Automatic Classification of Flight Calls of Crossbill Species (*Loxia spp.*)

Juha T. Tanttu[1*], Jari Turunen[1], Mikko Ojanen[2]

[1] *Dept. of Information Technology , Pori, Tampere University of Technology , P.O. Box 300 , FIN-28101 Pori, Finland*

[2] *Satakunta Environmental Research Institute, Turku University , FIN-28900 Pori, Finland*

ABSTRACT

A new method for automatic classification of bird songs is proposed. This method is based on tracking of the first harmonic components of the spectrogram. From the tracking data some features were selected. The final classification was then performed using a neural network. As a test case we use a set of flight call recordings for crossbills that were publicly available. The preliminary results indicate that we can classify correctly well over 70% of the crossbills using their flight calls.

INTRODUCTION

The speech recognition research has produced a vast set of methods in recent decades (1). However, to our knowledge, only few studies on the feasibility of automatic recognition of bird species (2-4) or even individual males of a given species (5-7) using sounds have been demonstrated. One of the reasons may be the lack of large quantities of good quality recordings which are usually needed to develop such methods.

In (8) Robb analyses the vocalizations of four crossbill species, Two-barred (*Loxia leucoptera L.*), Common (*L. curvirostra*), Scottish (*L. scotica*), and Parrot Crossbill (*L. pytyopsittacus*) using visual inspection of spectrograms and aural analysis of the recordings. The article is supplemented with a CD containing over 100 examples of vocalizations of these crossbill species - mainly Common crossbills. Based on the analysis of his recordings Robb proposes that the Common Crossbill vocalizations can be classified into 6 subgroups which he labels A-F.

In this paper we try to automatically recognize the 4 crossbill species and even the subgroups of Common Crossbills using their flight calls as data. We test specific methods that are partly inspired by speech processing research, partly developed for the specific task to identify, model and classify the flight calls of crossbill species. Our aim is to answer to two specific questions: are we able to classify the flight calls and do our classification results support the subgroup hypothesis proposed in (8).

METHOD

In principle our task is straight forward. In Figure 1 the spectrogram and time domain presentation of a typical flight call of a Common Crossbill is illustrated. This most common type of the flight call (Robb's type A) may be described as 'keep'. In the first phase the flight calls must be located and clipped from the continuous sound data. This is by no means a trivial task since recordings contain many types of crossbill vocalizations, vocalizations of other bird species, as well as background noise. The bird sounds were identified from the background noise by their energy content and after that the crossbill flight calls were manually selected from the data

For automatic classification a feature vector (a set of numbers) is used that describes the sound. For human eye it is relatively easy to notice even subtle differences in the spectrograms and human ear and brain constitute an effective voice recognition system. However, the recognition of flight calls of crossbills is not an easy task, since many ornithologists regard it very difficult to differentiate between the flight calls of Parrot Crossbill

and Common Crossbill. In this study we decided to use the tracking of the first and second harmonic components of the spectrogram. The contours are then described with the energy content of the first and second harmonics, their length in time and some features describing the shape of their trajectories.

Finally the feature vectors are classified using the self organizing map (SOM) (9). For the SOM the same number of clusters as species (4) was first used. Then Robb's hypothesis was tested using only the Common Crossbill flight calls with 6 clusters but also other numbers were tested.

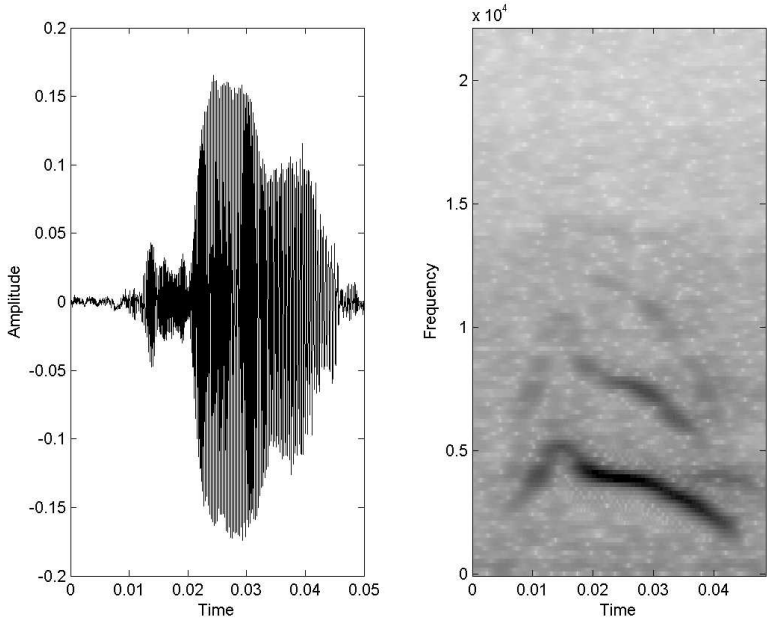

FIGURE 1. A spectrogram and time domain presentation of type 'A' Common Crossbill flightcall.

RESULTS

The automatic classification of the crossbill species is possible using their flight calls and we were able to identify over 70% of the calls correctly with SOM. The confusion matrices indicate that there are few crossbill sounds that are so close to each other that they are misidentified. Also the features that we are using affect the result. One aspect of further research is to use different types of features and test how they change the classification results.

ACKNOWLEDGMENTS

Useful discussions with Aki Härmä have helped us in this research.

REFERENCES

1. Deller, J. R., Proakis, J. G. and Hansen, J. H .L (**1993**), "Discrete-time processing of speech signals," Macmillan Publishing Company, 601- 847.
2. Anderson, S. E., Dave, A. S. and Margoliash, D. **(1996)**, "Template based automatic recognition of birdsong syllables from continuous recordings," J. Acoust. Soc. Am. **100**, 1209-1219.
3. Kogan, J. A. and Margoliash, D. **(1998)**, "Automated recognition of bird song elements from continuous recordings using dynamic time warping and hidden Markov models: A comparative study," J. Acoust. Soc. Am. **103**, 2185-2196.

4. McIlraith, A. L. and Card, H. C. **(1997)** , "Birdsong recognition using backpropagation and multivariable statistics", IEEE Trans. Signal Processing, **45**, 2740-2748.
5. Galeotti, P. and Pavan, G. (**1991**), "Individual recognition of male Tawny owls (*Strix aluco*) using spectrograms of their territorial calls," Ethology, Ecology & Evolution, **3**, 113-126.
6. Ito, K., Mori, K. and Iwasaki, S. (**1996**), "Application of dynamic programming matching to classification of budgerigar contact calls" J. Acoust. Soc. Am. **100**, 3947-3956.
7. Rogers, C. **(1995)**, "High resolution analysis of bird sounds," in IEEE Int. Conf. Acoust. Speech and Signal Processing, 3011-3014.
8. Robb, M. S. **(2000)**, "Introduction to vocalizations of crossbills in north-western Europe," Dutch Birding, **22**, 61-107 (includes a CD).
9. Kohonen, T. **(2001)** , "Self-Organizing Maps," Springer-Verlag, Berlin.