DIY bioacoustics

Insect identification and monitoring

Primary contact

Filippo Sanzeni, Service Design, Royal College of Art - filippo.sanzeni@network.rca.ac.uk

Team

We are a group of designers adopting an transdisciplinary to the intersection between science, systems research, art, acoustics and design.

- Davin Browner-Conaty, Service Design, Royal College of Art - davin.browner-conaty@network.rca.ac.uk
  Davin has an academic background in Philosophy graduating with a BA from Trinity College Dublin in 2016. He has done research both in bioacoustics and experimental audio research.
- Minwoo Kim, Service Design, Royal College of Art - minwoo.kim@network.rca.ac.uk
  Minwoo has an academic background in Computer Science, Architecture and Media. He was a visiting lecturer and senior researcher at the University in the South Korea. Some of his previous research is based on biological phenomena such as emergence, complexity and self-organisation.
- Filippo Sanzeni, Service Design, Royal College of Art - filippo.sanzeni@network.rca.ac.uk
  Filippo has an academic background in Communication Design and is an active member of the DIY movement. He is currently working on various sound-systems, including a modular synthesizer.

Summary

Non-invasive bioacoustic monitoring has become an increasingly effective way of monitoring ecosystem diversity and health.

Bioacoustics paired with machine learning has been cited as an effective way of automatically identifying animals such as frogs (Xie, 2017), birds (Zhao et al, 2017) and fish (Sattar et al, 2016) amongst other animals.

Bioacoustics is an area of scientific research which would benefit from (i) continued expansion of machine learning and automated identification of insect species (ii) creation of open source hardware for conducting research. Our aim is to contribute to (i) by applying bioacoustics and machine learning to insect recognition and to (ii) by creating an open source, diy and hackable acoustic sensor for identification of various insect species.

Proposal

Recent work on insect recognition and intelligent traps is seen in (Silva et al, 2014) and on methods of creating low cost sensors for insect recognition in (Silva et al, 2015). Problems with ambient noise in traditional acoustic recording are identified in (Chen et al, 2014) and they show how low cost optical sensors provide more accuracy and high data capacity than previous methods. We hope to build on this work by creating an innovative open source model and associated hardware for conducting research into insect ecosystems.
Our aim is to contribute to ongoing research into insect recognition and ecosystems by applying bioacoustics and machine learning to insect recognition and to the democratisation of scientific research by creating an open source, diy and hackable acoustic sensor for identification of various insect species.
The final sensor would be non-invasive, weatherproof and wireless and would link to a dashboard, displaying visually the patterns and statistics gathered.
In the first phase of development we will be using already available kits on the market for rapid prototyping and proof of concept. The second step will be creating a custom PCB which would fit all of the necessary components and circuitry. On the software side, we will be relying on open source projects, such as TensorFlow.

rapid prototyping and proof of concept. The second step will be creating a custom PCB which would fit all of the necessary components and circuitry. On the software side, we will be relying on open source projects, such as TensorFlow.

Timeline of development:

- 1st month: initial research and prototyping
- 2nd month: final prototype using aftermarket boards
- 3rd month: design, test and troubleshooting of the custom PCBs
- 4th month: UX, UI and AI training

Insects are vectors of diseases while also pollinating a large proportion of the world's food production. Further to this, they also constitute a growing food market which is expected to be worth 55 billion dollars by 2023. (Global Market Insight, 2016).

We hope that our research will contribute to the development of the use of bioacoustics in the study of insect ecosystems while also furthering the democratisation of science. Our interdisciplinary background matched with our current learning environment at the RCA will contribute to a project which is both innovative and grounded in a fruitful intersection of art, design, science and audio research.

Estimate components and budget

As stated before, we will be relying initially on aftermarket development boards. We will need a DSP evaluation board for audio management (±200 GBP, RS Components), a MEMS microphone array (such as MATRIX creator - 99 USD / 78 GBP). The cost of other components, circuitry and PCB manufacturing will be precisely established during the design phase.
We estimate a total budget for the project between 650 GBP and 750 GBP.

Bibliography:

Chen, Yanping, et al. "Flying insect classification with inexpensive sensors." *Journal of insect behavior* 27.5 (2014): 657-677.
Bardeli, Rolf, et al. "Detecting bird sounds in a complex acoustic environment and application to bioacoustic monitoring." *Pattern Recognition Letters* 31.12 (2010): 1524-1534.
Sattar, F, et al. "Identification of fish vocalizations from ocean acoustic data." *Applied Acoustics* 110 (2016): 248-255.
Silva, Diego F., et al. "Exploring low cost laser sensors to identify flying insect species." *Journal of Intelligent & Robotic Systems* 80 (2015): 313.
Silva, Diego F., et al. "Applying machine learning and audio analysis techniques to insect recognition in intelligent traps." *Machine Learning and Applications (ICMLA), 2013 12th International Conference on*. Vol. 1. IEEE, 2013.
Zhao, Zhao, et al. "Automated bird acoustic event detection and robust species classification." *Ecological Informatics* 39 (2017): 99-108.
Xie, Jie. "Multi-label classification of frog species via deep learning." *PeerJ Preprints* 5 (2017): e3007v1.
Global Market Insight "edible Insects Market Size, Share - Global Industry Report 2023." [online] Available at: https://www.gminsights.com/industry-analysis/edible-insects-market.