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BIRD SPECIES IDENTIFICATION USING SIGNAL PROCESSING

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SAMMANDRAG

Ett av projektets mål är att undersöka möjligheten till att identifiera fågelarter endast utifrån deras läten, detta är tänkt att göras genom signalbehandling i olika steg. Med en inspelning av en fågel kommer ljudfilen att först klippas till kortare samples och sedan Fouriertransformeras för att nå frekvensinnehållet i vardera sample. Härifrån analyserar vi all data och får fram tre features; frekvens, mönster och längd på lätet.

Som ett ytterligare mål i mån om tid planerades en applikation till de populäraste smartphone telefonerna. Applikationen var tänkt att ge en användare möjlighet att identifiera fåglar ute i fält. Inför detta gjordes en marknadsundersökning för att se vilka funktioner som användarna önskar.

Med de använda metoderna lyckades vi identifiera fågelarter med en säkerhet på ca 90 % i en brusfri miljö. Denna säkerhet påverkades starkt när vi använde oss av inspelningar från en mer naturlig miljö och fick en säkerhet på ca 50 % - 75 % med få störande ljud. Ifall användaren endast lyckas fånga kortare bitar av fågelns läte sjunker säkerheten ytterligare, ner till ca 20 % – 40 %.

ABSTRACT

One of the project goals is to examine the possibility to identify Swedish bird species from birdsong. This is planned to be done through signal processing. The audio file of a birdsong recording will first be cut into smaller samples and then Fourier transforms are utilized to analyze the frequencies in each sample. From here all the data is analyzed to obtain the three key features: frequency, pattern and length.

Another goal, time permitted, was plans for a smartphone application for common smartphones. The application was thought to give the user the ability to identify live birdsongs out in the field. A market research was done for the application to see what functions the user would want.

With the methods used, it proved possible to identify species with a success rate of about 90 % in a noise free environment. This success rate was less effective when using recordings from a more natural environment; we got a success rate of 50 % – 75 % with only a few disturbing noises. In cases where the user was able to catch only parts of the birdsong, the success rate decreased to 20 % - 40 %.

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1. INTRODUCTION

The dramatic increase of smartphones and other handheld devices in the modern society means that the general public has access to potent computing power at all times. This has redefined what we used to consider normal use of a cell phone and has opened the door to the vast app market we have today where developers use the sensors and processing power of the phones to analyze their surroundings. [1]

The goal for this project was to identify Swedish bird species by processing sound recordings. The idea for this bachelor's thesis was originally suggested by Electrical Engineering students from Chalmers whose idea was picked up by the institution for Signals and Systems. This report explains the process of selecting the method to identify birds with the background of classification and voice recognition. There are two focuses of the project; the first is the classification system done in MATLAB, and the second part describes the efforts to implement the method on a smartphone. [2]

1.1 BACKGROUND

In modern computing, a commonly used and potent tool is signal processing. Signal processing allows users to collect and analyze information obtained from the different sensors on the smartphones. Sound analysis is one common application of signal processing. Voice commands are a standard for new smartphones and there are many apps on the market for iOS and Android that use it. One of the commonly used apps is Shazam which can be used to record a clip of a song and provide information about the song title and artist. Apps like these are made to aid people in obtaining information from their surroundings. [3]

One common sound in the outdoors is the sound of birds. An experienced ornithologist can often identify birds based on their song, but that is a skill that takes much training and experience. But it's not only professionals who are curious about what birds are in their surroundings, so there was believed to be some public interest in having access to an app that could identify the more common birds.

There are many computer programs available for developing signal processing systems and smartphone apps. MATLAB is a widely used program in the industry and a powerful tool in signal processing since it features prewritten commands and toolboxes that can be used to analyze sound files. For the development of the smartphone app, Eclipse (which is a common Android environment using Java as programming language) was selected. [4]

1.2 PURPOSE

To create a "Shazam for birds" would be a colloquial way to describe this project. The goal is to create a program that can analyze recorded sound and determine which species of bird is on the recording.

The project has two larger goals, the first and the main goal being to create a classification system on a computer using software like MATLAB, second will be examining possibilities of implementing the system on a mobile device. The goal of the project was to design a classification system that was able to identify some of the more common birds in Sweden with good accuracy.

1.3 SCOPE AND BOUNDARIES

The main focus was the implementation in MATLAB and not the smart phone application. The practical implementation on mobile devices is excluded from the scope of the project; however the intentions of implementing it on a handheld device heavily influenced the design choices for the classification system.

Another important boundary was the number of birds the program would be able to identify; the training data was limited to Swedish birds in order to be able to verify the results with homemade recordings. Birds, like humans, have accent depending on the geographic location and any regional differences between the sounds were not considered when creating the identification process.

2. METHODS AND THEORY

2.1 PREVIOUS RESEARCH ABOUT BIRD RECOGNITION BY SOUND

In the earliest research in pattern recognition of birdsongs, features were extracted from frequency-time plots called sonograms by ornithologists, where an **element is a burst of sound separated by a distinct pause termed an inter-element interval**. The main features tried were the following:

- Highest energy frequency/element,
- Number of elements/song,
- Element duration,
- Inter-element interval,
- Song duration,
- Maximum and minimum frequency content,
- Frequency range,
- Duration and slope of chirping sounds, and
- Time and frequency of frequency changes.



One of the first researches in the field of automatic birdsong recognition using signal processing was done by Alex L. MacIlraith and Howard C. Card (1997) in their essay *Birdsong Recognition Using Backpropagation and Multivariate Statistics*. Their investigation consisted of six species, which had overlapping characteristic in frequency content, song components, and length of songs. The training set consisted of 127 recordings, while the test set consisted of 6 recordings. Their research showed “that only small gains were likely if more than eight variables retained.” In the preprocessing stage, windowed Fourier transforms were used with around 82-93% correct identification, with the lower figures having less computational requirements. [5]

2.2 INTERVIEWS AND MARKET RESEARCH

Significant effort was made to survey the interests among ornithologists and others interested. A long interview was completed with ornithologist hobbyist, Bill Karlström, and former doctor and hunter, Gunnar Stenström. Shorter interviews were also made with a random selection of six people to cover different categories of individuals.

1. Bill Karlström wanted besides an app that could detect bird's functions for playing other songs the bird has. He agrees that buttons for recording, playback, identification, diary and mapping should be provided for the user at any time. As an ornithologist he is rarely using a map on the field. [6]
2. Gunnar Stenström is now using a Samsung mobile that can withstand wet conditions, so he is interested in a bird app for his smartphone. He has been using an app for hunters that can allocate the hunting dog and provide information about many different animals for hunting. He would be interested if there was an app that quickly could detect flight noise from different geese. Hunters are forbidden to kill endangered species, so it is important for them to detect bird species quickly, he mentioned. [7]
3. The shorter interviews were made during one day in Gothenburg with random pedestrians. We were interested to hear what functions people wanted and if there is any market for a commercial app. Computer programmer, Olle Bergqvist, wants a fast app that can detect many birds, but he expressed concern about the wind noise in the recording. Elizabeth Stridsberg, 49 years old, wanted an app for an Ipad for her children that could detect birds with a pedagogical picture. She is willing to pay 40 SEK as that is what most games for kids cost nowadays. John Robin Andersson, 25 years old, wants an app for free, or no more than 7 SEK, that shows images of the birds, regions, rarity, and provides search functions. The older generation seems to want a free app that is easy to use and can just detect the species with just the name provided according to Eva Lawesson, 71 years old. [8]

Email correspondence with potentially interested parties

Contact was also made with an app provider through e-mail. Martin Ransgart Bonnier, is himself making a bird app for the Swedish market and became very interested in our project. He thinks many would want a bird detecting feature in the smartphone. Gunilla Idestrom, Swedish Department of Agriculture, also became interested in our app, but informs us that they could not use the pictures provided in their app as that would require Creative Commons licensing. In their app 39 species on the countryside are presented, which is a reasonable amount for our project. [9] [10]

2.3 APP DESIGN

The idea of the smartphone application was to port the identification algorithm to a handheld device in order to make it practically useful in real life situations. While a finished, functioning app was not in the scope of the project much time and thought was put into how an eventual app would function and look like.

2.3.1 INITIALLY SUGGESTED FEATURES

The purpose of using the app was that anyone in the proximity of a singing bird should be able to take out their handheld device, start recording and then identify the bird. Once the identification process was finished the user would be given a list of the best matches, a possibility to replay the sound they just recorded and then confirm the identification.

The app was drafted to have the following features.

- Record sound
- Identify after a recording is made
- A list of all birds in the databank with a checklist of birds you have identified
- Link to Wikipedia for further reading about each species
- Log book that saves time and geo information for each confirmed identification

The level of ambition for the app was been gradually decreased as the project came along due to the lack of time and the project members having little experience with designing and programming smartphone applications. At first it was planned to feature an information database and functions like being able to save and upload locations where birds were identified on the internet so other users could share that information. These ideas were dropped since that would require a server handling that data and that was considered to be outside the scope of the project. After the midterm meeting with the examiner the decision was made to focus mostly on the method in MATLAB and the app was to be as minimal as possible.

2.3.2 DESIGN

The drafted design of the app interface was made to reflect the simplicity of the functions. The interface was centered on the Record button in the middle of the screen in order to make it fast and easy to simply open the app and press record. Once a recording was made the user has the option to either listen to the recording they just made or go straight to identifying. Figure 1 shows the initial concept art for the design.

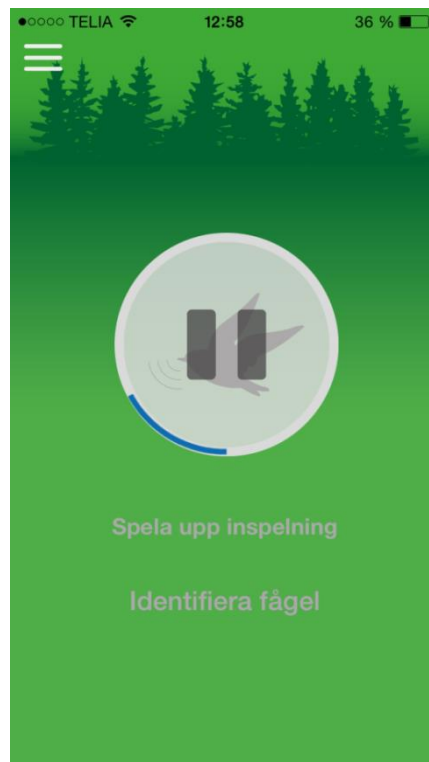


Figure 1 – Original design concept

2.4 ANDROID PROGRAMMING

The Android platform is based on the GNU Linux Operating System (OS). The Linux core controls the internal, while the Android libraries control the external. The external consists of telephone, video, graphics, and user interface and is engineered by the programmer. [11]

An android app is composed of four main components: Activities, Services, Content providers and Broadcast receivers.

- The activity is written as a single Java class, with the main activity extending Android's Activity class and forms the base.
- The service runs in the background and does not interact with the user.
- The content provider saves data between startups and changes.
- The broadcast receiver reacts to actions taken by the phone or new system conditions. [11]

One activity uses an Intent to request access to other application's processes and Intent filters are set in the manifest file. A complete documentation of the Android Development Kit (ADK) can be found at <http://developer.android.com>. [11]

2.4.1 THE PROGRAMMING PROCESS

The Android app was inspired by an app created by Deitel called FavoriteTwitterSearches. That app enables the user to save Twitter searches in the app for later use. This was implemented with links to Wikipedia instead with a String- input that could be implemented by an analyze function in C. The recording function was based on an Android Developers Audio Captures example and modified to AAC to enable playback. [12]

First the Layout-file for the main activity was built in XML-code. It is based on the layout from the FavoriteTwitterSearches app, but with no input text for the search-text and only for the tag-text. Two toggle buttons with audio capture, record, and play, were added to the bottom of the text. [12]

A time stamp with an ID number was developed for each save file, but was later dropped for an easier implementation using the getDate() method in the Calender function as a String. The recorded birds are then saved as an AAC-file using this String as the name for the file and the input String as a link to Wikipedia. [12]

The user can then click on the recordings and/or the bird name for playback or the Wikipedia-link. In the menu *bar*, buttons for *Analyze*, *Delete recordings*, and *Sharing* were meant to be added, but the analyze function was dropped in the end due to time shortage. The bird names meant to be analyzed were put in a

drop-down menu altogether with a quit-button. An alert dialog for taking strings from the analyze function was developed, but dropped in the end when the analyze function was not there to support it. Instead, alert dialogs are used whenever the user selects *Delete all recordings* or *Quit the app*. [12]

2.5 MATLAB

2.5.1 PATTERN RECOGNITION

Pattern recognition and classification is not limited to just sound; it is the process of analyzing data, determining significant features to evaluate, and making a classification based on their pattern.

The flow chart in figure 2 describes the system with an input and output; the input in this case is a sound file and the output is the name of a bird species that matches the frequency, pattern, and length. The steps in the flowchart are explained below. [13]

- **Segmentation**

The function of segmentation is to prevent separate different objects in the input. This is typically the most difficult problem in creating a pattern recognition system. The goal of segmentation is to determine how the song of a bird varies over time. [13]

- **Feature Extraction**

A feature is a property that distinguishes a certain object. The process of feature extraction means to find several properties that can be used to classify an object. [13]

- **Classification**

The purpose of a classifier is to combine the features and make a positive identification. In practice, a classifier will give the most probable answer due to the noise and other inaccuracies in the system. [13]

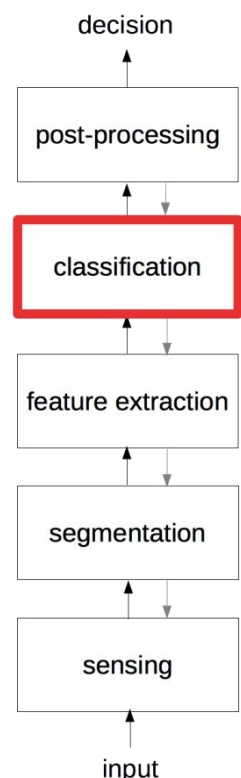


Figure 2 - Key parts of a pattern recognition system

2.6 MATLAB METHOD

2.6.1 TRAINING AND TESTING

For classification purposes it is important to separate the database in training and testing. The training files are used to verify that the system can correctly classify inputs with the extracted features. The accuracy of the training database should be as close to 100% as possible. The files being tested are compared to the training files in order to find a best match. [14]

2.6.2 CHOICE OF FEATURES

As discussed in the background, the features used to classify the bird should be distinguishing to that species. The process of identifying these features was very ad hoc and chosen by studying the Fast Fourier Transforms (FFT) of various birds in the database and how they differed between species in time. Many birds were in the same frequency range but had different patterns. Some birds' songs last for long periods of time while others have only short songs.

Feature 1: Length of song

The length of the song can vary between birds, so measuring how long a song lasts before it goes quiet was chosen as a feature. One problem with this feature is that it's not invariant; it might depend on when the recording starts and stops.

Feature 2: Pattern

The pattern feature looks at which order the dominant frequencies appear and compares them to the files in the database. In a real life situation, it is impossible to know in which part of the sound the record might start. Therefore when trying to match the recorded pattern with the database, it is necessary to time shift in order to maintain time invariance.

Feature 3: Frequency

The first feature includes the four dominant frequencies in each short segment of the recording. This is to see in which spectrum the energy of the sound is focused. The bulk of the energy should fall into a certain spectrum for each species of bird. However during initial investigation many birds were found to lie in similar spectrums, therefore additional features were chosen for more accurate results. Figure 3 shows an example of how the average dominant frequencies can vary over time for a particular bird.

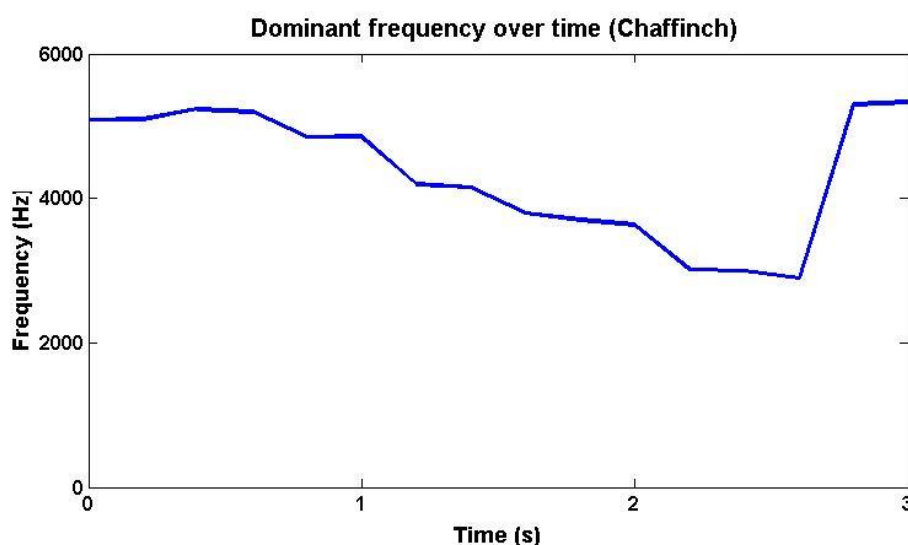


Figure 3 - Example of the frequency range in a song

2.6.3 TRADEOFFS WITH SPEED VS. PERFORMANCE

Since the intended implementation was for smartphones, there were tradeoffs to consider. The most important was how to segment the incoming recording; in speech recognition applications the segmentation process would actively try to distinguish each syllable to get the best performance. That method does however require a lot of processing power, meaning the calculation would take longer. Because speed was one of the most desired features of the app, the choice was made to do a more crude segmentation. Each incoming recording would be split into 0.2 seconds long samples. The number 0.2 seconds was chosen after experimenting with both shorter and longer samples and evaluating the benefits of the slower but more detailed identification process. [5]

2.7 FEATURE EXTRACTION

The method of extracting features from the sound recordings will be explained using an example from the Chaffinch (*Fringilla coelebs*).

The first step is to **read the sound file** in MATLAB using the **wavread()** function which will return two data vectors because it is a stereo file, figure 4 shows one channel of the .wav file. In order to avoid doing the same thing twice, only one of the vectors needs to be studied since the difference between the channels were considered negligible.

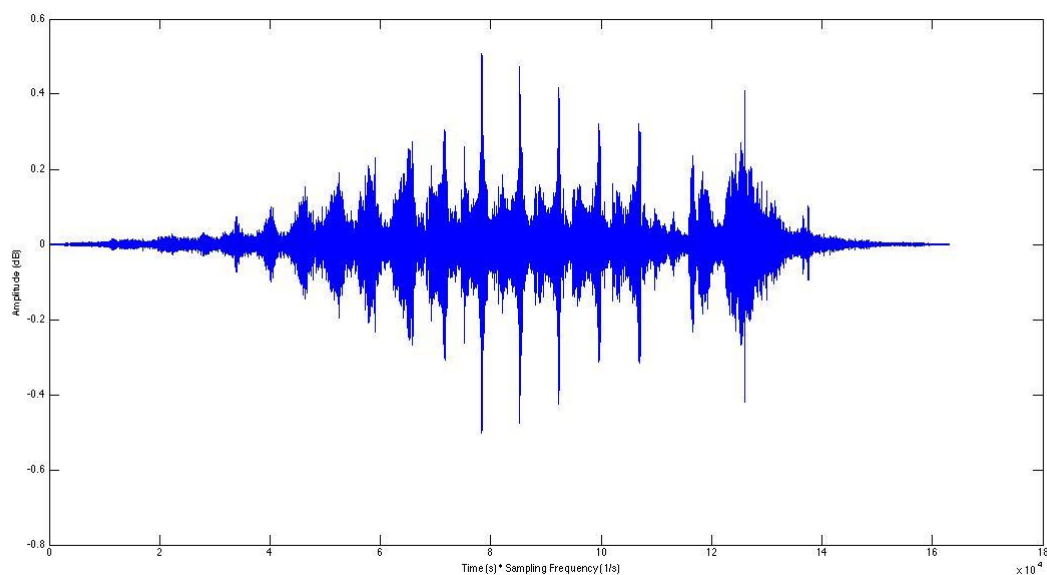


Figure 4 - Example of .wav input

2.7.1 METHOD OF OBTAINING DATA

Analyzing the frequency content of the whole recording **will not yield meaningful results since there is no time information**; the **data vector gets cut into several shorter parts in order to detect how the sound changes over time**. The example file is circa 3.7 seconds long. As previously mentioned the input is segmented into shorter samples, figure 5 and 6 shows the Fourier transform of two samples.

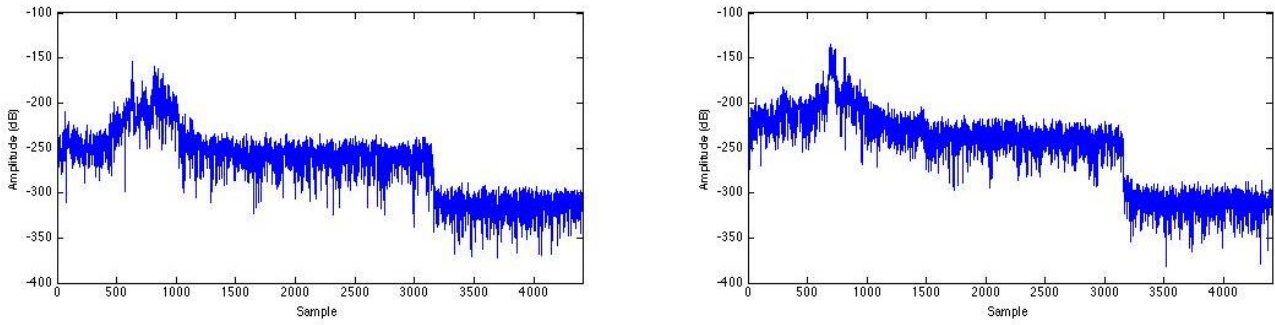


Figure 5 - FFT of two 0.2 second samples

These shorter samples are transformed into the frequency domain in order to obtain data on the frequency content using the FFT and is windowed to remove very low and very high frequency noise ($5 < \text{Hz} < 15000$). The windowed signal is then averaged to reduce noise. This signal is then normalized to set the peak amplitude as 1.

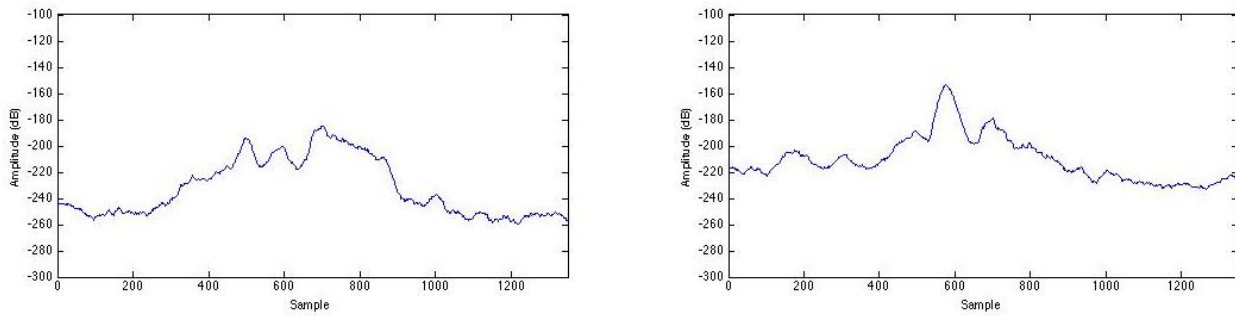


Figure 6 - Windowed and noise reduced samples

The data of the four peak frequencies are stored in an $N \times 4$ matrix (where N is the number of samples and 4 are for the four peak frequencies that are contained in each sample). This means the resulting vector will contain information about which frequencies are in the signal and in what order they appear. This is the vector with the three features that are being compared to the database to find the species with closest values.

2.7.2 ACQUIRING THE FINAL RESULT

The three features described above will be viewed in their totality in order to get an accurate result. The individual features are normalized to a probability between 0 and 1. The total probability is given by the product of the three probabilities in order to get a balance in case there are some very weak features.

3. TIME PLAN

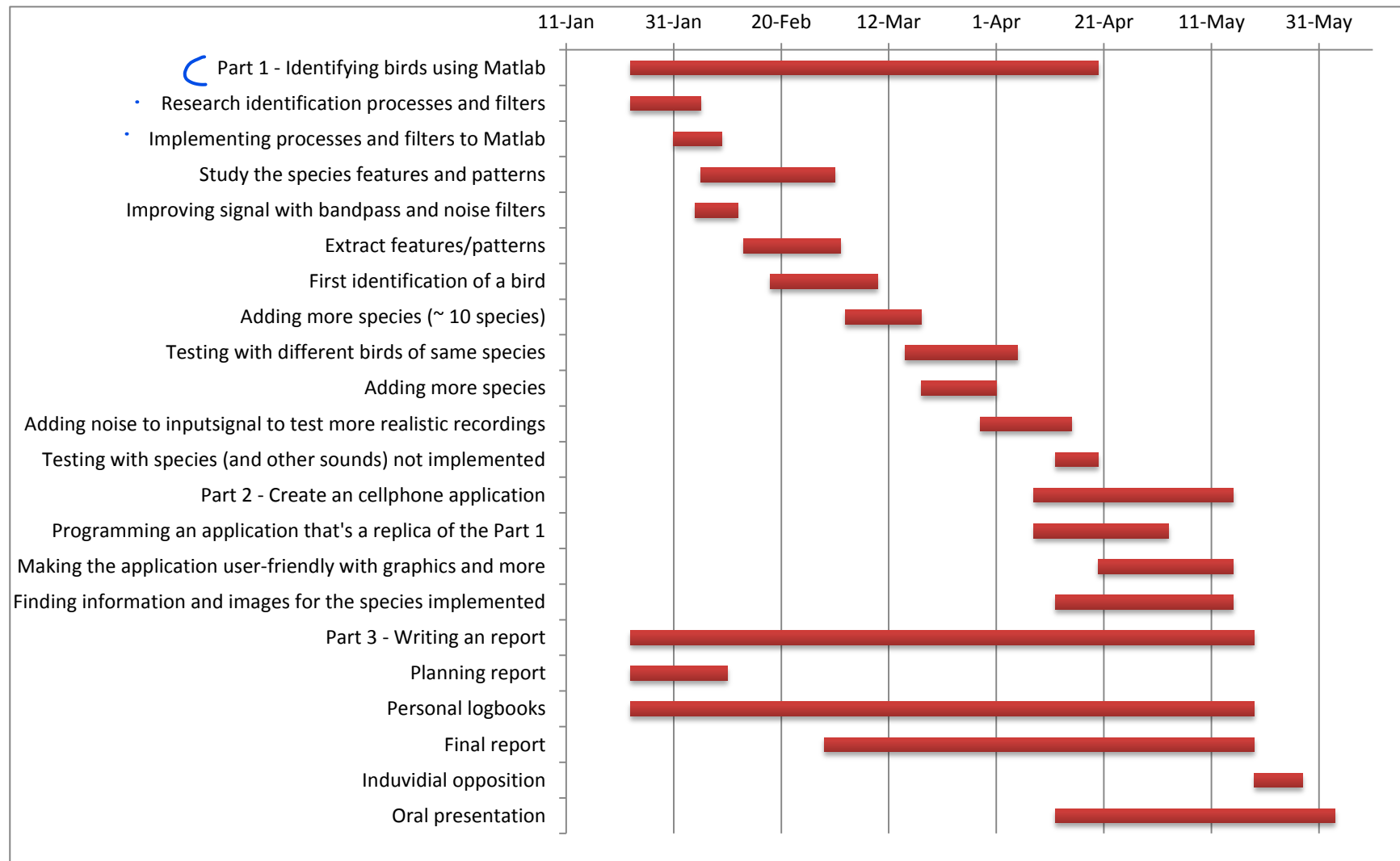


Figure 7 - Initial Gantt chart from the planning report with tasks and timeline

4. RESULTS

In order to evaluate the effectiveness of the classification system a test database containing 47 different species of birds was created with a corresponding training database. The test database consisted of 220 bird recordings that were compared to the recordings in the training database.

4.1 MATLAB

4.1.1 THRESHOLD AND OVERLOAD

In order to distinguish which samples was just noise and which contained a signal a threshold and overload value was chosen. The threshold was set from the normalized value of the FFT amplitudes, by varying the threshold value it was observed that a threshold of circa 40% of the peak value gave the best results.

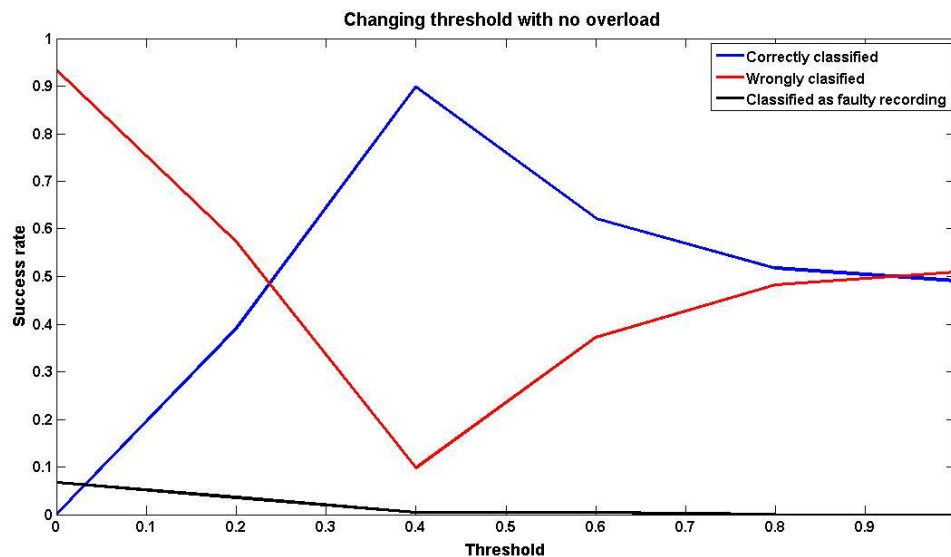


Figure 8 - Success rate with different thresholds

Since the threshold was based on a normalized value instead of an absolute limit an overload value was introduced in order to reduce misclassifications. As figure 8 shows a low threshold will give many misclassifications, introducing an overload meaning if there were more than 1000 measured points above the threshold value the signal was considered to be too noisy and discarded. Figure 9 shows that that limit reduced misclassifications while having no negative impact on the success rate.

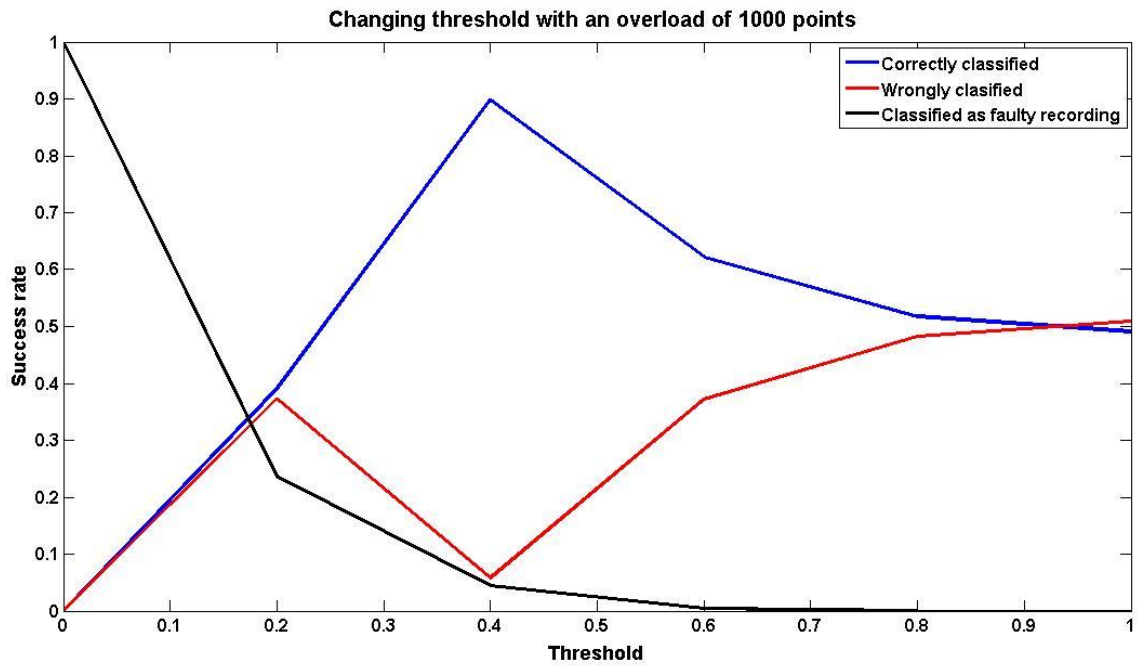


Figure 9 - Success rate with different thresholds and an overload

4.1.2 ADDING NOISE

While the recordings used for testing already had ambient noise further noise was added to see how the classifier would perform. The added noise was random Gaussian noise with a variance between 0 and 2. All three features and their combined value dropped sharply with the increased noise; figure 10 shows that the most heavily affected feature was the four dominant frequencies.

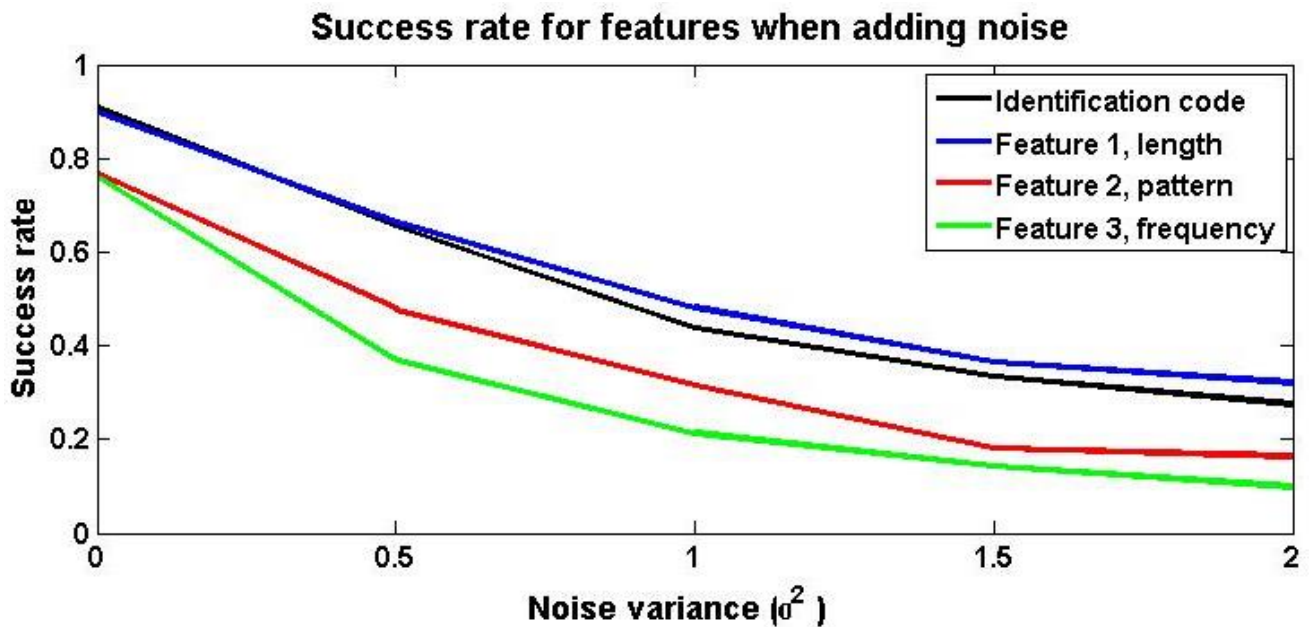


Figure 10 - Impact of noise with different variance

4.1.3 FRAGMENTED RECORDINGS

The previous results were all obtained by comparing the full content of the recording with the training database, in a realistic scenario a user was assumed to often be unable to get the full song in a smartphone recording due to the difficulty of predicting when a song would start or finish. To simulate that effect the test files were cut short at different points and then analyzed, the results for this test is shown in figure 11. This too had a significant impact on the success rate. The length feature was especially affected; this reflects the lacking invariance in that feature.

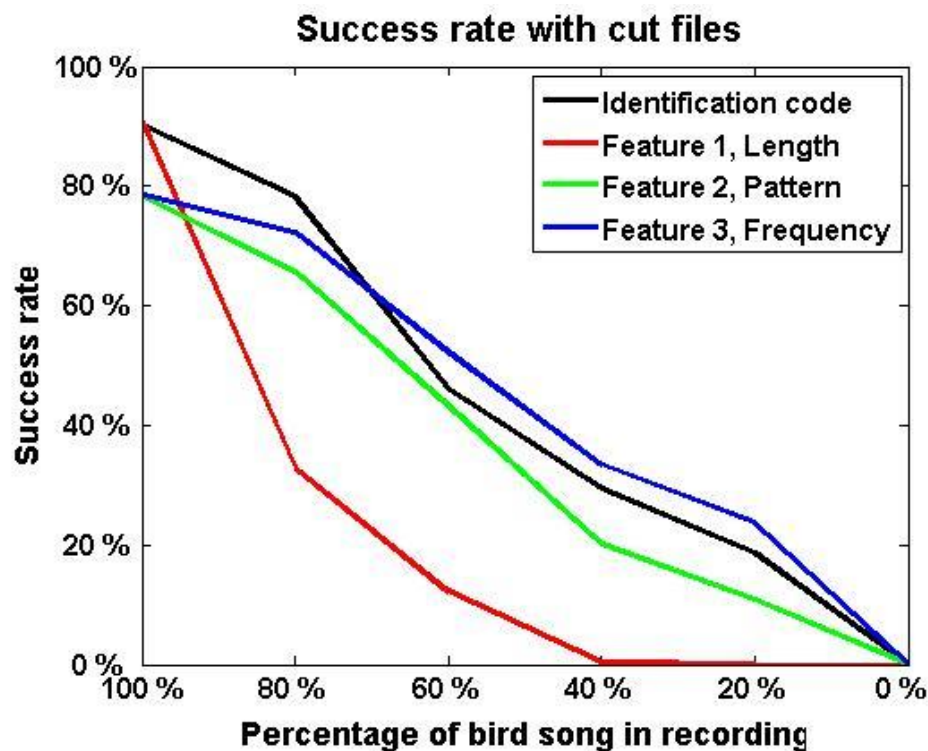


Figure 11 - Impact of cutting the signal short

4.1.4 SMARTPHONE RECORDINGS

Even if the project did not result in a functioning app, one of the intended uses was to analyze smartphone recordings. Field recordings were made and analyzed in MATLAB to examine the differences between smartphone recordings and the ones in the test database. The smartphone recordings were found to be much noisier. When comparing the noise level on the different smartphone recordings to the recordings with added noise their variance was estimated to be between 0.3 and 0.8 as is indicated by the bars in figure 12.

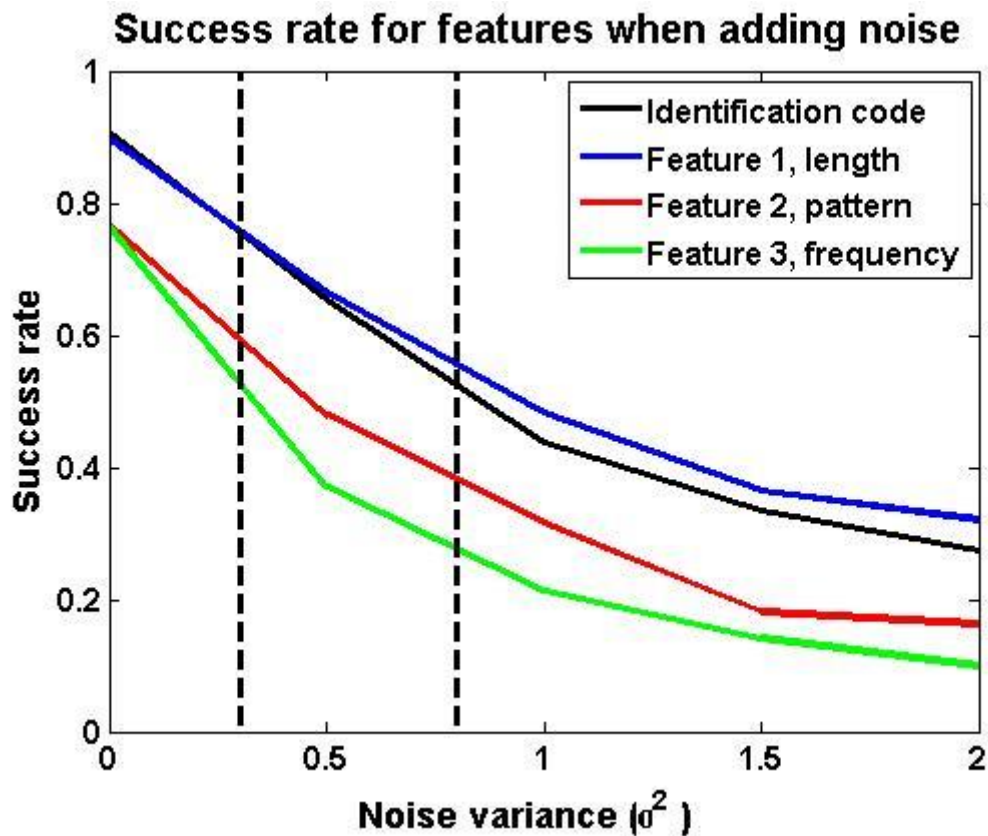


Figure 12 - Approximated noise range of smartphone recordings

4.2 SMARTPHONE APPLICATION

After the midterm meeting with the examiner it was made clear it was not something that should be considered a priority. There was a basic interface created but the main goal of making the classification system work on Android was dropped.

5. DISCUSSION

5.1 PROBLEMS

MATLAB

One of the most significant problems was the fact that the database was contaminated. In the reference files there were high levels of noise such as wind and other animals, this compounded with the noise on the recorded files created a big problem with identification. The characteristics of the noise varied greatly and there was no method that could be applied to all situations, noise from wind could often have a white noise characteristic while other animals would be colored noise. Had the reference files been recorded in a noise free environment the success rate would likely have been higher.

The microphone quality on smartphones was also an issue. Field tests were performed by recording birdsong on a smartphone and then transferring that file to the computer for analysis in MATLAB, their success rate was lower than the professional recordings. Smartphones are typically used within arm's reach and their microphones were not good at picking up distant sounds.

Limitations in the amount of sounds in the database were another source of inaccuracy. Some birds have very many different songs for different situations which mean that not all inputs had a good match in the database. The similarity between some of the birds was also a problem. Many of them were in the same frequency range and their patterns could be a decent match to one another's.

5.2 EVALUATION OF RESULTS

The main goal of the project was to investigate the possibilities of creating an identification method in MATLAB that could identify different birds from sound recordings. The test of the final version of the identification system gave as high as 90% positive identifications, which given the problems discussed above is considered a satisfying result.

The secondary goal to implement this method on a smartphone application was not met; however it wasn't within the scope of the project to finish it. Work on it was still done during the project, but after the midterm meeting with the examiner it was considered to have low priority and the ambition level was lowered over time. Since no project member had prior experience with this kind of programming it was more a personal goal from the project members to improve their app development skills.

5.3 GROUP DYNAMICS

The workload became divided between the three biggest goals of the project, the MATLAB code, the app and the report. In retrospect there should have been more cooperation and intersectional work to stimulate the progress in especially the app creation which proved difficult. Communication was sometimes lacking which meant that the same task was done twice by different members, which was wasting time.

5.4 THE FUTURE OF THE PROJECT

The market surveys showed there was a clear interest for an app of this kind. One of the most obvious areas this app could be used is for educational purposes by providing both children and adults with a way to identify the birds around them, combining an interest in nature and the outdoors with technology that is increasingly in the homes and classrooms.

The performance could be improved by different segmentation, such as distinguishing individual tones instead of the fix 0.2 second limit. Like in human speech recognition there is much important information in the higher frequencies even though that's not where the bulk of the energy lies. This project did not examine any weighting methods to extract that information, but it is possible.

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APPENDIX

INTERVIEWS (TRANSLATED FROM SWEDISH)

QUESTIONS FOR ORNITHOLOGISTS AND HUNTERS

Hello! My name is ... and I am writing my Bachelor thesis in Electro Technology at Chalmers. My team is making an app to identify bird species from their sound. It will among other things analyze the frequency of the bird calls. Could I ask you some questions about this?

1. If we could make a working app that can detect birds efficiently. What other functions would be interesting for you as an ornithologist/hunter?
2. On the starting page of the app we plan to have many buttons for fast access. (record button, play button, identify button, bird diary button, map button with observations) Follow-up question: Do you think there is any button missing or that should be taken away?
3. If it has not been discussed: How do you use maps yourself when bird watching?
4. We plan to identify birds by allowing only one bird per file. Do you know any database that has such file available?
5. Anything else I have not mentioned that you think would be interesting?
6. Would you like to receive newsletters about the app or be part and evaluate a test version in the future? (answers not included in Appendix)

I would like to thank you for the interview and for taking your time. If there is anything you are wondering or ideas about the project comes up you can always send us an e-mail.

Gunnar Stenström, hunter.

1. He thinks it would be interesting to have a dog detector for the hunting dogs.
2. He has no further comment on the button layout.
3. He thinks it would be interesting to see the dog using a GPS to quickly find the prey.
4. (Not asked)
5. There is an app out on the market for free called "Viltappen" that you could check out. It is important for hunters to detect birds that are endangered. He thinks that bird calls are hard to tell apart and all hunters have to learn them to get license.

Bill Karlström, ornithologist.

1. He would like to hear the other sound that the bird has besides the main ones.
2. He likes the suggested buttons.
3. "I rarely use maps".
4. Go to Gothenburg ornithologist association. There maybe you could find someone.
5. It would be nice to also have a picture of the bird.

QUESTIONS FOR STREET INTERVIEW

1. On the starting page of the app we plan to have many buttons for fast access. (record button, play button, identify button, bird diary button, map button with observations) Follow-up question: Do you think there is any button missing or that should be taken away?
2. How would you like us to present a map function in the app?
3. What functions do you consider the most important ones?
4. How much would you pay for an app on the Play Store? For free or with a cost?
5. Anything else I have not mentioned that you think would be interesting?
6. Would you like to receive newsletters about the app? (answers not included in Appendix)
7. Would you like to evaluate a test version in the future? (answers not included in Appendix)

Olle Bergqvist, programmer, (30 years old?)

1. Good as it is.
2. With daily statistics.
3. Fast and able to show many results with many birds.
4. For free or under 10 SEK.
5. I think it would be hard to take away the wind noise.

Lars Sjögren, ornithologist (interrupted interview)

Have you seen sonograms that ornithologists use. Birds of the Western Palearctic is a good book to use.

Elizabeth Stridsberg, 49 years old

1. She thinks it was good as it is.
2. It would be interesting if the map could show how many birds are living at certain places. Send reports if any rare birds are sighted somewhere.
3. A picture of the bird would be great.
4. My kids are using Ipad and could maybe buy it would ordinary computer games cost around 40 SEK.

John Robin Andersson, 25 years old

1. He thinks it was good as it is.
2. He would like to have a picture, region and numbers on the map.
3. Search a bird such as Chaffinch and find it in the app.
4. He would like to have it for free or for 7 SEK.
5. He would absolutely download such an app he said during the interview.

Ragnar Lagergren, 47 years old

1. He thinks it is good as it is.
2. No comment.
3. A picture of the bird found would be great and also a checklist with seen birds. It would be nice with a link to a website about the bird.
4. (Forgot to ask the question)
5. I would create a lot of interests among ornithologists he thinks.

Henning Eriksen, 47 years old

1. He think it is good as it is.
2. No comment.
3. No comment.
4. He think he could pay 15 SEK for such an app.
5. He think it would be interesting to see it in practice.

Eva Lawesson, 71 years old

1. She does not want a bird diary.
2. No comment.
3. The name of the species is the most important function.
4. She would like to have it for free if possible.
5. She thinks it is a great idea.

E-MAIL CORRESPONDENCE (TRANSLATED FROM SWEDISH)

Swedish Department of Agriculture

1. Hello responsible person for the app LärKvitter at the Swedish Department of Agriculture. We are three students at the Civil Engineer Program at Chalmers that is working on our Bachelor thesis. In the project we analyze bird sounds to be able to identify bird species through an application on a smartphone. Swedish Department of Agriculture app, LärKvitter, spreads knowledge about bird life in the nature which is the same goals we have. Therefore it would be interesting to have information and pictures of birds as a complement to our app that focus on identifying the bird species. So we are wondering if you would be interested in starting a collaboration in the future? Will attach our planning report in the mail. Regards /...
2. Hello ...! Good idea you have to find a way to catch and detect bird calls. It is a request that many people has proposed to us. They think we should examine if the possibility exists. We have, however, not put any effort in finding if the technical possibilities exist already today. So far we have chosen to update the app with more bird species. So it would be nice if you could examine if it would be possible. Consideration should also be taken if such a function could fit into different models of smartphones. What do you think a cooperation would be? Regards /Gunilla Ideström ...
3. Hello Gunilla Ideström. Nice to hear that there is interest among users out there. We are sure that we soon can develop a working app that could detect birds with good accuracy. We have now been able to identify 50 birds to 85 % accuracy through wav-files. On a smartphone we plan to use the microphone for soundrecovery and believe it is going to work. We are trying to develop an algorithm that could make it easier and would be happy if we could cover most common Swedish birds. On your app there is around 39 birds, which is a bit few. Some species like "vit stork" is not as common we believe. We have now people programming on both Iphone and Android so a test version should come out soon. We would need information, pictures and sound files with copyright, so it is mostly that we seek collaboration about. It would be good if information about the bird is provided even though there is no internet connection. Regards/...
4. Hello ...! We have the rights to pictures, sound and information within the app LärKvitter. So we cannot take out the pictures, recordings and text and make a new app, because then new deals are required. However, we could make our app have more functions, which is within our deals with photographers etc. So I am still a bit unsure how you can have use for our pictures, texts and

recordings. Do we need to send the files to you? However then we need to regulate between us what we can and should do. That we only have 39 species at the moment, where one is “vit stork” is because we have focus on birds common in the open fields (fields, pastures and meadows and to some extent farm environments). We think we could build out to include more species in the future, but not this term. Regards /Gunilla Idestrom

5. Hello Gunilla. Thanks for your fast response. Nice to hear that you are interested in building the app with more functions. We are now developing our own app, that we plan to release together with the report. We could put the birds you have in our database so it easy to integrate such a function in our app. Would you be interested in such a function, then could you specify what efficiency you would like to have at what price so we can make tests to fulfill them. We have discussed to use pictures and files and have decided to use simple links to Wikipedia for time being, so we have no need for either files or pictures in our app. Regards/ ...

Bonnier Fakta Publishing

1. Dear Martin Ransgart. We read at natursidan.se that you in Bonnier plan to release an app of “Fågelguiden” with release date 2014. Hope you can keep the good quality you have on the book also on the app coming up. We are three students that are studying Civil Engineering at Chalmers and analyze bird sounds as our Bachelor thesis. This is to identify bird species through an app in a mobile phone, because we think many Swedish people would be interested to know what kind of birds are singing in the forest or the garden with just a click of a button. Your work, “Fågelguiden”, spreads knowledge about birds in the nature which is similar to our goals. Therefore it would be interested if we could complement your app with a function to identify the bird species. We have now achieved to identify 50 birds with 85 % accuracy on one hundred wav-files. We are wondering if you would be interested in a collaboration with the app in the future? Send the planning report for the project in the mail. Regards/ ...
2. Hello. It is surely a interesting project you are making. To identify birds in that way you describe is surely something that would help many nature interested. I will together with some colleagues read through your project description. The app will most likely be released during the autumn. Let us keep contact. Regards /Martin Ransgart