Documentation
Project Title: Animal Fire-Alarm
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Abstract:

Often, only human communication channels are considered in forest fires. Initial approaches to involving animals and plants in dealing with forest fires are primarily investigating how animals can warn *us* and recognize fires earlier. At the same time, we know that a complete forest ecosystem includes thousands of species. The aim of this project is to present a fire alarm that is controlled by LoRaWAN and uses ultrasound to warn animals of sources of fire and scare them away in the right direction. At the same time, a version of the fire alarm can serve as an art object to promote advocacy work for climate protection at a political level. The aim is to make a contribution to comprehensive climate and disaster protection that takes into account the entirety of ecological interrelationships. This prototype pictures a very simple version of the design implemented in the forest or as an art object without LoRaWAN but simple buttons and only one ultrasound as an example.

Three keywords:

1. animal fire-protection
2. Community based prototyping
3. Ceramics fire protection

Resource Overview:

(An overview of the hardware, software, protocols, and libraries that were essential to your project. Choose the things that fit to your project from this list, ~~cross over~~ the things that you did't use, add if necessary.this list is only an rough overview, don't be to specific)

- (OPAmp), speaker, ~~motors, solar panels,~~ batteries~~, NE555/556~~, basic electronic components, ~~custom PCB~~

- ~~ESP32,~~ Arduino Uno, ~~Raspberry Pi~~

- Arduino IDE~~, Platform IO~~

- Arduino~~, pure C++, (Micro-, Circuit-) Python~~

- Chat GPT

- 3D printing, ~~lasercutting, CNC, woodworking,~~ papier-mâché, moss

- ~~Lora, Wlan, Bluetooth, I2C~~

1. Urgency / Context / Status Quo (400 words)

Consider this as the already given context: https://lifolab.cargo.site/content#about.

Based on the interdisciplinary approach, methods from the fields of design, social sciences and electrical engineering were implemented in the development of the animal fire alarm. Due to the collective collaboration with other students, impulses such as LoRaWAN[1] as a transmission technology for sending and receiving the signals were taken up. The fire alarm can also be combined with the drones researched in the **Reallabor Wald scope**, which can 'switch on' the animal fire alarms as transmitters over the forest, anticipating the source of the fire. The ideas on island nature and sustainability developed on site in Corsica were particularly relevant for this project. Right from the start, one of the guiding principles was to find a design for the prototype that was as environmentally friendly as possible and, ideally, natural. This led to the basic material ceramic, just as the cork oaks and widespread mosses native to Corsica are to be taken up in the design of the fire alarm as an art object.

The **gap in research about fire protection for animals** is surprisingly clear. If you look for warning systems for animals, you simply won't find a fire alarm. As described in the abstract, there are only solutions to make fire alarms for humans more animal-friendly or to make it easier to find animals in fires. No technology tries to address animals directly. Furthermore, mainly indoor technologies are being developed. There are no considerations for nature-friendly outdoor solutions, although animals are the first to be directly affected, even before humans in settlements close to forests[2].

The project is inspired on the one hand by ultrasonic devices to repel rodents and on the other by recent research into fireproof natural materials. For the latter, nanotech is leading the way, as they have carried out many experiments with ceramics in nature on forest fires and the use of fire resistance[3]. A miniature version of their ceramic double layers would be ideal for the animal fire alarm. The effectiveness of ultrasonic devices depends on volume and frequency range. Promising products are simple Amazon devices already[4].

2. Topic / Approach / Solution (400 words)

The idea of the animal fire alarm is characterized by its simplicity and environmentally friendly implementation. As already outlined, there is no single solution to protect animals from forest fires. Although large mammals can often still flee due to the heat and smoke,

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[1] LoRaWAN means Long Range Wide Area Network. It can communicate data up to 10km with a frequence-based mechanism. For it's long range, it would work perfect in the forest between drones and the animal fire alarm.

[2] https://abc7.com/what-happens-wild-animals-during-wildfires/5646916/
https://www.animal-ethics.org/tiere-bei-naturkatastrophen/
https://www.nationalgeographic.de/tiere/2018/07/wie-gehen-wildtiere-mit-waldbraenden-um
https://www.rnd.de/panorama/waldbraende-im-mittelmeerraum-was-bedeutet-das-fuer-pflanzen-und-tiere-7QYNLOLZSRBYRPDUIXUMYGWYUE.html

[3] https://nanotechmaterials.com/fire-protective-coating-system/

[4] https://www.amazon.de/Ultraschall-Sch%C3%A4dlingsbek%C3%A4mpfer-Ungezieferabwehr-Insektenvertreiber-Rattenabwehr/dp/B0BJ92QZ7X,
https://www.amazon.de/Durimi-Maulwurfsvertreiber-effektiver-Maulwurf-W%C3%BChlmausvertreiber/dp/B0CYZLGWVW

rodents and insects in particular are unsettled by the many sensory impressions and often hide in trees or caves, where they are caught up in the fire. The acoustic fire alarm appeals to all these animal species. It can also be easily installed anywhere in the forest in an environmentally friendly manner thanks to the ceramic ball as a casing. As many of the technologies used in the "Reallabor Wald" are based on LoRaWAN, the animal fire alarm can be embedded in an overall network to improve the technical response to forest fires.

In addition to the idea itself, **two aspects of the animal fire alarm are particularly outstanding**. Firstly, ceramic is a superlative material. Ceramic is particularly fireproof, releases very few chemicals into the environment, is particularly stable, allows acoustics to pass through particularly well and is sustainable in terms of production, extraction and recycling[5]. The only drawback is that ceramic is sometimes damaged at the edges, which is countered by choosing the shape of the sphere. The second special feature is that the same prototype can be used for different purposes thanks to its simple technical functionality. Firstly, it can be used as a fire alarm, secondly as a guide for animals with ‘natural forest sounds’ and thirdly as an art object with the speech by Greta Thunberg at the UN in 2018.

The focus of the work is therefore on implementation in existing systems such as the existing advocacy work on climate protection, the network of sensors, drones and transmitters from LoRaWAN in the forest and the forest ecosystem itself with nature-friendly design. At the same time, the idea itself is completely new and offers room for experimentation and adaptation as to what else can be built into the ceramic ball and which acoustics are best suited to protecting the animals.

3. Experiments / Steps of making process / Tools

In the best case, I wanted to make a prototype that has a ceramic ball, is played with LoRaWAN (e.g. by balloon drone see *image_1*), a loudspeaker (plays 13,5-20kHz up til 96db) and a GPS transmitter or RF-Sender (Keyfinder)[6] to find the balls again after a forest fire. Overall, the set-up should correspond to *image_1*.

As I didn't have access to a ceramics, I had two sphere halves printed using 3D printing. This allowed me to get an impression of the appearance, but at the same time see all the electronics. As I also didn't have the electronics for ultrasound (small but efficient ultrasonic loudspeaker), I limited myself to an 8 Ohm loudspeaker with which everything was powered by a 9V battery. To store the sounds to be played, I used a DFPlayer mini (see *image_2*[7]) and an Arduino. The main problems were with this interface. All in all, I had to use an Arduino MKR Wan, which could have used LoRaWAN, for example, with an Arduino Nano and an Ardunino Uno to try to connect the DFPlayer. Only the last one worked (See *video_1*).

As I have never worked with electronics myself, this took a lot of time.The main problem was that the Ardunio MRK Wan's internet codes for the DFPlayer mini accessed a library that the Arduino MRK Wan did not have.

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[5] See a complete List of the thinking process about the materials under “images*” thinking_process*

[6] https://www.amazon.de/Esky-Schl%C3%BCsselfinder-Sachenfinder-Taschenlampe-Lichtzeichen-KF-02/dp/B011F97OSU

[7] Or https://lab.arts.ac.uk/books/physical-computing/page/how-to-use-dfplayer-mini-to-play-mp3

With the Arduino Nano, the programmes were not played or nothing was heard. I wasn't able to check whether it was due to the electronics or the programme until the end, as I switched to the Arduino Uno at this point. As formatting the correct SD card also took some time and I had to buy a new card that only had 4 GB, I couldn't rule out the fault with the SD card for a long time[8]. Another student had had good experiences with this and it worked well for me. Due to a lack of time, I used a button instead of LoRaWAN and left out localisation technology such as Keyfinder or GPS for the time being.

The circuit diagram for my current prototype is as shown in *image_2*. With a 9V battery, 3 different songs stored on the SD card can be played. The starting point is the 'forest noise' with which a 'natural forest environment' is to be simulated. In the best case, these are recordings made on site and you know the bird calls and that they do not say anything irritating. This is followed by an example of Greta Thunberg's speech at the UN in 2018, in the function of an art object. Instead of using LoRaWAN, for example, the box would have to be played via WiFi to switch on this sound in the event of a forest fire in the city. The last song, for example, corresponds to 13KHz, a relatively low frequency, so that we can hear it during demonstrations. Also, as I couldn't use moss and kork from Korsika directly, it is a papier-maché pad with moss. See more in the folder *images*.

4. Instruction to rebuild your final prototype

You need: cable, a 9V battery, an Arduino Uno, a DFPlayer mini, a mini SD card, a button, a 1k Ohm resistor, an 8 Ohm speaker, a ceramics ball

Step 1:

Format the SD card to FAT32 or FAT 16 using "SD Card Formatter". Play your sounds, e.g. Hertz frequency, forest noise, a speech, onto the SD card. Name the songs '0001.mp3', '0002.mp3' etc. It is important that you copy them to the SD card in the order in which they are to be played.

Step 2:

Wire the speaker, the button and the DFPlayer Mini with the Arduino Uno according to the circuit diagram in *image_2*, also see https://www.youtube.com/watch?v=tF-v66PNqBo

[8] See problems similar to this:
https://wolles-elektronikkiste.de/dfplayer-mini-ansteuerung-mit-dem-arduino

Step 3:

Play the programme on the Ardunino Uno. See *code_button_DFPlayer.*

Step 4:

If this works, solder the circuit to a circuit board and supply the power to the Arduino using the 9V battery instead of the laptop. **Your prototype is ready!**

5. Reflection (400 words)

Reflecting on the project, we can certainly say from a human perspective that the urgency for us lies more in an early warning system for people. At the same time, the idea is a concrete and direct response to the dangers that already exist for animals and the ecosystem.

Since the idea itself is simple in structure, the prototype corresponds in some respects to the idea. It was to be a ceramic ultrasonic music box played with LoRaWAN. Now it is still a quiet normal jukebox played with a button. So the idea is already visible, but the prototype is still a long way from being usable. I would be surprised if anything at all could be heard in the forest at the current volume.

Further development will therefore require extensive research into the necessary loudspeakers and their power supply, some experiments with the creation of the ceramic ball and the use of LoRaWAN and a simple localisation technique. I think that the right speaker and a really fireproof ceramic shell are by far the biggest challenges.

The three most important lessons for me are definitely learning how to work on electronics in general and specifically soldering and programming. In addition, the research for environmentally friendly materials (by means of detailed preliminary considerations) and collective prototyping are central gains of the work.

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