Arribada's Human-Wildlife Conflict Solution: Open, Accessible Technology to Solve Conservation Challenges

Case Study

Goal

We are creating a solution that aims to solve human-wildlife conflicts in remote areas of the globe. Our goal is to provide a smart, reliable low-cost device that can operate on its own, on a battery, for a number of months before it needs to be recharged.

We are developing this solution for use in India with elephants and Greenland with polar bears. We are keen to expand its applications to more species and areas in the near future and believe this open-source technology can be adapted and integrated into other solutions.

Challenge

Today, detecting animals with vision systems requires an extensive infrastructure including a power source, technical support, or connectivity. However, not all areas have the resources and capability of doing that. Unlocking access to this technology in such remote areas entails creating a device that is smart, low cost, energy efficient, and is as simple as using a phone. Any kind of connected wires or solar panels for example would limit the effectiveness in the field and limit deployment. The communities need autonomous monitoring and control over where these devices should be placed.

Solution

We provide a low-cost thermal detection system that can identify specific animal species. It can be placed in remote communities where there are human-wildlife conflicts. We use Arm Cortex-M microcontrollers in our system as it is designed to be a very low-cost, energy efficient solution that can automatically detect species and transmit an alert to the community in the way they need to receive it. Our product is built with Arm Mbed OS as it eases our development and time-to-product.

Benefits

Our Human-Wildlife Conflict Technology brings three key benefits:

✣ Everyday surveillance for the communities

Deploying a low-cost device that can monitor any place valuable to the community – a fence around crops or the entrance of a town near the sea ice for example – brings enormous value to them. Human lives can be saved, human-wildlife conflicts can be avoided, animals be preserved, and crops and incomes can be protected.

✣ Local economic value

Because this solution is open source, there is an opportunity for local entrepreneurs to resell it. They can manufacture the devices which can be distributed and maintained by a local company in the community, creating local economic value while getting support from Arribada with reducing human-wildlife conflicts.

✣ Accessibility

Our solution is open source, and we share our models as well as our operating system and hardware with developers. We want to make it as accessible as possible to see it enhanced over time and integrated into new products.

Applications

Our technology can perform both object detection and object classification. It is currently developed for use in India with elephants and Greenland with polar bears. We are keen to expand its applications to more species and areas in the near future and believe this open-source technology can be adapted and integrated into other solutions.

Polar bear identification and detection in Greenland

Ittoqqortoormiit is one of the most remote settlements on the planet with a population under 500 inhabitants. The town is equipped with an incinerator for the rubbish of the local community. Polar bears can smell it when the incinerator is active.

Figure 1
Ittoqqortoormiit's incinerator in the foreground

Attracted by the smell, they go from the sea ice to the incinerator and to the town, day or night. Especially at night, it is difficult to see polar bears and this is when a conflict may arrive, resulting in the death or injury of either the polar bear or the human.

1. Our sensor provides three levels of monitoring:
    - On the pathway to the incinerator from the sea ice to detect a polar bear as soon as it comes to the incinerator.
    - When the polar bear is waking towards the town.
    - When the polar bear is in town.
2. Our device sends an alert to the local officials at each stage of monitoring.

Figure 2
Polar bears detected with Arribada's technology

Elephant identification and detection in India

In India, our sensor is used to:

- Monitor electric fences built to prevent elephants to access specific areas.
- Monitor crops.

Crops and subsistence farming are really important to the local population. If an elephant damages crops, not much can be done to fix this. By alerting the community before an elephant gets to a protected place, local officials can send community herders who have the power to respond and are allowed to deal with elephants or mitigate conflicts.

Figure 3
Elephants at ZSL Whipsnade Zoo were photographed to train the model

1. Our sensor provides three levels of monitoring:
    - When the elephant is at a certain distance.
    - When the elephant breaks through the fence.
    - When the elephant is in the protected area.
2. Our device sends an alert to the local officials at each stage of monitoring.

Figure 4
The sensor detects and classifies the objects

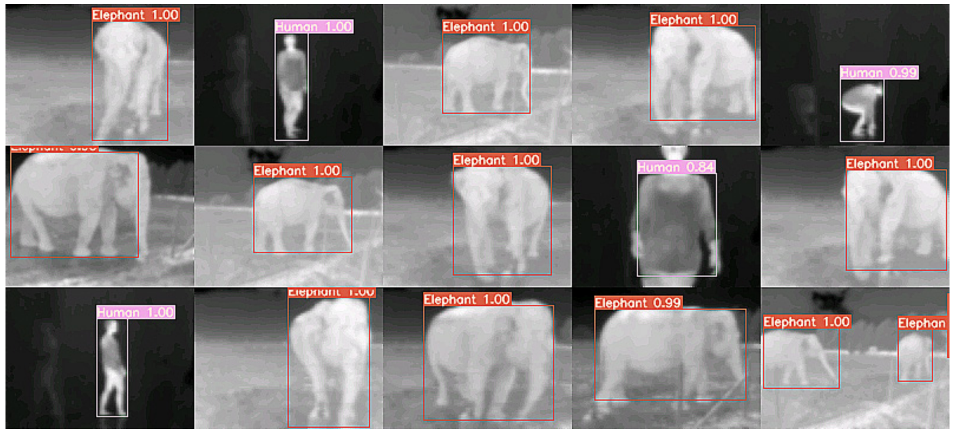
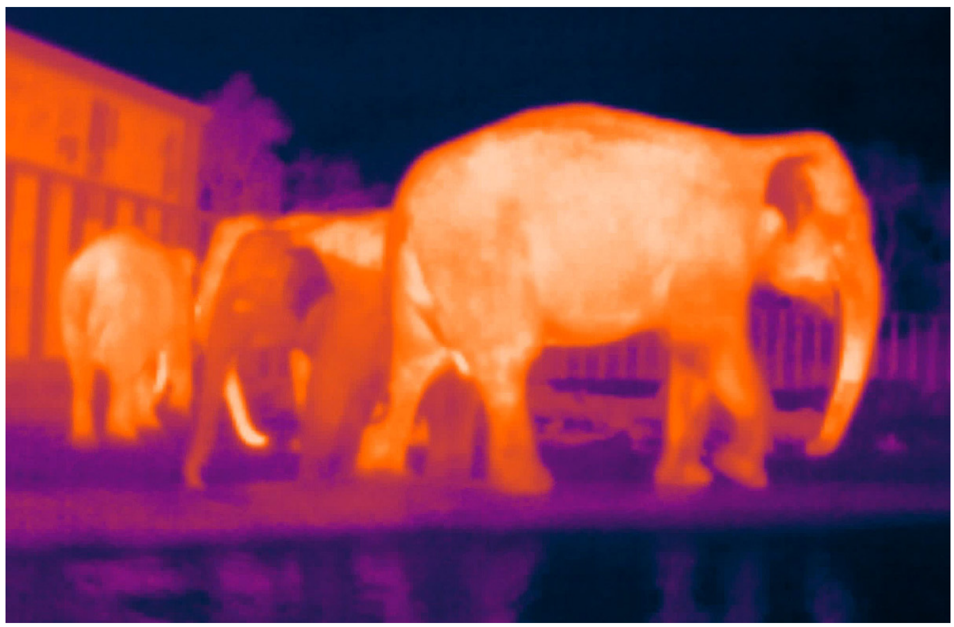


Figure 5
Elephants captured by thermal sensor



Design challenges

A lot of low-resolution thermal sensors already exist and can be used to detect the absence/presence of warm-blooded objects. However, for us the resolution is very important because we cannot generate an alert when there are only blurry objects in the background. We must be able to say whether the object detected is our target species. Our system must be highly capable and accurate.

This implies two significant challenges for our design.

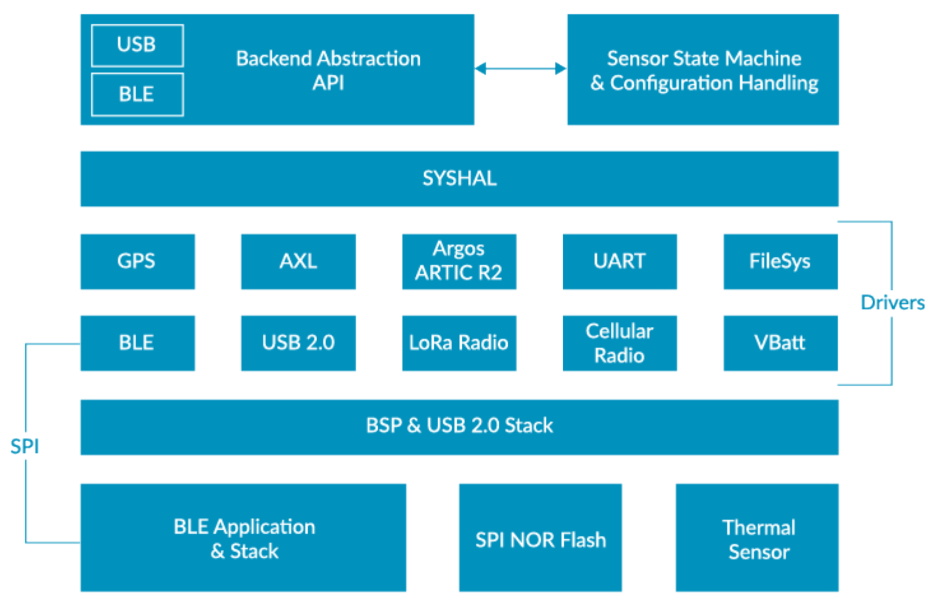
✣ Memory

The only way to build a low-cost device is to use a microcontroller, where memory (flash and RAM) is limited. Reducing the size of the models to work in constrained environments without losing any of the performance is a challenge. For our elephants use case for example, we took more than thirty thousand images to train our model over several months. We used that to prove we could build the model, and then had to shrink that model down in size.

✣ Battery

If you wake up your sensor too often, you consume power. One challenge consisted in awaking our sensor only when needed and in the most efficient way. To make sure we could work on a battery-operated device, we had to optimize our models. For example, is it best to wake up the sensor and look at several frames at the same time, seeing animals moving into a certain direction, at a certain speed and decide to not wake up the sensor again until two minutes later, saving power? Or is best to be continuously watching the same object even if it is not doing much?

Figure 6
Design Challenges



More challenges will come along as we continue developing our solution. Our prototype today is running and working on a Cortex-M4, building it into a physical product will bring its own challenges including building an easy-to-use user interface and scale of economy.

Figure 7
A prototype in the field

Figure 8
Team members working on a prototype in Ittoqqortoormiit

Design implementation

A key technical barrier was how we could rapidly train and classify models and get them onto microcontrollers in an efficient way. We used the Edge Impulse ML development tool with Arm Mbed OS that allowed us to train our models in the cloud, where we have all our data. This tool allowed us to train our models and convert them into a C+ repository that we can simply push to a device – an Arm-based device. Using Edge Impulse and Mbed OS allowed us to save software development time with tools that seamlessly work, so we can focus our time on the hardware. We were able to look at our needs (RAMs, etc.) and rapidly adapt our solution. As battery life is a primary concern for our solution, we were also able to look at inference times and find the right balance between time when the sensor is on and time spent processing the image.

Why Arm

What's great for us working with Arm is the support, the ecosystem and the developer community.

We have been using Arm microcontrollers and Mbed OS in other products and there was no reason for us to change on this project. The support of Arm and its ecosystem has helped us achieve success.

As a small NGO, resources are limited, and it is harder to skill up in a completely new space. Working in an environment where there is a lot of support from the community is crucial.

With Edge Impulse working with Arm microcontrollers, we would like to use some of the instructions and optimization coming in this space. This is coming with the Cortex-M55 processor and we want to be ready for the significant performance increases in Arm microcontrollers. We are trying to pre-empt what is going to be most efficient for us and the future of Arm microcontrollers is exciting to us.

Looking ahead

As our toolchain gets better and we manage to make it more efficient and simpler to train models and push them to devices, having control over the model itself, we foresee a lot more use of machine learning (ML) in vision applications in conservation.

This is just the beginning of what is possible. Vision-based ML on microcontrollers is new and evolving.

"Inference on the edge has unlocked access to monitoring wildlife in real-time, delivering insights quicker and helping to address human-wildlife conflict concerns by generating alerts in real-time".
- Alasdair Davies, Technical Director, Arribada

About Arribada

Arribada co-develops open, customizable, and impact-driven conservation technologies for conservation organizations across the globe, driving down costs and scaling up access to the tools and solutions we need to solve conservation challenges, together.

Thank you to WWF Netherlands and WILDLABS for funding the development of our Arm-powered human-wildlife conflict solution as part of their human-wildlife conflict technology challenge and to the Zoological Society of London for developing the elephant detection model.

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