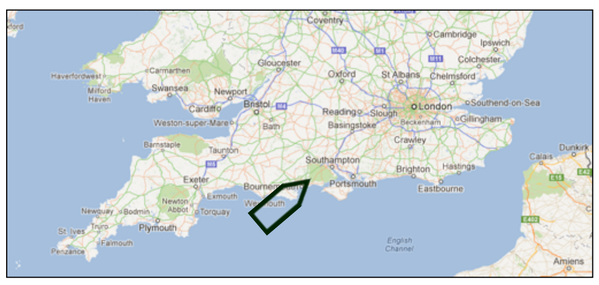
Smartphone-powered Citizen Science for Bioacoustic Monitoring

Davide Zilli, Oliver Parson, Geoff Merrett and Alex Rogers
Electronic and Software Systems Research Group, School of Electronics and Computer Science, University of Southampton

1 The New Forest Cicada

A highly endangered insect with some characteristic properties



- Only cicada native to the UK
- Only present in the New Forest
- High pitched call at ~ 14 kHz
- Difficult to hear for people > 40

Can citizens and their smartphones prevent its extinction?

In Summary

The New Forest cicada is a highly endangered insect that hasn't been spotted for the last 20 years. The best way to find it is by listening to the call it emits, but this is at the limits of our hearing range. We have developed an HMM-based smartphone app that can automatically detect and classify this call, as well as visualise the frequencies we can't hear. This will enable hundreds of citizen scientists to detect this insect before it becomes extinct for good.

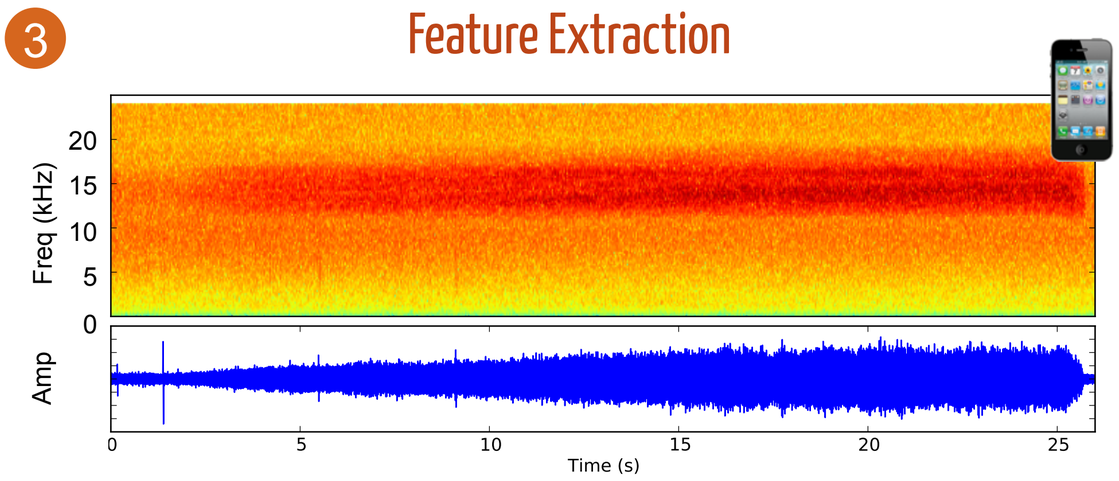
2 Real Time Detection Demo

Electronic Cicada

Press Here

Press the button to emulate the sound of the cicada and trigger the live detection, implemented on iOS (see "Classifying sound" below). A smaller sound sample provides better computational efficiency but makes the detection more sensitive to noise.

3 Feature Extraction

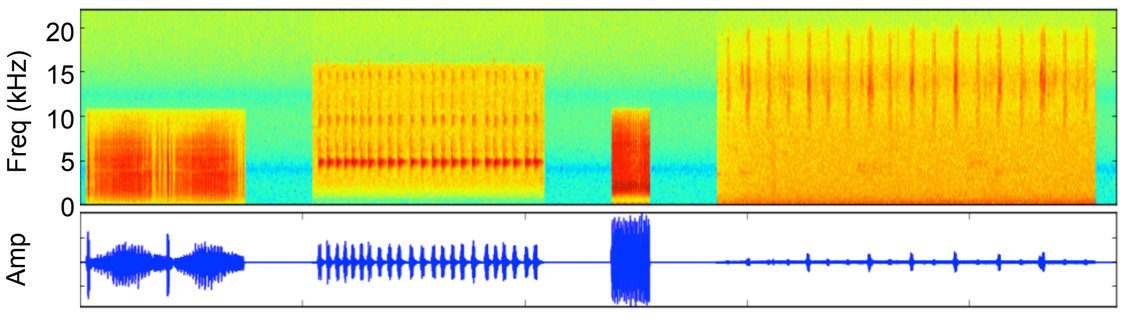


Three features have been identified in the *Cicadetta Montana* call:

- A strong 14 kHz carrier wave signal
- A strong increasing amplitude
- A weak 7–8 ms amplitude modulated pattern

The 14 kHz frequency feature is extracted from the call through the use of the **Goertzel Algorithm**, an efficient technique that evaluates individual terms of the Discrete Fourier Transform. We divide this band (~1 kHz wide) by and equal one at 8 kHz to normalise the sound independently from the intensity of the call.

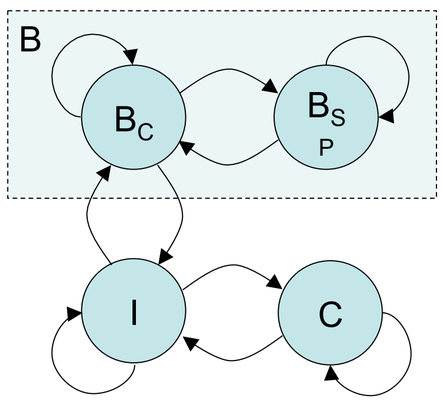
However, other insects are present in the New Forest, and their call can confuse an automated classifier; most notably, the dark bush cricket sings at the same frequency, but with short chirps.

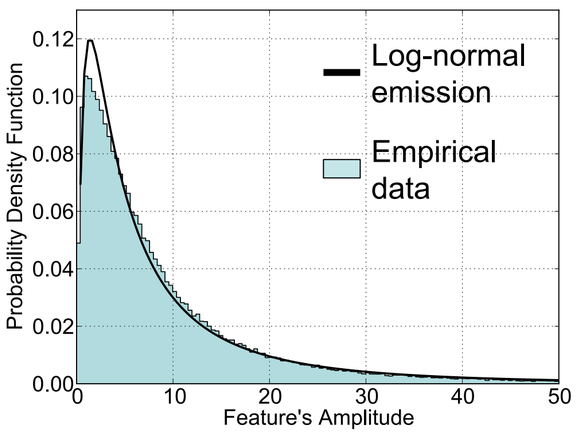


Therefore, we feed this feature to a **Hidden Markov Model** (HMM) that takes advantage of the characteristic time domain of the cicada.

4 Classification with 4-state HMM

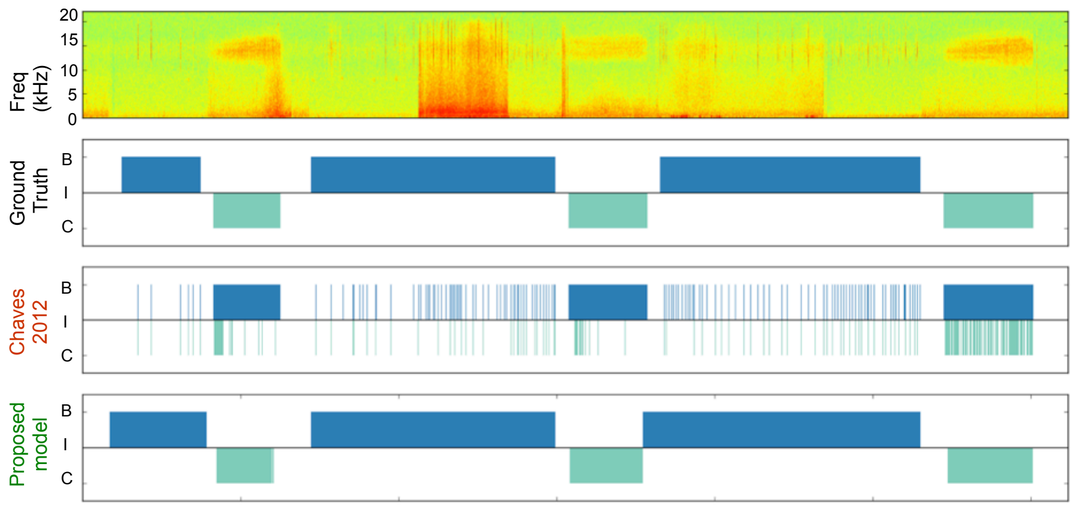
We propose a four-state HMM for cicada detection, in which the states consist of: an *idle* state in which no insect is singing (I), a *cicada* singing state (C), a state where the *dark bush cricket* is chirping (B_C) and a *short pause* in between the dark bush cricket's chirps (B_{SP}).





5 Results

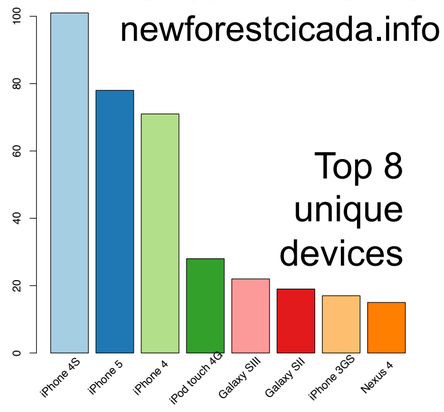
The graph below shows the sonogram of a sample dataset with three cicadas and several bush crickets (1); the ground truth, manually labelled (2); the output of a state-of-the-art approach for batch insect classification (3); and the output of our model (4).



The state-of-the-art approach fails to distinguish cicadas and bush crickets as it removes unsounded periods and relies only on the frequency domain. Our model leverages on the time-domain to distinguish a continuous call from a chirping one.

6 The system deployed

Search for *Cicada Hunt* or visit newforestcicada.info



Top 8 unique devices