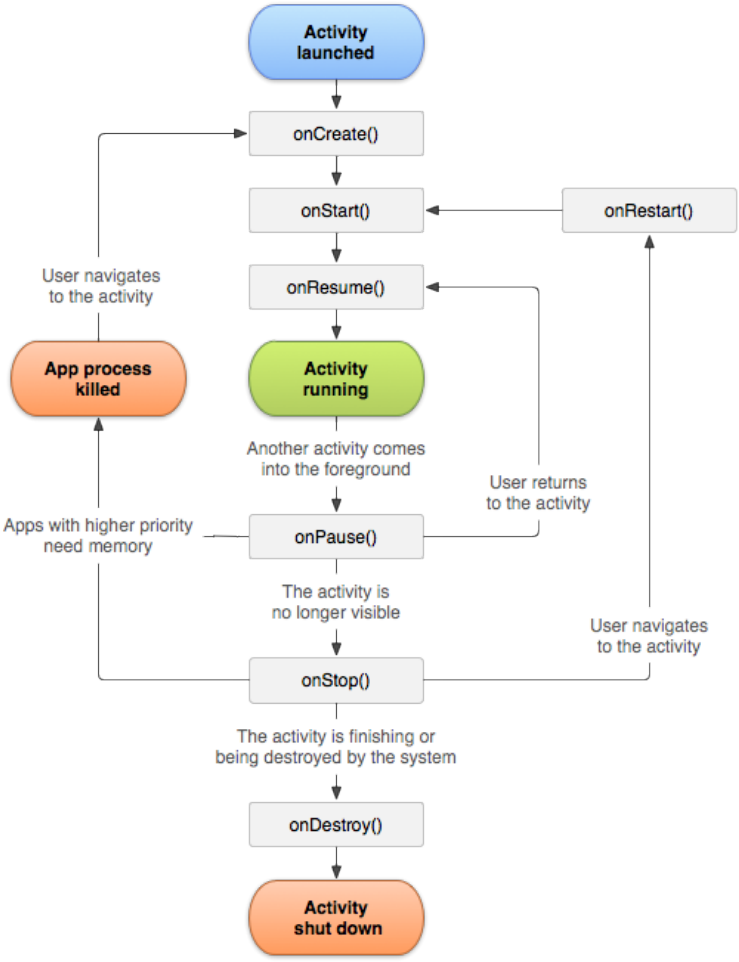


Figure 6.2.: Lifecyle of an Android Activity
Source: http://developer.android.com/reference/android/app/Activity.html

6.4.1.3. ART and Dalvik

ART and Dalvik are virtual machines that are run by the Android os and are responsible for executing applications. These virtual machines are different from the JVM and are the reason for the differences in code such as slightly different syntax, different available libraries and a different way of compiling code and resources.

[9] Developers - Resources:
https://developer.android.com/guide/topics/resources/overview.html, 2016-02-18

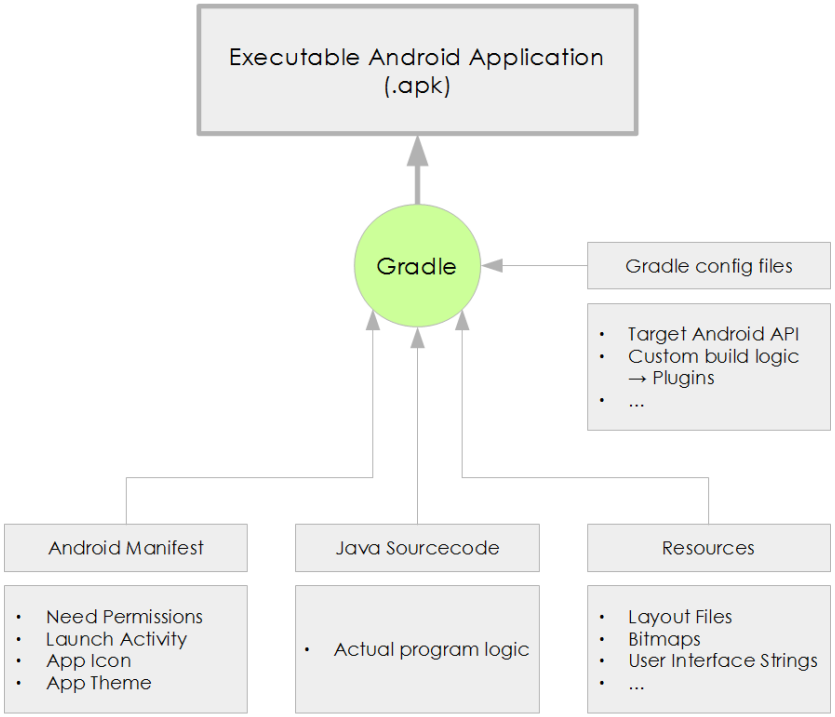


Figure 6.3.: Simplified process of the build ingredients of an Android application

Dalvik

Dalvik is the older option for interpreting code and was introduced together with the first version of Android. It has been Android's runtime environment for applications up until Android 5.0, where it was exchanged for ART.

Dalvik uses Just-In-Time compilation, which means that it converts the .dex files of an application into machine code at runtime and not beforehand. This happens every time an application is invoked. By doing so, installation times can be kept short and the memory usage of applications on the device stays very well manageable.[10]

ART

ART was introduced with Android 4.4 where it was available as an alternative runtime environment, however Dalvik was still used by default. With the update to Android 5.0, Dalvik was completely replaced by ART as the official Android runtime environment. The main difference between ART and Dalvik is that ART uses Ahead-Of-Time compilation, which means that applications are compiled into machine code during the first installation. By doing so, applications do not have to be compiled every time the app is started, ensuring faster startup times of applications and lower CPU consumption at the cost of longer initial installation times and slightly higher storage usage compared to Dalvik. In addition, there where also made im-

[10]Wikipedia - Just in time compilation: https://en.wikipedia.org/wiki/Just-in-time_compilation, 2016-02-21

provements to the Garbage Collector, debugging features and improved detail in exceptions and crash reports.[11]

6.4.1.4. Executing Programs

Java

In Java, the sourcecode is compiled into Java-bytecode. This code represents an instruction set which is the same, no matter which platform the program should run on. The only thing that differs, according to the target platform, is the JVM. It executes the Java-bytecode while being executed by the CPU of the machine it is running on. Therefore, Java applications can run on any platform, provided there's a JVM available for it.[12]

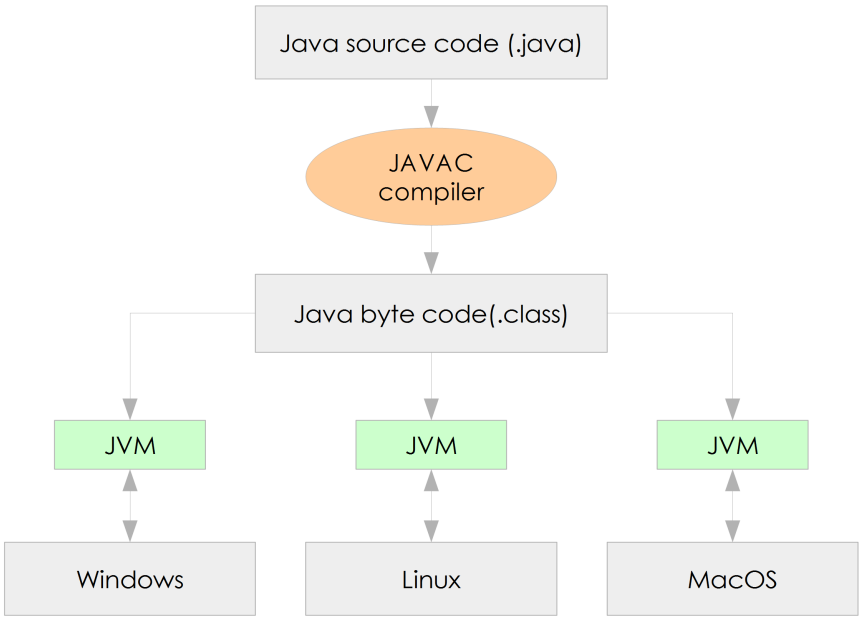


Figure 6.4.: Compiling and execution process of a Java program

Android

When an Android application is to be compiled, all the ".jave" files are compiled into ".class" files. These files are then compiled into Dalvik executables (".dex"). How the code gets compiled (target version, etc.), depends on the gradle settings of the project. The compiled resources (e.g. layout files), the uncompiled resources (e.g. bitmap), the ".dex" files and the Android Manifest are put into one ".apk" file that acts as a container, similar to a ".zip"file.

[11] Android - Art and Dalvik: https://source.android.com/devices/tech/dalvik/, 2016-02-21

[12] Stackoverflow - Java, platform independent, JVM: https://stackoverflow.com/questions/21810538/c-and-java-virtual-machine-code-execution, 2016-02-18

Signing

The last step before being able to use an application is signing it. Signing applies a digital certificate to the application that is needed for its installation process.

Apps can be signed in either debug or release mode, debug mode is used as long as the app is being coded and tested and release mode is being used when the app is ready for publishing.[13]

Debug certificates are created automatically by the Android SDK and use a private key with a known password so the user doesn't have to enter it every time changes are applied to the project.

When the time is ready to officially publish the application, the signed release version can be created, using its own certificate. For this, a keystore and a private key have to be created, which can be done by using Android Studios "Generate Signed APK" Wizard.

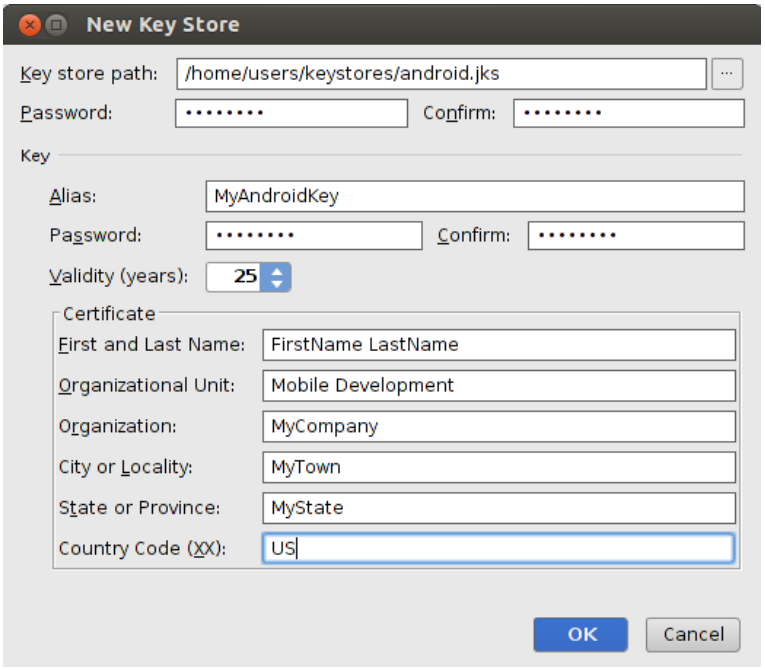


Figure 6.5.: Keystore Windows of the APK signing Wizard of Android Studio
Source: https://developer.android.com/tools/publishing/app-signing.html

The first step is creating a keystore containing multiple private keys (user input as seen in figure 6.5). Then, the keystore and another private key can be selected. Once the correct passwords are entered the application can be signed.

Signing an application is important for the following reasons:

- App upgrade
  To ensure not every user can "update"your application and replace it with their own, the certificates are compared when attempting to do so. The update of an application only works if the certificates are the same.

[13] Developer - Signing your applications: https://developer.android.com/tools/publishing/app-signing.html, 2016-02-19

- Modularity
  In Android, multiple apps can run inside the same process if the certificates match. Therefore, it is possible to just update a single module without touching anything you don't want to change.

- Signature based permissions
  Android offers the possibility of apps exposing functionality to each other, depending on the certificate they use. Therefore it is possible to limit access to functions of an application that can be used by other applications in order to retain sufficient security.

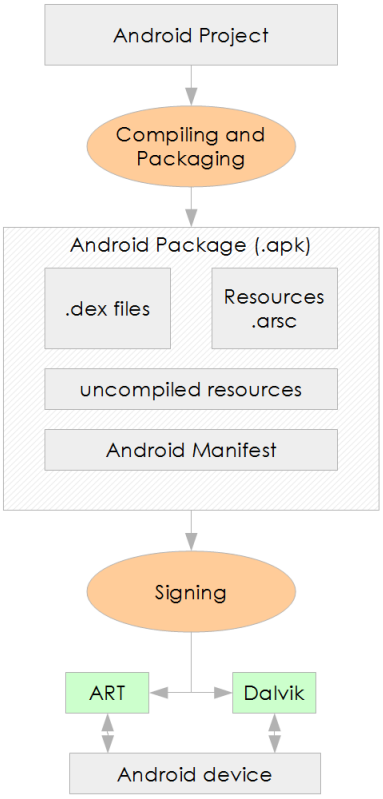


Figure 6.6.: Compiling and execution process of an Android application
Source: https://developer.android.com/tools/building/index.html

ART and Dalvik

Once an application is signed, it can be installed on the desired device. ART and Dalvik are based on the same principle as the JVM and effectively run the application. For more information see section 6.4.1.3.

7. Calculation

A calculation is carried out when a business has to calculate a selling price for a product. Due to market competition and pressure on costs, the calculation of a product has become very important in the last few years.

7.1. Cost-type accounting

The cost-type accounting is the first step of a cost accounting and includes the apportionment of costs.

7.1.1. Classification of cost categories

7.1.1.1. Personnel costs[1]

Personnel costs are caused by employing staff. A business is defined as labour-intensive when a major part of the total costs are caused by personnel costs. A typical labour-intensive business is for example a law firm.
Personnel costs can either be

- wages or salaries,
- social costs prescribed by law or contract or
- other personnel costs (e.g.: severance payments or job advertisements).

Social costs prescribed by law or contract can be, for example, social security payments or holiday pay.

7.1.1.2. Cost of material[2]

Cost of material is caused by usage and further processing of material in a company. The used material has to serve the object of the business. A business is defined as material-intensive when a major part of the total costs is caused by cost of material. Typical material-intensive businesses are found in the production industry. Types of material costs are:

[1] https://de.wikipedia.org/wiki/Personalkosten, 2016-03-26

[2] https://de.wikipedia.org/wiki/Materialkosten, 2016-03-16

- Raw material costs
  Raw material costs can be for example metal in the metal industry or diamonds in the jewellery industry.
- Process material costs
  In certain industries, process material costs can present a major part of the material costs, for example when a business has an excessive consumption of electricity.
- Cleaning agents or packaging material

7.2. Cost centre accounting[3]

A cost centre is the place where costs arise due to the work that has been done. It can either be separated by areas of responsibility or by spatial or accountancy issues. Hence, from the accounting perspective, a cost centre can be seen as a separate department of a business which forms costs. Examples for cost centres would be a purchasing department, a warehouse or a sales department.

A cost centre can either be a main cost centre or a service cost centre. Costs caused by a main cost centre can directly be attributed to various cost objects, the costs of a service cost centre have to be attributed to a main cost centre.Schneider et al. (2013)

7.2.1. Direct costs[4]

Direct costs are expenses which can be directly attributed to a cost-unit, such as wood being a direct cost of a manufactured item of furniture. Direct costs can also be labour costs which come about when producing a certain product.

7.2.2. Overhead expenses [5]

Overhead expenses have to be apportioned among the produced goods or cost centres. For example, the heating costs of a business cannot be attributed to a certain product but have to be apportioned among the cost centres (mostly per square metre).

[3] https://de.wikipedia.org/wiki/Kostenstelle, 2016-03-17

[4] https://de.wikipedia.org/wiki/Einzelkosten, 2016-03-17

[5] https://de.wikipedia.org/wiki/Gemeinkosten, 2016-03-17

7.3. Cost-unit accouting[6]

7.3.1. Single-stage process costing

When conducting a single-stage process costing, all arising expenses for producing a product get divided by the produced quantity.

$$\frac{Costs}{Unit} = \frac{Arising\ expenses}{Produced\ quantity} \tag{7.1}$$

7.3.1.1. Advantages and disadvantages

On the one hand, single-stage process costing is very practical and simple in use. Unfortunately, it can only be used for businesses which produce one product and practice mass production (no individual or special production).

7.3.1.2. Example

A business has to spend 10000 € a month on producing 1000 pieces of a certain product with one production process. What are the manufacturing costs of one product?

$$\frac{Costs}{Unit} = \frac{10000\ €}{1000} = 10\ €\ per\ unit \tag{7.2}$$

7.3.2. Multistage process costing

A multistage process costing can be conducted when a product passes several production stages to be finished.

7.3.2.1. Example

A steel spring gets produced from raw material to the final product. The product has to pass through several production stages and every workshop department cashes up for their intermediate product. The costs per workshop department get added to the "purchase costs" from the previous department.

7.3.3. Overhead calculation

Usually, products with varying material costs and different direct labour costs are manufactured in different production sequences and with different manufacturing methods. In this case, the

[6] Schmid (2013)

overhead calculation is used. The exact data for calculating can be found in the cost distribution sheet.

7.3.3.1. Single-stage overhead calculation

The overhead costs have to be calculated with an overhead rate from a reference value. The reference value is, depending on the business being labour- or material-intensive, the manufacturing labour costs or the direct material costs. A single-stage overhead calculation should only be used when the overhead costs are only a minor part of the total costs.

7.3.3.2. Double-stage overhead calculation

The double-stage overhead calculation divides the overhead costs into two overhead cost types, the material and factory overheads. The default pattern for the implementation of a double-stage overhead calculation is according to table 7.1.

	material costs
+	material overheads
+	production labour costs
+	factory overheads
=	production costs

Table 7.1.: Double-stage overhead calculation

8. Used tools and technologies

8.1. Java

Official website: http://java.com

Java is a general-purpose programming language, which is able to run on every platform with only compiling the source code once. Java source code is compiled into into an intermediate language called Java bytecode, which is intended to be executed by a virtual machine written especially for the host operating system.

The latest version of the standard edition (SE) is Java 8, however, Java SE 9 is already in development and announced to be released in 2017. Earlier versions are still supported by Oracle and other companies but only on a commercial basis. As of 2016, Java is one of the most popular programming languages in use according to the *TIOBE Programming Community* and *Programming Language Popularity* Index.

8.1.1. JAudio

Official website: http://jaudio.sourceforge.net

JAudio is a Digital Signal Processing project built to provide a program for audio feature extraction. Properties, such as beat points, statistical summaries, MFCCs, SRP, ZCR can be extracted. Additionally, these properties can be used as input for the machine learning program „Weka “.

JAudio can be used as a stand-alone program with a graphical user interface (GUI) or a command line interface (CLI). In addition, a Java library version is also available.

8.1.2. REngine and RServeEngine

Official website: http://rforge.net/Rserve/

These libraries are needed for communication between an R and a Java program. The RServeEngine enables communication between Rserve (section 8.3.3) and Java. The REngine provides the needed classes for representing R objects and includes methods for assigning Java values, converting R variables into Java types, plus having many more features.

8.1.3. JMF MP3 Plugin and JLayer

Websites: http://www.oracle.com/technetwork/java/javase/download-137625.html, http://javazoom.net/javalayer/javalayer.html

The Java Media Framework (JMF) MP3 Plugin and the JLayer library enable handling mp3 encoded files with Java.

8.1.4. MySQL connector

Documentation: http://dev.mysql.com/doc/connector-j/en/

The MySQL connector is a implementation of the *Java Database Connectivity (JDBC) API*, which enables communication between a Java client program and a database. The driver enables executing MySQL commands like inserts, updates or queries.

8.2. Python

Official website: https://www.python.org

Python is a widely used general-purpose, high-level programming language. The aim of the design philosophy is to provide a good code readability and a syntax which allows to express concepts in fewer lines of code compared to other languages, such as C++ or Java. Python interpreters are available on many operating system, allowing code to by executed on various systems. Additionally, Python is the recommended language for developing Raspberry applications due to the easy GPIO access and good support community.

8.2.1. RPi.GPIO

Website: https://pypi.python.org/pypi/RPi.GPIO

The RPi.GPIO package provides a class to control the GPIO on a Raspberry Pi. This package enables reading from and writing to the GPIO pins.

8.3. R

Official website: https://www.r-project.org

R is a programming language and software environment focused on statistical computing and graphics. The main application of R is statistics, data mining and data analysis. R implements a wide variety of statistical and graphical techniques, including linear and nonlinear modeling,

classical statistical tests, time-series analysis, classification, clustering, and many more. R is easily extensible through functions and extensions.

One further, great advantage of R is the vast support for third party packages which enable a wide range of additional applications. All of these packages are maintained and available via a central repository (cran). For analysing sound, the extensions tuneR and seewave can be used.

8.3.1. TuneR

Documentation: https://cran.r-project.org/web/packages/tuneR/index.html

The TuneR package provides a collection of tools for analysing music, extracting features like MFCCs, handling wave files, reading mp3 files and many more options. The provided „Wave "class enables presenting a sound wave within R, which is crucial for working with sounds and analysing them afterwards.

8.3.2. Seewave

Documentation: https://cran.r-project.org/web/packages/seewave/index.html

Seewave is an extended package for sound analysis and synthesis. The package processes time analysis (oscillograms and envelopes), spectral content, cross correlation and autocorrelation, zero-crossing, dominant frequency, 2D and 3D spectrograms and many other analyses. This package depends on the tuneR package (see section 8.3.1).

8.3.3. Rserve

This package allows R to act as a socket server (TCP/IP or local sockets) which allows binary requests to be sent to R. Client-side implementations are available for popular languages. This allows applications to use facilities of R without the need of linking to R code.

8.4. Android

Android is an open source operating system for mobile devices, developed by Google Inc. For further information see chapter 6.

8.5. IDEs

Integrated development environments (IDEs) are software applications which provide comprehensive facilities for programming and software development. Normally, an IDE consists of a

source code editor, build automation tools and a debugger. Therefore, IDEs present a single program in which all programming tasks are done.

8.5.1. Eclipse

Official website: http://www.eclipse.org

Eclipse is a powerful IDE primary focused on developing Java applications, but also suitable for developing with C, C++, PHP, Python, R and many other environments. The Eclipse Software Development Kit (SDK), which includes the Java development tools, is meant for Java developers.

Due to its flexible extension ability, users are able to install plug-ins for almost every task concerning software development. This is also the reason why programming C++, Python, R is easily possible within Eclipse.

8.5.2. RStudio

Official website: https://www.rstudio.com

RStudio is the common IDE for the programming language R. It includes a console, a syntax-highlighting editor that supports direct code execution, as well as tools for plotting, history, debugging and workspace management.

8.5.3. Android Studio

Official website: https://developer.android.com/

Android Studio, based on IntelliJ IDEA, is the official IDE for developing Android applications. For further informations see section 6.3.

8.6. Sonic Visualiser

Official website: http://www.sonicvisualiser.org

Sonic Visualiser is free software, which enables visualising, analysing and annotating sound files. Looking at audio visualisations, such as spectrogram views with interactive adjustment of display parameters, becomes really easy by using this program. Furthermore, Sonic Visualiser

allows to run feature-extraction plugins to calculate annotations automatically, using algorithms such as beat trackers, pitch detectors and so on.

8.7. Audacity

Official website: http://www.audacityteam.org

Audacity is a free digital audio editor and recording application. Audacity can be used for post-processing of all types of audio by adding effects such as normalization, trimming, and fading in and out.

8.8. FFmpeg

Official website: http://ffmpeg.org

FFmpeg is a free, complete and cross-platform solution to record, convert and stream audio and video.

"FFmpeg is the leading multimedia framework, able to decode, encode, transcode, mux, demux, stream, filter and play pretty much anything that humans and machines have created. It supports the most obscure ancient formats up to the cutting edge. No matter if they were designed by some standards committee, the community or a corporation." [1]

8.9. MySQL

Official website: http://www.mysql.com

MySQL is an open-source relational database management system (RDBMS). MySQL is widely used for client-server database solutions.

8.10. Git

Official website: http://git-scm.com

Git is an open source distributed version control system, used by many developers around the world. Git's popularity is due to the high performance, efficiency and many advanced features.

Version control systems are highly advisable for software collaboration, since they enable a convenient workflow. The key issue of version control systems is keeping track of the history

[1] About FFmpeg - http://ffmpeg.org/about.html, 2016-02-14 15:01

of files. In order to do so, these systems create an entire history, including all changes, of the work being performed. With these informations, stored on an accessible storage for everyone, it becomes easy to work together because you are always dealing with the newest revision and your changes are available for everyone. Therefore, you have no complications working together on the same project. And even if two or more people work on the same file, Git avoids confusion by providing powerful merging tools.

We decided to use Git because it is one of the leading version control systems,which is, in addition, easy to use despite numerous functions.

8.11. Latex

Official website: http://www.latex-project.org

Latex is a typeset system widely used for advanced writing tasks. Due to well structured documents and many useful extensions, i.e for mathematics, it is perfect for writing scientific documents, as well as diploma and Ph.D. theses.

Part IV.

Implementation

Appendix

A. Time Protocol

A.1. Benjamin Hackstock

Date	Description	Time spent
2015-03-06	First informational meeting with Prof. Frischmann	0h 30m
2015-03-08	Online data management setup	1h 00m
2015-06-02	Research wireless charging	1h 30m
2015-06-03	Meeting and discussion with Prof. Frischmann	1h 00m
2015-06-12	Group discussion: hardware incl. scoring model, functional specification	1h 00m
2015-06-16	Elaborating functional specifications	1h 00m
2015-06-17	Meeting and discussion with Prof. Frischmann	0h 40m
2015-06-19	Brainstorming on project title	0h 45m
2015-06-30	Elaborating survey questions	0h 35m
2015-08-07	Elaborating survey questions	1h 30m
2015-07-09	Meeting with Prof. Frischmann and Prof. Greinöcker	1h 00m
2015-08-16	Group meeting	1h 30m
2015-09-09	Meeting with Prof. Frischmann and Prof. Greinöcker	1h 30m
2015-09-14	Android Studio setup	0h 45m
2015-09-16	Android Studio setup and research	0h 45m
2015-09-19	Questionary update, Android Studio research	2h 20m
2015-09-22	Research: Android layouts	0h 30m
2015-09-23	Research: Android gestures	1h 15m
2015-09-26	Research: Android fragments	3h 15m
2015-09-27	Research: Android threads	1h 30m
2015-09-28	Research: LaTeX, Android services	2h 45m
2015-09-29	Corrected: Patent theory	0h 30m
2015-09-29	Research: Android usability and design	1h 30m
2015-09-30	Meeting with Prof. Frischmann and Prof. Greinöcker	0h 20m
2015-09-30	Research: Android basics	0h 45m
2015-09-30	Research: prior diploma theses	1h 15m
2015-10-01	Usability research and theory writing	1h 30m
2015-10-03	Usability research and theory writing	0h 30m
2015-10-05	Usability research and theory writing	0h 40m
2015-10-07	Discussion with Prof. Greinoecker on usability and survey	1h 20m
2015-10-08	Questionary update	0h 40m
2015-10-11	Online Questionary writing	2h 40m
2015-10-13	Questioning volunteers	0h 45m

2015-10-16	Android coding	2h 00m
2015-10-22	Usability research and theory writing	0h 30m
2015-10-25	Usability research and theory writing	2h 30m
2015-10-26	Usability research and theory writing	1h 20m
2015-10-27	Usability research and theory writing	3h 00m
2015-11-02	Operational concept writing	1h 00m
2015-11-03	Operational concept writing	1h 00m
2015-11-03	Android coding and research	1h 00m
2015-11-05	Operational concept writing	1h 00m
2015-11-07	Research: offline speech recognition, operational concept edit	1h 30m
2015-11-08	Research: offline speech recognition, speech recognition writing	1h 15m
2015-11-09	Android coding and research	1h 00m
2015-11-11	Android coding and research	2h 00m
2015-11-12	Android coding and research - material design	2h 00m
2015-11-13	Android coding and research - floating action button	1h 30m
2015-11-15	Android coding and research - fragment integration	1h 00m
2015-11-17	Android coding and research - tab swipe layout	2h 00m
2015-11-20	Android coding and research - recyclerView	1h 00m
2015-11-21	Anrdoid coding and research - images for results	3h 00m
2015-11-22	Android coding and research - intents with extra data	1h 00m
2015-11-24	Android coding and research - intents with extra data	2h 00m
2015-11-25	Android coding and research - splash screen, FragmentAdapter	3h 00m
2015-12-01	Creating operational concept graph	0h 30m
2015-12-02	Android coding and research - StackOutOfMemory	1h 15m
2015-12-03	Android coding and research - intent extras	0h 50m
2015-12-09	Creating operational concept graph	1h 00m
2015-12-18	Writing proposal for Jugend Innovativ	1h 00m
2016-01-09	Android coding and research - recording service	6h 00m
2016-01-10	Android coding and research - audio	1h 00m
2016-01-12	Android research - sockets	0h 30m
2016-01-13	Android research - sockets	1h 00m
2016-01-14	Android coding - sockets	1h 00m
2016-01-18	Correcting thesis: patent search	0h 45m
2016-01-21	Android research - streams	1h 15m
2016-01-21	BeTheBest' - application preparations	1h 25m
2016-01-22	BeTheBest' - application writing	0h 40m
2016-01-23	BeTheBest' - motivation paper writing	0h 50m
2016-01-23	Eurac - project report writing	1h 40m
2016-01-24	Eurac - project report writing	1h 35m
2016-01-25	Eurac - project report writing	2h 05m
2016-01-26	Eurac - project report writing	0h 35m
2016-01-28	Eurac - project report writing	1h 15m
2016-01-29	Eurac - project english summary writing	1h 40m
2016-01-31	BeTheBest - writing and application submission	0h 45m
2016-01-02	Usability research and theory writing	1h 25m

2016-02-02	Usability research and theory writing	1h 20m
2016-02-04	Usability research and theory writing	0h 45m
2016-02-10	Audio introduction writing and usability research	3h 35m
2016-02-11	Introduction writing	2h 00m
2016-02-11	Usability research and theory writing	3h 30m
2016-02-11	Correcting thesis: chapter 4	1h 00m
2016-02-12	Usability research and theory writing	1h 30m
2016-02-13	Usability research and theory writing	2h 00m
2016-02-13	Correcting thesis: classification	0h 20m
2016-02-13	Android research and theory writing	1h 25m
2016-02-14	Correcting thesis: used tools	0h 30m
2016-02-14	Research: LaTeX and Android	1h 15m
2016-02-15	Android theory writing	1h 20m
2016-02-17	Android research and theory writing runtime	1h 25m
2016-02-18	Research and theory writing JVM, Dalvik, Gradle	3h 35m
2016-02-19	Figure design Android	1h 25m
2016-02-20	Android theory research	1h 10m
2016-02-21	Andorid theory research	1h 00m
2016-02-23	Jugend Innovativ - Android theory adding pictures	2h 15m
2016-02-25	Jugend Innovativ - correcting and writing	0h 50m
2016-02-26	Jugend Innovativ - proposal writing	1h 30m
2016-02-27	Jugend Innovativ - proposal writing	1h 00m
2016-02-27	Android writing and research: application concept	1h 45m
2016-02-29	Android writing and research: application concept	0h 35m
2016-03-01	Research: class diagram	0h 30m
2016-03-01	Android application specific concept writing	1h 00m
2016-03-01	Android application coding: UI	1h 15m
2016-03-03	Android application coding: UI & basic activity navigation	3h 20m
2016-03-05	Android application coding: RecordActivity, UI and functionality	6h 15m
2016-03-07	Android theory writing	1h 00m
2016-03-08	Android application coding: source extraction, AudioAntSettings UI	0h 55m
2016-03-10	Android application coding: UI	3h 10m
2016-03-11	Android application coding: UI & helper classes	3h 45m
2016-03-12	Android application coding: recording service	4h 10m
2016-03-13	Android application recording service coding	3h 45m
2016-03-14	Thesis writing: implementation	3h 20m
2016-03-15	Thesis writing: implementation and introduction	4h 15m
2016-03-16	Thesis writing: abstract, acknowledgement & Android coding: file to string	3h 50m
2016-03-17	Thesis writing: implementation, Android optimisations	5h 30m
2017-03-19	Thesis writing: implementation, Android optimisations	6h 00m
2019-03-20	Android coding: CommunicationService	6h 30m
2016-03-21	Android optimisations audioantsettings & recordactivity	9h 00m
2016-03-22	Android coding, thesis writing	6h 20m

2016-03-23	Android code restructuring, auto connect coding	7h 10m
2016-03-24	Android coding: AlarmActivity & Thesis writing: implemenation	8h 10m
2016-03-26	Thesis writing: implementation	7h 40m
2016-03-27	Thesis writing: implementation	9h 45m
2016-03-28	Thesis writing: implementation	6h 00m
Sum		254h 10m

Table A.1.: Time protocol Benjamin Hackstock

A.2. Florian Langer

Date	Description	Time spent
2015-03-06	First informational meeting with Prof. Frischmann	0h 30m
2015-05-10	Creating time managment table	0h 40m
2015-05-21	Meeting and discussion with Prof. Frischmann	1h 00m
2015-05-26	Competitor analysis	0h 30m
2015-06-02	Competitor analysis	1h 20m
2015-06-03	Meeting and discussion with Prof. Frischmann	1h 00m
2015-06-12	Group discussion: hardware incl. scoring model, functional specification	1h 00m
2015-06-17	Meeting and discussion with Prof. Frischmann	0h 40m
2015-06-19	Brainstorming: Project title	0h 45m
2015-06-28	Component research (shopping list)	1h 00m
2015-07-01	Component research (shopping list)	0h 20m
2015-07-01	Meeting and discussion with Prof. Frischmann and Prof. Greinöcker	1h 00m
2015-07-03	Product and patent application research	1h 00m
2015-07-08	Elaborating survey questions	1h 30m
2015-07-09	Meeting and discussion with Prof. Frischmann and Prof. Greinöcker	1h 00m
2015-08-16	Meeting of collaborators	1h 30m
2015-09-09	Meeting and discussion with Prof. Frischmann and Prof. Greinöcker	1h 30m
2015-09-09	Tests with the Raspberry Pi GPIO pins	1h 30m
2015-09-20	Pretesting, proofreading and correcting the questionary	0h 45m
2015-09-30	Meeting with Prof. Frischmann and Prof. Greinöcker	0h 20m
2015-09-30	Tests with the Raspberry Pi GPIO pins	0h 30m
2015-09-30	Python, SourceTree and GitLab research	1h 30m
2015-10-01	Meeting with Prof. Frischmann	0h 30m
2015-10-09	Online questionary writing	2h 40m
2015-10-09	Research sensors	1h 30m
2015-10-16	Research survey	1h 00m
2015-10-16	Thesis writing: survey theory	1h 00m
2015-10-20	Thesis writing: survey theory	1h 30m
2015-10-23	Thesis writing: survey theory	1h 00m
2015-10-25	Thesis writing: survey theory	1h 30m
2015-10-27	Thesis writing: survey theory	2h 00m
2015-10-28	Revising survey theory	1h 00m
2015-11-02	Operating concept writing	1h 00m
2015-11-08	Research: Raspberry Pi hardware	1h 00m
2015-11-15	Troubleshooting Raspberry Pi problems	2h 00m
2015-11-22	Troubleshooting Raspberry Pi problems	1h 00m
2015-11-22	Connecting the Raspberry Pi with notebook over Wifi/ hotspot	1h 00m
2015-11-23	Testing the Raspberry Pi GPIO pins	1h 30m

2015-11-23	Coding methods for controlling LEDs	0h 15m
2015-11-26	Testing the microphone	2h 00m
2015-12-02	Drawing drafts of the AudioAnt	0h 45m
2015-12-08	Research: sockets	2h 00m
2015-12-09	Research: recording audio with Raspberry Pi	2h 00m
2015-12-09	Testing the microphone	1h 00m
2015-12-16	Tests with LED's and buttons	2h 00m
2015-12-16	Coding: connection with sockets (Python-Java)	2h 00m
2015-12-30	Design of the prototype on the pinboard	1h 00m
2015-12-30	Collecting data for missing components	1h 00m
2016-01-01	Configuring the Raspberry Pi, researching Samba	3h 00m
2016-01-01	Testing buttons	1h 30m
2016-01-05	Testing buttons, fixing problems with the buttons	3h 00m
2016-01-05	Researching GPIO	1h 00m
2016-01-06	Testing display	1h 30m
2016-01-06	Testing buttons and LEDs of the Raspberry Pi	2h 00m
2016-01-06	Setting up new Raspberry Pi image, Samba, Python	1h 30m
2016-01-06	Troubleshooting Raspberry Pi GPIO pins	2h 30m
2016-01-15	Testing the new Raspberry Pi	1h 45m
2016-01-17	Research: competitor analysis	2h 15m
2016-01-24	Designing prototyp GPIO	0h 15m
2016-01-24	Testing the speaker	0h 30m
2016-01-24	Testing the LEDs and buttons	2h 45m
2016-01-24	Testing the QI transmitter	0h 30m
2016-01-27	EURAC - writing project report	2h 00m
2016-01-28	EURAC - writing project report	1h 00m
2016-01-31	Research transistor as a switch	0h 30m
2016-02-03	Designing circuit diagram	3h 00m
2016-02-04	Shopping for power supply and light source	2h 00m
2016-02-14	Thesis writing: competitor analysis theory	2h 00m
2016-02-15	Thesis writing: competitor analysis theory	1h 00m
2016-02-16	Thesis writing: competitor analysis theory	1h 00m
2016-02-18	Expanding operating concept	2h 00m
2016-02-18	Online shopping for components	1h 00m
2016-02-18	Research: relay module	1h 00m
2016-02-19	Designing circuit diagram	1h 00m
2016-02-20	Designing circuit diagram	2h 30m
2016-02-21	Thesis writing: editing survey theory	2h 00m
2016-02-22	Thesis writing: competitor analysis theory	1h 30m
2016-02-23	Thesis writing: competitor analysis theory	3h 00m
2016-02-24	Design planning, drafts	2h 00m
2016-02-25	Thesis writing: competitor analysis theory	1h 30m
2016-02-26	Constructing the prototype	4h 30m
2016-02-28	Thesis writing: survey theory	2h 00m
2016-02-29	Thesis writing: survey theory	1h 00m

2016-03-01	Constructing the prototype	6h 30m
2016-03-03	Constructing the prototype	4h 00m
2016-03-09	Thesis writing: survey theory	3h 00m
2016-03-10	Thesis writing: survey evaluation	3h 00m
2016-03-11	Thesis writing: survey evaluation	3h 00m
2016-03-13	Editing circuit diagram, proofreading survey	3h 00m
2016-03-14	Collecting links of hardware components	1h 00m
2016-03-15	Researching calculating	1h 00m
2016-03-15	Thesis writing: calculation theory	1h 30m
2016-03-16	Thesis writing: calculation theory	2h 00m
2016-03-16	Thesis writing: finishing survey & competitor analysis	2h 30m
2016-03-17	Thesis writing: calculation theory	3h 00m
2016-03-18	Thesis writing: calculation theory	1h 00m
2016-03-20	Thesis writing: finished calculation theory	2h 00m
2016-03-21	Thesis writing: calculation implementation	2h 00m
2016-03-22	Thesis writing: calculation implementation	2h 00m
2016-03-22	Thesis writing: correction survey theory & implementation	0h 30m
2016-03-22	Thesis writing: hardware theory	1h 30m
2016-03-23	Thesis writing: finished calculation implementation	1h 30m
2016-03-24	Thesis writing: hardware theory	3h 30m
2016-03-25	Thesis writing: hardware theory	2h 30m
2016-03-26	SourceTree research	0h 30m
2016-03-27	Thesis writing: hardware implementation	6h 00m
2016-03-28	Thesis writing: hardware implementation	5h 00m
2016-03-31	Thesis writing: hardware implementation	2h 00m
2016-04-03	Thesis writing: correction of all parts	2h 30m
Sum		183h 30m

Table A.2.: Time protocol Florian Langer

A.3. Daniel Sparber

Date	Description	Time spent
2015-03-06	First informational meeting with Prof. Frischmann	0h 30m
2015-03-08	Online data management setup	1h 00m
2015-03-08	Elaborating goals	0h 15m
2015-05-10	Creating time managment table	0h 40m
2015-05-14	Designing drafts for the AudioAnt	1h 30m
2015-05-21	Meeting and discussion with Prof. Frischmann	1h 00m
2015-06-02	Patent seach	1h 15m
2015-06-03	Meeting and discussion with Prof. Frischmann	1h 00m
2015-06-12	Group discussion: hardware incl. scoring model, functional specification	1h 00m
2015-06-15	Writing down previously discussed matters	0h 30m
2015-06-17	Researches for scoring model + finishing scoring model	0h 40m
2015-06-17	Meeting and discussion with Prof. Frischmann	0h 40m
2015-06-19	Brainstorming: Project title	0h 45m
2015-06-26	Writing general proposal	1h 30m
2015-06-30	Writing draft proposal for offical application	0h 45m
2015-07-01	Meeting and discussion with Prof. Frischmann and Prof. Greinöcker	1h 00m
2015-07-08	Elaborating survey questions	1h 30m
2015-07-09	Meeting and discussion with Prof. Frischmann and Prof. Greinöcker	1h 00m
2015-07-19	Revising survey questionary	1h 00m
2015-07-25	Revising survey questionary	1h 00m
2015-07-25	Setting up LaTeX and Git repository for LaTeX files	0h 30m
2015-07-30	Research: Steppat (introduction)	0h 30m
2015-08-01	Meeting with Prof. Frischmann	1h 00m
2015-08-01	Setting up Raspberry Pi	1h 00m
2015-08-09	Setting up workspace and corresponding Git repository	0h 30m
2015-08-12	Research: Steppat (audio signals)	1h 20m
2015-08-16	Meeting of collaborators	1h 30m
2015-08-16	Coding chapter two examples of the audio Coding book	1h 00m
2015-08-22	Coding chapter two examples of the audio Coding book (finished)	1h 00m
2015-08-24	Research: Steppat (compression of audio files)	1h 30m
2015-08-25	Research: Steppat (tools for audio file handling)	0h 45m
2015-08-26	Research: Steppat (tools for audio file handling)	0h 45m
2015-08-27	Research: Steppat (visualisation of audio files)	1h 00m
2015-08-28	Research: Steppat (Fourier Transformation)	1h 15m
2015-08-28	Research: Steppat (spectral analysis)	0h 50m
2015-09-09	Meeting and discussion with Prof. Frischmann and Prof. Greinöcker	1h 30m
2015-09-09	Testing the Raspberry Pi GPIO pins	1h 30m

2015-09-11	Tutorials: R (Coding language introduction, variables, vectors, logic statements)	1h 00m
2015-09-12	Tutorials: R (matrices, table, importing data)	0h 45m
2015-09-13	Tutorials: R (packages, working directories, scripts)	0h 50m
2015-09-15	Research: JAudio	0h 40m
2015-09-15	Filling out proposal form	0h 20m
2015-09-15	Researching and testing: JAudio GUI and features	1h 20m
2015-09-17	Thesis writing: used tools, audio analysis	0h 45m
2015-09-17	Research: Java and Raspberry Pi	0h 25m
2015-09-19	Research: Java sound recoginition, WEKA	1h 20m
2015-09-20	Thesis writing: patents, requirements for assigning a patent	0h 40m
2015-09-20	Research: Streaming audio, Java and Raspberry Pi microphone, FFT	0h 45m
2015-09-21	Thesis writing: Patents: general, novelty, non-obviousness, exclusions	1h 00m
2015-09-22	Resarch: Sound recogniton - a cognitive way	0h 40m
2015-09-23	Thesis writing: added patent sections	0h 20m
2015-09-24	Thesis writing: intellectual property, patent specification	1h 00m
2015-09-26	Thesis writing: patent offices, patent search	1h 15m
2015-09-27	Thesis writing: patent search platforms, professional patent search	0h 30m
2015-09-27	Research: sound recognition	0h 45m
2015-09-28	Research: feature extraction, recognition algorithms	1h 00m
2015-09-28	Applying HTL thesis template	0h 30m
2015-09-29	Refactoring writing workspace	1h 00m
2015-09-29	Setting up local Android workspace	0h 30m
2015-09-30	Meeting with Prof. Frischmann and Prof. Greinöcker	0h 20m
2015-09-30	Thesis writing: Sound, soundwaves	0h 45m
2015-10-01	Meeting with Prof. Frischmann	0h 30m
2015-10-01	Protocol writing, creating LaTeX template	0h 45m
2015-10-01	Survey, patent search	1h 00m
2015-10-03	Patent search, thesis writing: performed patent search	1h 00m
2015-10-03	Updated titel page, modified template	0h 30m
2015-10-04	Patent search, thesis writing: patent overview (CN202551174U)	1h 30m
2015-10-05	Restructured main LaTeX file	0h 30m
2015-10-05	LaTeX research, thesis writing: patent search	1h 25m
2015-10-06	Thesis writing: patent claims (CN202551174U)	0h 40m
2015-10-06	Thesis writing: patent description (CN201551174U)	0h 50m
2015-10-08	Information about ÖPA patent search from Prof. Frischmann	0h 15m
2015-10-08	Thesis writing: difference between utility models and patents	1h 10m
2015-10-10	Patent search proposal ÖPA	1h 20m
2015-10-11	Thesis writing: utility model CN201556267U, revising patent search	2h 00m
2015-10-11	LaTeX research	0h 45m
2015-10-12	Revising patent search, patent search proposal ÖPA schema drawing	1h 30m

2015-10-12	Audio analysis tests with Audacity	0h 45m
2015-10-13	Tests with JAudio	1h 15m
2015-10-14	Corrected patent search chapter, added missing citations	2h 40m
2015-10-16	Tests embedding JAudio	1h 15m
2015-10-17	Tests embedding JAudio	3h 05m
2015-10-18	Research and tryouts: Java and microphones	2h 15m
2015-10-19	Research (overview): feature extraction, windowing, supervised machine leraning	1h 00m
2015-10-20	Setup testing workspace	0h 35m
2015-10-20	Visualising audio features	0h 50m
2015-10-21	Discussion with Prof. Greinöcker about audio analysis strategy	0h 45m
2015-10-21	Working out demarcation criteria	0h 50m
2015-10-22	Audio analysis approaches	1h 45m
2015-10-23	Rserve: tests and research	1h 00m
2015-10-24	Including Rserve into Android, Android tutorials (basics, permissions)	1h 00m
2015-10-26	Including Rserve into Android	2h 00m
2015-10-28	Thesis writing: Audio analysis applicationroaches	1h 00m
2015-10-29	LaTeX document to rtf: research, installation and converting	1h 00m
2015-10-29	Revise survey theory and usability	0h 40m
2015-10-29	Android Studio: troubleshooting javax imports	0h 50m
2015-11-01	Gathering and analysing ringtones	1h 30m
2015-11-02	Visualising audio features of ringtones, performing audio analysis	2h 00m
2015-11-03	Analysing results of JAudio extraction	1h 45m
2015-11-04	Research Android and audio, tryouts Android	2h 00m
2015-11-05	Research: Android feature extraction	1h 00m
2015-11-07	Audio recognition concept	1h 45m
2015-11-08	Research statistical methodes	1h 00m
2015-11-09	Updated analysis concept, research and tryouts R	1h 30m
2015-11-10	R packages tuneR and seewave tryouts	1h 00m
2015-11-14	Read wav file with Java and generate array with sample values	4h 00m
2015-11-15	Windowing: implementing Hann window	1h 45m
2015-11-16	Java and R, passing values	1h 30m
2015-11-17	Calling R analysis via Java	2h 45m
2015-11-18	Extract strongest frequency from input signal	2h 15m
2015-11-19	Raspberry Pi setup	0h 45m
2015-11-19	Java audio stream from microphone	1h 40m
2015-11-21	Analysing audio stream	2h 20m
2015-11-22	Analysing audio stream	3h 00m
2015-11-23	Discussion with Prof. Greinöcker	1h 00m
2015-11-23	Implementing automatised testing (adapting existing code)	1h 45m
2015-11-24	Implementing automatised testing (adapting existing code)	3h 00m
2015-11-26	Implementing automatised testing (database)	2h 20m
2015-11-28	Implementing automatised testing (database)	1h 20m
2015-11-29	Implementing automatised testing (database)	2h 20m

2015-11-29	Writing application for the EURAC competition	1h 00m
2015-11-30	Extracting strongest frequency	1h 15m
2015-12-01	Performing tests, adjusting dedection parameters	2h 45m
2015-12-03	Raspberry Pi configuration, running Java programm on Raspberry Pi	3h 15m
2015-12-06	Tests with ffmpeg	0h 45m
2015-12-13	Converting wav files to mp3	3h 15m
2015-12-14	Analysing mp3, added logger	2h 30m
2015-12-15	Applying for Jugend Innovativ competition	0h 45m
2015-12-15	Analysing ÖPA search patents	1h 15m
2015-12-16	Enabling communication between Python and Java, tried audio analysis on the Raspberry Pi	4h 00m
2015-12-17	Fixing Raspberry Pi issues	1h 30m
2015-12-18	Fixing Raspberry Pi issues	2h 00m
2015-12-19	Fixing Raspberry Pi issues	1h 30m
2015-12-20	Fixing Raspberry Pi issues	1h 30m
2015-12-21	Fixing Raspberry Pi issues, trying out audio analysis	2h 00m
2015-12-22	Updated socket (Java / Python), trying out audio analysis on the Raspberry Pi 2	2h 00m
2015-12-23	Trying out audio analysis on the Raspberry Pi 2	2h 30m
2015-12-24	Rewriting strongest frequency dedection, multiple peaks	5h 30m
2015-12-25	Reserch features, implementing Spectral Rolloff Point (SRP)	5h 45m
2015-12-29	Audio analysis: support for multiple sounds	4h 00m
2015-12-30	Thesis writing: patent search (WO2008067638A1, US8269625B2)	2h 00m
2015-12-31	Thesis writing: patent search (WO2011000113A1), added patent applicationendix	2h 30m
2016-01-01	Thesis writing: patent search (further ÖPA results), summary	1h 30m
2016-01-02	Research features (MFCC, LPCC)	2h 00m
2016-01-03	Implementing MFCC	2h 15m
2016-01-04	Implementing and testing MFCC	3h 00m
2016-01-05	Implementing energy analysis, testing the analysis	5h 00m
2016-01-06	Testing, filtering tryouts, Raspberry Pi GPIO input	4h 30m
2016-01-07	Connection between Python and Java	3h 00m
2016-01-08	Modifications for Raspberry Pi	2h 00m
2016-01-09	Revised Python code	1h 30m
2016-01-11	Tests with XML	1h 30m
2016-01-12	Correlation (pearson coefficient)	2h 00m
2016-01-14	Research Classification	1h 30m
2016-01-18	Linear Discriminant Analysis (LDA), sounds XML	3h 00m
2016-01-23	EURAC project report, be the best proposal	2h 30m
2016-01-24	EURAC project report writing	3h 45m
2016-01-25	EURAC project report writing	1h 00m
2016-01-26	EURAC project report writing	1h 15m
2016-01-27	Alert light Raspberry Pi	1h 30m
2016-01-28	Alert light Raspberry Pi	1h 00m

2016-01-30	Revising code, error handling, video for the BeTheBest competition	4h 30m
2016-02-01	Research XML; XSLT	1h 00m
2016-02-02	Implemented XSLT for recorded sounds, bugixes	3h 30m
2016-02-03	Moved properties to a XML file	2h 00m
2016-02-06	Refactroing config properties, bugfixes, testing	6h 30m
2016-02-07	Classification revised, theory audio	3h 00m
2016-02-08	Extended logging, thesis writing: audio signals	6h 30m
2016-02-10	Evaluating long term test logs, Thesis writing: windowing, Fourier transform	7h 30m
2016-02-11	Thesis writing: window overlap, DFT, FFT	5h 30m
2016-02-12	Thesis writing: classification	6h 00m
2016-02-13	Thesis: proof reading usability, used tools	1h 30m
2016-02-14	Thesis writing: used tools	3h 30m
2016-02-16	Thesis: correcting, writing approach	5h 00m
2016-02-17	Thesis writing: approach (analysis process)	1h 45m
2016-02-18	Thesis writing: feature selection	3h 45m
2016-02-19	Thesis writing: feature selection (spectrum)	1h 00m
2016-02-20	Thesis writing: feature selecten (completed)	3h 15m
2016-02-21	Thesis writing: feature implementation	3h 45m
2016-02-22	LaTeX issues, project report “Jugend Innovativ”	4h 00m
2016-02-23	Android correction, project report “Jugend Innovativ”	2h 00m
2016-02-24	Hardware discussion, CAD drawing, project report “Jugend Innovativ”	4h 30m
2016-02-25	CAD drawing	3h 00m
2016-02-26	Manufacturing the prototype	4h 00m
2016-02-27	Project report “Jugend Innovativ”	2h 30m
2016-02-29	Hardware controller: Display tests	2h 00m
2016-03-01	Manufacturing the prototype	5h 00m
2016-03-02	Updating hardware controller	3h 15m
2016-03-03	Manufacturing the prototype, testing	5h 30m
2016-03-04	Testing the prototype	1h 15m
2016-03-05	Testing the prototype	3h 30m
2016-03-07	Thesis writing: match rate	2h 00m
2016-03-08	Thesis writing: match rate (energy)	2h 30m
2016-03-09	Thesis writing: match rate (strongest frequency)	3h 00m
2016-03-12	Thesis writing: match rate (MFCC)	5h 00m
2016-03-13	Thesis writing: classification	3h 30m
2016-03-14	Thesis: Correction patent search, writing testing and abstract (german)	6h 00m
2016-03-15	Thesis writing: hardware controller	3h 00m
2016-03-16	Thesis: correcting; research Raspberry Pi AP mode, testing	5h 00m
2016-03-17	Raspberry Pi: Wifi and hotspot	7h 00m
2016-03-18	Raspberry Pi microphone issues	2h 00m
2016-03-19	Server side implementation for Android application	9h 00m

2016-03-20	Server side implementation for Android application	8h 30m
2016-03-21	Raspberry Pi: extending hardware controller; demo video	9h 00m
2016-03-22	Server side implementation for Android application	4h 45m
2016-03-23	Thesis: correction audio, formatting	2h 00m
2016-03-24	Android application implemeted	6h 00m
2016-03-25	Android communication bugfixes	9h 00m
2016-03-26	Thesis: corrections	2h 00m
2016-03-27	Thesis: corrections	2h 00m
2016-03-29	Thesis: corrections and formatting	5h 00m
2016-03-30	Thesis: corrections and formatting	2h 00m
2016-03-31	Thesis: corrections and formatting	1h 45m
2016-04-01	Thesis: corrections and formatting	2h 00m
2016-04-04	Thesis: corrections and formatting	2h 00m
Sum		451h 00m

Table A.3.: Time protocol Daniel Sparber

B. Survey

Fragebogen AudioAnt

Wir, Daniel Sparber, Benjamin Hackstock und Florian Langer, drei Schüler der HTL-Anichstraße entwickeln im Rahmen unserer Diplomarbeit ein Hilfsgerät für Menschen mit eingeschränktem Hörvermögen.

Unser Hilfsgerät soll dazu in der Lage sein, bestimmte Töne wie z.B.: das Läuten der Türklingel zu lernen und bei Vorkommen zu erkennen. Wenn ein Geräusch erkannt wird, gibt das Gerät Lichtblitze und einen Warnton aus. Optional kann bei verwenden der entwickelten Smartphone-App eine Benachrichtigung an das Smartphone gesendet werden um den Benutzer auf diese Weise vom Auftreten eines Geräusches zu informieren. Dadurch können Geräusche die ansonsten aus verschiedensten Gründen überhört werden würden (z.B. durch Musikhören im Zimmer, Nichttragen des Hörgerätes,...) wieder wahrgenommen werden.
Zusätzlich ist eine Funktion geplant, die Hilfeschreie erkennen kann und so bei der Benutzung durch ältere Menschen im Notfall Hilfe durch Verwandte oder Einsatzkräfte rufen kann.

Der Fragebogen soll uns dabei helfen, die Priorität von einzelnen Features abzuschätzen und die Entwicklungsschwerpunkte für unser Hilfsgerät richtig zu setzten.

Figure B.1.: Survey - Page 1 (Introduction)

Aktuelle Situation

Welche Geräusche überhören Sie besonders häufig?

- [ ] Handy & Telefon
- [ ] Türklingel
- [ ] Wecker
- [ ] Sonstiges:

Wie gut ist Ihre Hörleistung ohne Hörgerät?

Lassen Sie diese Frage aus, falls keine genauen Werte bekannt sind.

- ○ Normalhörig (Hörschwelle < 20dB)
- ○ Gering Schwerhörigkeit (Hörschwelle 25-40 dB)
- ○ Mittelgradige Schwerhörigkeit (Hörschwelle 40-60 dB)
- ○ Höchgradige Schwerhörigkeit (Hörschwelle > 60 dB)
- ○ An Gehörlosigkeit grenzende Schwerhörigkeit (Hörschwelle > 80 dB)
- ○ Gehörlos

Falls Sie ein Hörgerät besitzen, wie oft verwenden Sie dieses zu Hause?

- ○ Immer
- ○ Oft
- ○ Manchmal
- ○ Selten
- ○ Nie

Figure B.2.: Survey - Page 2 (Current situation)

Technische Affinität

Im Rahmen der Entwicklung der Smartphone-App und der Platte ist es für uns wichtig, zu wissen auf welchen technischen Stand die potenziellen Nutzer unserer Entwicklung sind. Die folgenden Fragen sollen uns dies ermöglichen.

Besitzen Sie ein Smartphone?

- ○ Ja
- ○ Nein

Besitzen Sie ein Tablet, einen Laptop oder einen Computer?

- ○ Ja
- ○ Nein

Falls vorhanden, tragen Sie Ihr Smartphone am Körper bzw. in Sicht- oder Hörweite?

Dies soll uns helfen die Sinnhaftigkeit von Benachrichtigungen auf das Smartphone einzuschätzen.

	1	2	3	4	5	
Ja, immer	○	○	○	○	○	Nein, nie

Welche Anwendungen nutzen Sie auf ihrem Smartphone/Tablet/Computer?

- ☐ Webbrowser
- ☐ E-Mail Anwendungen
- ☐ Office-Programme (Word, Excel, PowerPoint, usw.)
- ☐ Spiele
- ☐ Sonstiges:

Figure B.3.: Survey - Page 3.1 (Technical affinity)

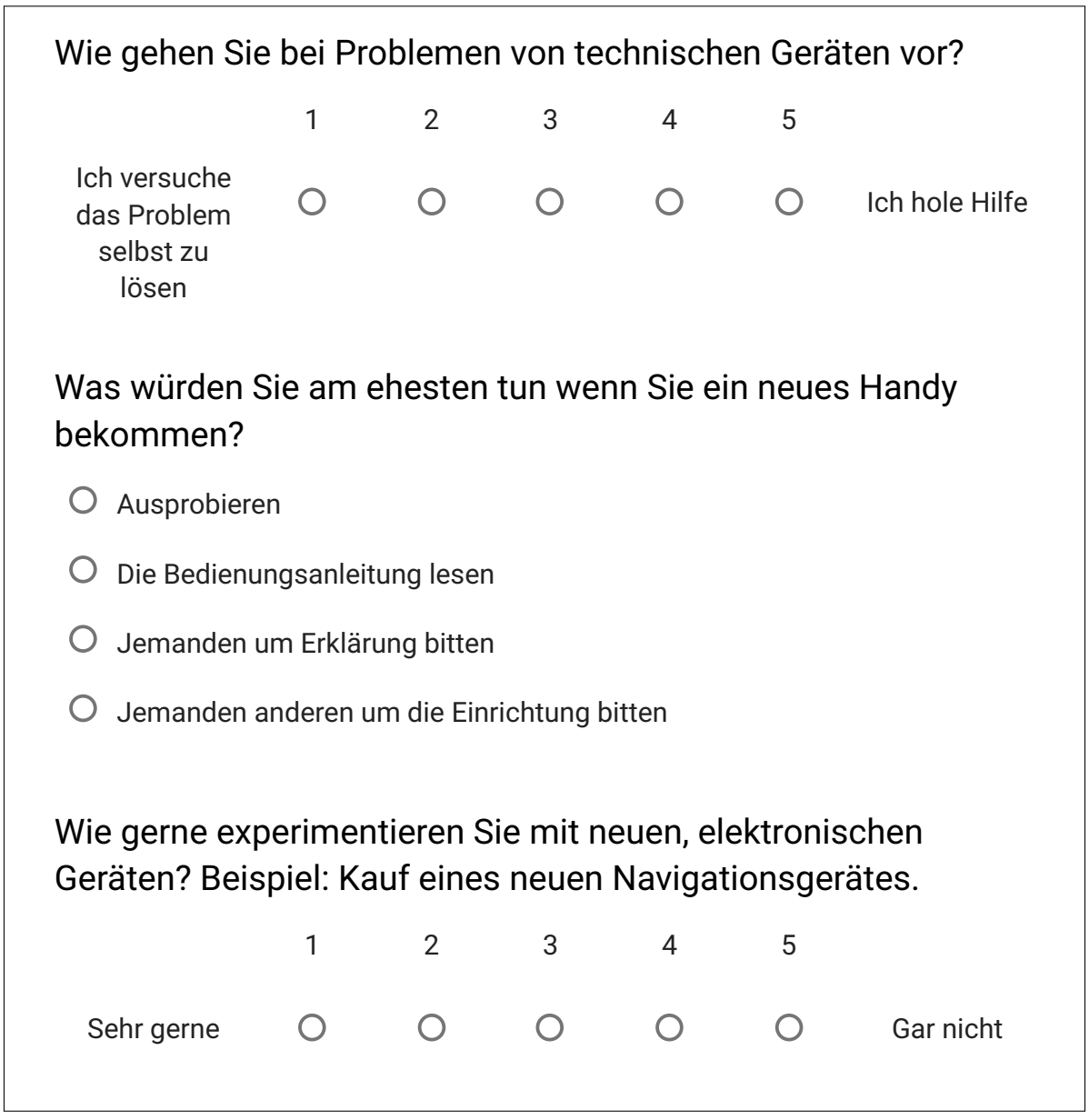


Figure B.4.: Survey - Page 3.2 (Technical affinity)

Hilfsgerät

Die folgenden Fragen sollen uns helfen, besser auf Wünsche und Anregungen von potenziellen Kunden einzugehen und diese später in der Praxis besser umsetzen zu können.

Worauf legen Sie besonders viel Wert?

Bitte 2 Antworten auswählen!

- [ ] Leichte Bedienbarkeit
- [ ] Viele Einstellmöglichkeiten
- [ ] Kompakte Bauweise
- [ ] Zuverlässige Erkennung
- [ ] Optisch ansprechendes Design

Soll die Geräuschanalyse eher empfindlich sein, dafür aber öfter fälschlicherweise ein erkanntes Signal melden oder weniger Fehlerkennungen haben, dafür aber evtl. manchmal Geräusche überhören?

	1	2	3	4	5	
Empfindlichere Erkennung	○	○	○	○	○	Zuverlässige Erkennung

Halten Sie eine Erkennung von Hilfeschreien in Notfällen für sinnvoll?

- ○ Ja
- ◉ Nein

Figure B.5.: Survey - Page 4 (Assistant tool)

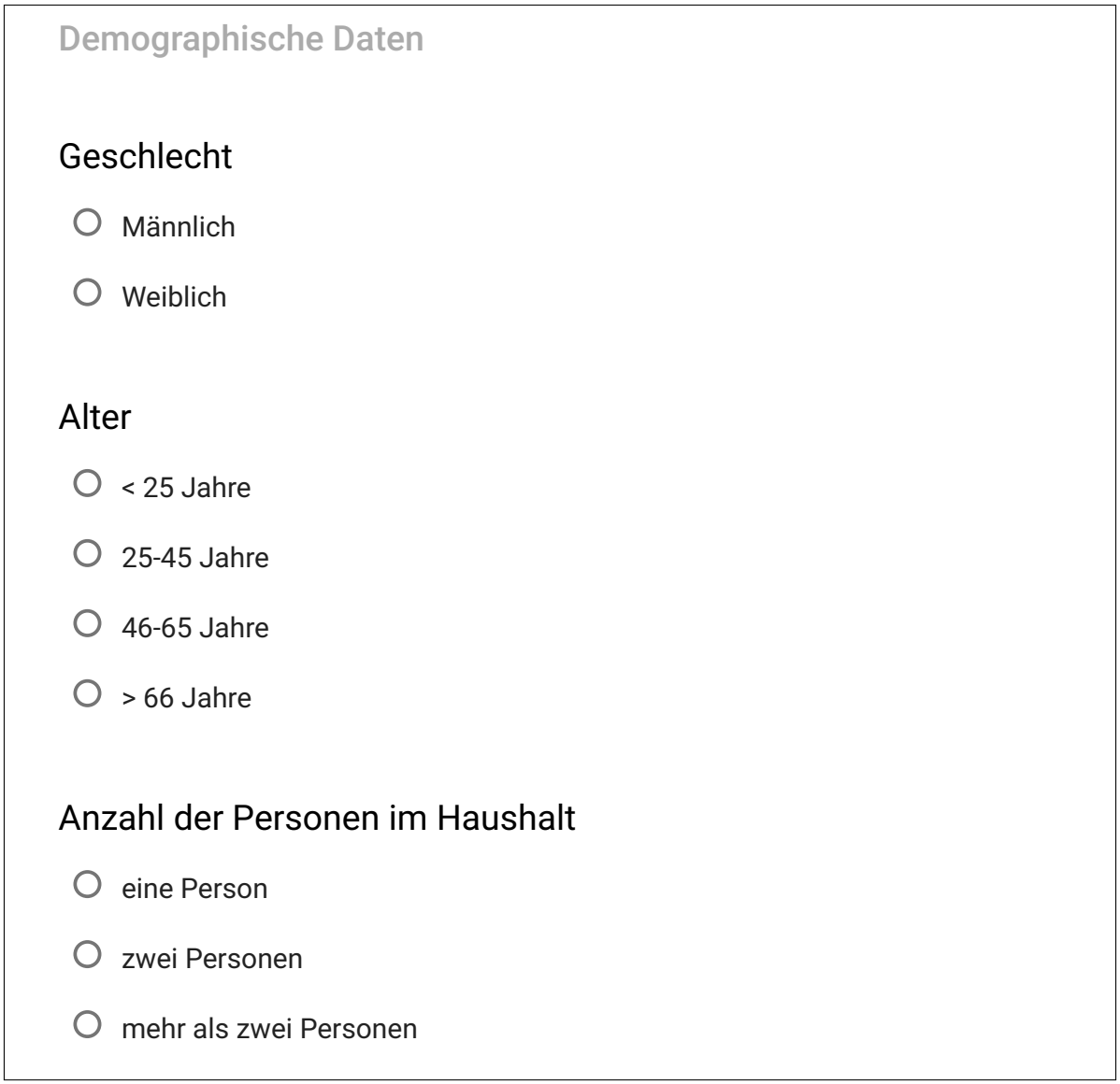


Figure B.6.: Survey - Page 5 (Demographical data)

C. Patent search

C.1. ÖPA patent search proposal

C.2. ÖPA patent search results

österreichisches patentamt

RE 729a UNI / FHS / HTL - RECHERCHENANTRAG

Antrag auf Erstellung eines gem. §33 Patentamtsgebührengesetz unentgeltlichen schriftlichen Gutachtens über den Stand der Technik gem. §57a Z1 Patentgesetz für Dissertationen und Diplomarbeiten

Aktenzeichen *(wird vom Österreichischen Patentamt vergeben!)*

An das
Österreichische Patentamt
Dresdner Straße 87
1200 Wien

IPC:
Ref.:
TA:

Bitte für amtliche Vermerke freihalten!

Die eingeklammerten Zahlen verweisen auf Erläuterungen in der angeschlossenen Ausfüllhilfe!

(1) **Antragsteller/in**

Vor- und Zuname, *ggf. Geburtsdatum/Firmenwortlaut sowie Firmenbuchnummer/Vereinsname*	Anschrift/en *(Wohnadresse bzw. Unternehmenssitz) Straße/Hausnr., PLZ/Ort, Bundesland*
Daniel Sparber, 25.02.1997	Spitz 18/1, 6406 Oberhofen im Inntal, Tirol

(2)

Telefon	Telefax	E-Mail
+43 664 2432067		sparber.daniel@gmail.com

Beilagen, die das zu recherchierende konkrete technische Problem ausführliche darlegen

(3) 1 Seiten Beschreibung (2fach) (4) 1 Blatt Zeichnungen (2fach)

(5) ☐ Zusammenfassung (2fach)

Datum	**Unterschrift(en)** *(Antragsteller/in)*

(6) **Bestätigung des Institutsleiters, Studiengangleiters bzw. des Direktors/Abteilungsvorstandes**

Es wird bestätigt, dass der/die Antragsteller/in die Recherche für seine/ihre Dissertation/Diplomarbeit am Institut
HTL Anichstraße
mit dem Titel
AudioAnt
benötigt.

Name *(Institutsleiter, Studiengangleiter bzw. Direktor/Abteilungsvorstand)*
Direktor: Mag. Günther Laner

Telefon	Telefax	E-Mail
+43 (0)512 59717 0	+43 (0)512 59717 72	direktion@htlinn.ac.at

Datum und Unterschrift *(Institutsleiter, Studiengangleiter, Direktor/Abteilungsvorstand)*, Stampiglie *(zB Rundsiegel)*

DVR 0078018 RE 729a, v01.10, Seite 1

Figure C.1.: ÖPA patent search proposal - Page 1

Beschreibung

Gegenstand der Recherche ist ein elektronisches Hilfsmittel für Personen mit eingeschränktem Hörvermögen. Dieses Hilfssystem soll das alltägliche Leben zahlreicher Menschen erleichtern, indem es diverse Hinweistöne (z.B. Haustürklingel) erkennt und dies kenntlich macht.

Das Hilfsgerät ist in der Lage, über ein Mikrofon Töne aufzunehmen und erlernte Audiosignale (Telefonklingeln, Türglocke, Wecker, Hilferufe, etc.) mittels Audioanalyse zu erkennen. Wurde ein Signal erkannt, gibt das Gerät einen lauten Warnton, sowie ein optisches Signal (Lichtblitz) aus.

Das Hilfsgerät beherbergt folgende Hauptkomponenten:

(1) **Mikrofon:** zur Aufnahme von Umgebungsgeräuschen

(2) **Rechnereinheit:** zur Analyse der eingehenden Audiosignale

(3) **Lautsprecher:** zum Ausgeben eines Warntons

(4) **Lautstärkenregler:** zum Regeln der Warntonlautstärke

(5) **LED Streifen:** zum Erzeugen eines Lichtblitzes

(6) **LED Statusleuchte:** zeigt an, ob das Gerät gerade in Verwendung ist

Kennzeichen des Gerätes:

(1) Das Gerät ist dadurch gekennzeichnet, dass es nach dem Lernen eines Signales dieses eigenständig wiedererkennt.

(2) Das Gerät ist dadurch gekennzeichnet, dass die oben genannten Hauptkomponenten in einem Gehäuse untergebracht sind.

(3) Das Gerät ist dadurch gekennzeichnet, dass es portabel ist und direkt nach dem Anstecken an das Stromnetz betriebsbereit ist.

Figure C.2.: ÖPA patent search proposal - Page 2

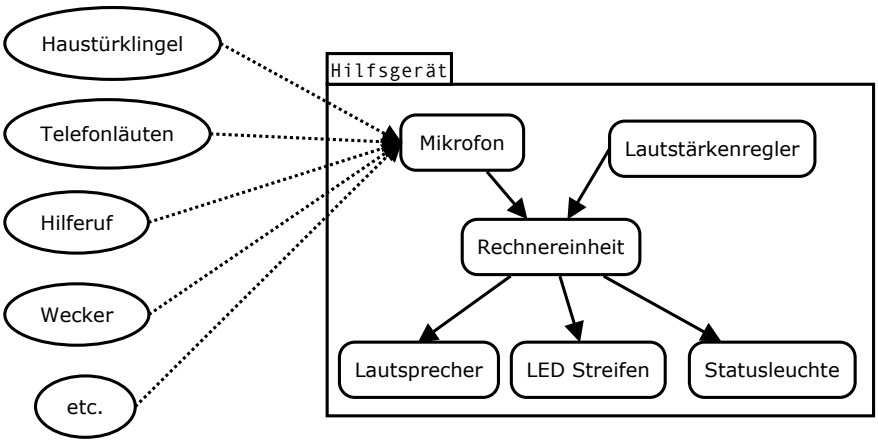


Abbildung 1: Schematische Darstellung des Hilfsgerätes

Figure C.3.: ÖPA patent search proposal - Page 3

österreichisches
patentamt

Gruppe Technik
Dresdner Straße 87, PF 95
1200 Wien
Telefon +43 (0)1 53424 0
Fax +43 (0)1 53424 535
www.patentamt.at
UID ATU38266407
DVR 0078018
Bankverbindung
BIC: BUNDATWW
IBAN: AT75 0100 0000 0516 0000

Daniel Sparber
Spitz 18/1
6406 Oberhofen im Inntal

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Wien, 04.11.2015

Geschäftszahl: 3 RG 31/2015 - 1
Antragsdatum: 16.10.2015

Bitte Geschäftszahl bei allen Eingaben anführen!

Recherche (§ 57a Z 1 PatG)

über den Stand der Technik,

erstellt auf Grund Ihres Antrags vom 16.10.2015 mit dem Betreff elektronisches Hilfsmittel für Personen mit eingeschränktem Hörvermögen.

Es sind die im beigefügten Recherchenbericht angegebenen einschlägigen Druckschriften ermittelt worden. Die Vollständigkeit der Ermittlung kann nicht gewährleistet werden.

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1 Beilage(n)
Recherchenbericht

Figure C.4.: ÖPA patent search results - Page 1

Erläuterungen zum ermittelten Stand der Technik:

D1: WO 2008067638 A1 (HARMONYA TECHNOLOGIES INC) 12.06.2008 "Environment sensing system for the hearing-impaired"

D1 beschreibt ein System zum Erkennen eines bestimmten Geräusches in der Umgebung einer tauben bzw. schwerhörigen Person. Hierzu wird ein erkanntes Umgebungsgeräusch mit Hilfe eines Vibrationssignals und einer auf einem Display angezeigten Nachricht an eine vom Benutzer getragene persönliche Vorrichtung übertragen.

D2: US 2011025499 A1 (HOY LESLIE D. ET AL.) 03.02.2011 "Signal processing system and methods for reliably detecting audible Alarms"

In **D2** werden akustische Alarmsignale, welche beispielsweise von einem Feueralarm, Rauchmelder oder CO2-Detektor ausgesendet werden, an eine persönliche Vorrichtung eines Benutzers, welche z.B. in ein Bett integriert sein kann, übertragen.

D3: WO 2011000113 A1 (HARMONYA TECHNOLOGIES) 06.01.2011 "Multiple sound and voice detector for hearing-impaired or deaf person"

In der in **D3** eingesetzten Vorrichtung wird durch Vergleich von vorab abgespeicherten Signalen mit aufgenommenen Umgebungsgeräuschen zwischen non-verbalen Signalen und dem gesprochenen Wort unterschieden.

D4: WO 0074013 A1 (EVETS COMM LTD) 07.12.2000 "Alarm system"

In **D4** analysiert eine spezielle Analyseeinheit die mit einem Mikrophon aufgenommenen Umgebungsgeräusche und kann in Abhängigkeit des erkannten akustischen Signals, bei dem es sich beispielsweise um einen Feueralarm handelt, ein entsprechendes Licht zum Leuchten bringen.

D5: DE 19816752 A1 (NEUMAIER MARTIN) 28.10.1999 "Einrichtung und Verfahren zur Erzeugung eines Steuersignals zur Ansteuerung wenigstens einer Signalquelle, die ein für einen Hörgeschädigten wahrnehmbares Signal erzeugt"

Eine spektrale Analyseeinheit sorgt in **D5** dafür, dass zwischen unterschiedlichen akustischen Signalquellen wie dem Läuten einer Türglocke oder dem Läuten des Telefons unterschieden werden kann, sodass in Abhängigkeit der erkannten Signale ein Vibrationsmelder oder ein Blitzlichterzeuger aktiviert werden.

D6: KR 20110092479 A (YANG KWANG) 18.08.2011 „Alarm displaying apparatus and method for persons hard of hearing"

In **D6** kommt eine Reihenanordnung von Mikrophonen zum Einsatz, um bestimmte akustische Signale aus den Umgebungsgeräuschen herauszufiltern, sodass in Abhängigkeit

Figure C.5.: ÖPA patent search results - Page 2

der erkannten Alarmsignale entsprechende Lämpchen zum Leuchten gebracht werden können.

D7: US 4237449 A (ZIBELL J SCOTT) 02.12.1980 "Signalling device for hard of hearing persons"

In **D7** ist ebenfalls bereits die Aufnahme von bestimmten Geräuschen, wie dem Laut einer Autohupe, einer Polizeisirene, einer Türglocke oder eines Feueralarms, mit einem Mikrophon vorgesehen, wobei in Abhängigkeit des erkannten Geräusches eine LED dazu gebracht wird, ein Blinklicht abzugeben.

D8: JP 2004073417 A (WATANABE MASAHIRO) 11.03.2004 "Report apparatus"

Gemäß **D8** werden die mit einem Mikrophon aufgenommenen akustischen Signale, welche von bestimmten Küchengeräten oder anderen elektrischen Haushaltsgeräten ausgesandt werden, für schwerhörige Personen verstärkt.

D9: WO 2014168594 A1 (OKSUN AKIN) 16.10.2014 "Warning system comprising wristband embodiment"

Die in **D9** beschriebene Vorrichtung zur Erkennung von bestimmten Alarm- oder Warnsignale ist in eine Armbanduhr mit Display integriert, sodass auch den Signalen entsprechende Nachrichten für den Benutzer angezeigt werden können.

D10: US 2009154744 A1 (SNYDER WAYNE HARVEY) 18.06.2009 "Device for the hearing impaired"

Auch in **D10** werden akustische Signal mit Hilfe einer Reihe von Mikrophonen aufgenommen. In Abhängigkeit des erkannten Signals werden entsprechende Symbole auf einem Display der Vorrichtung für taube bzw. schwerhörige Personen angezeigt.

D11: JP 3043730 B1 (NEC GUMMA LTD) 22.05.2000 „Auditorily disabled person assisting instrument"

Eine Vergleichsschaltung sorgt in der in **D11** beschriebenen Vorrichtung dafür, dass zwischen bekannten akustischen Signalen wie Alarmsignalen und unbekannten bzw. nicht näher spezifizierten Signalen wie Umgebungsgeräuschen unterschieden werden kann.

D12: DE 4033673 A1 (PRELL MAX) 30.04.1992 "Drahtloses Alarm-/Kommunikationssystem für Schwerhörige"

Ein in einer Tasche unterbringbarer Empfänger teilt in **D12** schwerhörigen Personen den Empfang von unterschiedlichen akustischen Signalen wie Telefon, Klingel, Wecker oder Baby-Alarm mit.

Figure C.6.: ÖPA patent search results - Page 3

Recherchenbericht zu **RG 31/2015**

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Klassifikation des Anmeldungsgegenstands gemäß IPC: ***G08B 5/36*** (2006.01); ***G08B 21/00*** (2006.01); ***H04R 25/00*** (2006.01)
Klassifikation des Anmeldungsgegenstands gemäß CPC: ***G08B 5/36*** (2013.01); ***G08B 21/00*** (2013.01); ***H04R 25/00*** (2015.10)
Recherchierter Prüfstoff (Klassifikation): G08B, H04R, G10L
Konsultierte Online-Datenbank: EPODOC, WPI, TXTDE, TXTEN
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Kategorie*)	Bezeichnung der Veröffentlichung: Ländercode, Veröffentlichungsnummer, Dokumentart (Anmelder), Veröffentlichungsdatum, Textstelle oder Figur soweit erforderlich	Betreffend Anspruch
	WO 2008067638 A1 (HARMONYA TECHNOLOGIES INC) 12. Juni 2008 (12.06.2008) Zusammenfassung; Figuren 1, 4; Beschreibung der Figuren; Ansprüche 1-24; US 2011025499 A1 (HOY LESLIE D. ET AL.) 3. Februar 2011 (03.02.2011) Zusammenfassung; Figuren 1, 3; Beschreibung der Figuren; Ansprüche 1-20; WO 2011000113 A1 (HARMONYA TECHNOLOGIES) 06. Januar 2011 (06.01.2011) Zusammenfassung; Figuren 2, 5-9; Beschreibung der Figuren; Ansprüche 1-98; WO 0074013 A1 (EVETS COMM LTD) 07. Dezember 2000 (07.12.2000) Zusammenfassung; Figur 1; Beschreibung der Figur; Ansprüche 1-16; DE 19816752 A1 (NEUMAIER MARTIN) 28. Oktober 1999 (28.10.1999) Zusammenfassung; Figuren 1, 4-7; Beschreibung der Figuren; Ansprüche 1-34; KR 20110092479 A (YANG KWANG) 18. August 2011 (18.08.2011) englische Zusammenfassung; Figur 1; Beschreibung der Figur; Ansprüche 1-7; US 4237449 A (ZIBELL J SCOTT) 02. Dezember 1980 (02.12.1980) Zusammenfassung; Figuren 1-2, 4; Beschreibung der Figuren; Ansprüche 1-10; JP 2004073417 A (WATANABE MASAHIRO) 11. März 2004 (11.03.2004) englische Zusammenfassung; Figur 1; Beschreibung der Figur;	

Datum der Beendigung der Recherche:	Seite 1 von 2	Prüfer(in):
04.11.2015		STOLL Judith

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- **Y** Veröffentlichung **von Bedeutung**: der Anmeldungsgegenstand kann nicht als auf erfinderischer Tätigkeit beruhend betrachtet werden, wenn die Veröffentlichung mit einer oder mehreren weiteren Veröffentlichungen dieser Kategorie in Verbindung gebracht wird und diese **Verbindung für einen Fachmann naheliegend** ist.
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- **E** Dokument, das **von besonderer Bedeutung** ist (Kategorie **X**), aus dem ein „**älteres Recht**" hervorgehen könnte (früheres Anmeldedatum, jedoch nachveröffentlicht, Schutz ist in Österreich möglich, würde Neuheit in Frage stellen).
- **&** Veröffentlichung, die Mitglied der selben **Patentfamilie** ist.

DVR 0078018

Figure C.7.: ÖPA patent search results - Page 4

Fortsetzung des Recherchenberichts zu **RG 31/2015**
Seite 2 von 2

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	Ansprüche 1-4; WO 2014168594 A1 (OKSUN AKIN) 16. Oktober 2014 (16.10.2014) Zusammenfassung; Figuren 1-3; Beschreibung der Figuren; Ansprüche 1-6; US 2009154744 A1 (SNYDER WAYNE HARVEY) 18. Juni 2009 (18.06.2009) Zusammenfassung; Figuren 1-2, 5-7; Beschreibung der Figuren; Ansprüche 1-15; JP 3043730 B1 (NEC GUMMA LTD) 22. Mai 2000 (22.05.2000) englische Zusammenfassung; Figuren 1-2; Beschreibung der Figuren; Ansprüche 1-3; DE 4033673 A1 (PRELL MAX) 30. April 1992 (30.04.1992) Zusammenfassung; Figur 1; Beschreibung der Figur; Ansprüche 1-16;	

Figure C.8.: ÖPA patent search results - Page 5

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E. List of Figures

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