TRAILGUARD AI AND VARIANTS: TECHNOLOGY FOR WILDLIFE CONSERVATION

ERIC DINERSTEIN
RESOLVE
www.resolve.ngo
ANTI-POACHING

HUMAN-WILDLIFE CONFLICT

WILDLIFE MONITORING (VISUAL & ACOUSTIC)
The Scale of the Problem

35,000 Elephants are killed by poachers each year
The Scale of the Problem

Only ~1000 Mountain Gorillas are left in the wild
Reserves are very remote
Introducing TrailGuard AI
TrailGuard AI in the field
TrailGuard AI solves 5 challenges

- Durability
- Cost
- Connectivity
- Battery
- Data volume
Integration with EarthRanger
Rapid Response Team

Gateway with Sat Modem

TrailGuard AI unit

Protected Areas (WDPA)
TrailGuard AI

(placed on a trail in a Kenyan reserve)

TG AI

4.0" L x 0.5" W (exposed)

TG AI communications unit (GSM/LoRa/WiFi)

3.0" L x 0.5" W

Battery unit hidden in or behind the tree

4.5" L x 2.8" W

PIR sensor detects motion and triggers camera
TrailGuard AI X Design

TrailGuard multi-purpose communications unit

+ 

Intel AI Camera Reference Board
One Hardware Platform, Many Use Cases

TrailGuard AI X: anti-poaching

RiverGuard AI X: protection of indigenous lands

FireGuard AI X: detection of wildfires

VillageGuard AI X: human-wildlife conflict

WildEars AI X: acoustic monitoring

WildEyes AI X: wildlife monitoring

Myriad X VPU
RiverGuard AI units 1 and 3 sit camouflaged at the confluence of two streams. Images that are classified to contain boats/humans are transmitted over LoRa to the Gateway. This saves battery and shares the cost of a modem across multiple camera units.

Gateway unit receives images via LoRa and transmits to the Internet via BGAN $40 satellite modem, which then sends alert to tribal leaders at HQ.

RiverGuard AI unit 4 sits at the perimeter of the indigenous reserve, acting as an early warning system if any outsiders attempt to enter the reserve.

RiverGuard AI unit 2 sits camouflaged at a river access point near a large mahogany grove, which could be the target of high-value illegal logging.
Carnivores

Lion | Tiger | Mountain lion | Wolf
---|---|---|---
Hyena | Snow leopard | Black bear | Polar bear
Cheetah | Leopard | Jaguar | Brown bear

Herbivores

African elephant | Hippopotamus | Asian elephant | Wild boar
Gorilla

Gorilla

Flopsy

Mopsy

Gorilla

Flopsy
Coming in 2020: WildEars AI
Acoustic Monitoring and Detection on the Edge
“Twitcher”

Automatic PTZ video following of species

Ian Ingram
San Diego Zoo Global

Camera Trap Technology Symposium
Mountain View, CA
2019-11-06
Motivations

- Polar bear maternal denning observation
- Observation of species of interest in similar contexts
- Element of intended observatory in the San Diego Zoo Biodiversity Reserve:
  - Long-term monitoring of biodiversity in that reserve
  - Public-facing interface to that ecosystem and the data being collected about it
Motivations

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- Aspirational: collecting images/videos of birds/bats/insects on the wing and/or well-above ground/canopy, thus gathering data about species (and/or activities of species) that traditional camera traps are less well-suited for
Current Polar bear maternal denning observation
Technical summary:

Twitcher is two things glued together:

- A real-time object detector
- An off-the-shelf IP pan-tilt-zoom surveillance camera

By three other things:

- A single board computer
- An edge-AI device
- A bit of custom code
Prototypes:

● Current field unit core components:
  ○ Camera: Hikvision 3MP 4x PTZ IP surveillance camera
  ○ Single board computer: Raspberry Pi 4
  ○ Edge-AI device: Google Coral USB Accelerator
  ○ Object detector: Mobilenet SSD v2 pre-trained on COCO

● Current bench unit core components:
  ○ Camera: Hikvision 4MP 25x IR PTZ IP surveillance camera
  ○ Object detector: YOLOv3-tiny (re-trained on species of interest)
  ○ CPU and GPU: various
Tracking regime dependent on application

- **Calm**: for applications like the polar bear maternal denning one, want smooth, fluid tracking and zooming that errors on the side of keeping polar bears in frame and holding the camera still once well-framed

- **Twitchy**: for applications that are about collecting stills and short video snippets of species (more of the “twitcher” side of things; more akin to camera traps), want quick tracking/zooming that errors on the side of rapidly getting target large and clear in frame
Future work

- Distant target detection system integration
- Improve controller for polar bear observation application
- Longer field deployments
- Adding LoRa to send abbreviated activity/status reports
- Taking over focus-control of camera
- Coupling with 360 degree view camera
Contributors:

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To give people the tools to measure the world around them and to empower everyone to advocate for the environment.

FieldKit aims to dramatically reduce the cost of research-grade environmental sensors, and to simplify the processes of data management, visualization and sharing.
Users

Field Scientists  Conservationists  Citizen Scientists  Educators  Environmental Justice
FieldKit Ecosystem

FieldKit.org

FieldKit App
(iOS & Android)

FieldKit Hardware

With support from:
Hardware “Darwin”

Details:
- Fully open source hardware and firmware, designed at Conservify
- Modular hardware architecture (upgradable radios, power, etc.)
- Offer both microcontroller and Linux SoC top board
- Support integration of cellular, satellite, and LoRa connectivity
- Suite of available sensor modules and user-defined modules, that are automatically recognized and support hot-swapping
- Backplane in both 4- and 8-sensor module configurations

Technology:
- Firmware: C/C++, Arduino IDE Compatible
- Working to support the Dat protocol on the hardware
Hardware (Core and Radio)
Different Hardware Configurations

• Sensor modules can be deployed in various configurations, with firmware automatically detecting different sensor types and changing configuration and app details accordingly

• Backplane offers the opportunity to connect from one to four sensors, with the possibility of expanding as needed

• An additional sensor module can be plugged into the back of the Radio board, offering the ability to deploy in small locations or pipes
  • This configuration is used in our CTD
Hardware Configurations (examples)
**FieldKit Camera Trap Connector**

**Details:**
- There exist a considerable amount of “dumb” camera traps in use for ecological research that do not require replacing.
- Lack of telemetry and radio/sensor integration limits usefulness in operation in the field.
- Creating a way to augment existing hardware could have large scale impact on existing research.

**Technology:**
- Document camera actuations (when/how many), trigger sensor readings, and add external solar power capabilities using IO expander, some power management and a boost converter.
- Next generation “spoofs” SD through multiplexer and flash memory.
- Incorporate existing camera traps into existing FieldKit LoRaWAN network.

**Partnership with:**

![ARRIBADA initiative logo]
Hardware Enclosure

Details:
- Custom designed case, made to be 3D printed or injection molded
- Allow various mounting configurations and installation positions
- Create customizable flat stock or laser cut acrylic passthrough plate
  - Allows for specific cable gland configurations to be mass produced and quickly swapped out
  - Create a place for user-designed add-ons for the enclosure (things like Stephenson screens, custom mounts, specialty sensor holders, etc.)
App

Supports:
- Management of sensor fleet
- Connect and download data from device
- Data visualization capabilities
- Sensor configuration and calibration
- Drives best practices around scientifically relevant deployments and metadata
- Sensor firmware upgrades

Technology:
- Built in NativeScript and Vue
- Supports the Dat protocol
Website

Supports:
- Project, organization, and deployment administration
- Advanced sensor configuration, diagnostics, and management
- Innovative map- and chart-based data visualization capabilities
- Social integration, including sharing of data points and ranges
- Data annotations, metadata, privacy, and embargo
- Custom data export templates (CSV, JSON, XML, Jupyter Notebook, PDF report)

Technology:
- Front-end: JavaScript and Vue, D3/SVG
- Back-end: Golang, PostgreSQL, AWS (Terraform)
- Supports the Dat protocol
- Mobile-first to support smooth app experience
Open Sensor Library

Ultrasonic Sensor

Introduction
This is a guide to understand and build ultrasonic sensor-based devices for the use in environmental monitoring. Two examples will be outlined for FieldKit devices: a weather station and a flood/water level meter.

Be sure to check the files on Github: https://github.com/FieldKit/Ultrasonic...
Data Approach

- Data is always available through in-app and web visualizations and innovative data exploration, sharing, and annotation features
- FieldKit is built on the Dat Protocol, providing version histories and distributed web functionality from the hardware, app, and website
- Data can be exported using RAW, JSON (GeoJSON, JSON Lines), .CSV, .PDF data report, R, D3, Jupyter Notebook projects with working code examples
- FieldKit metadata contains provenance information, including verified calibrations, and links to details of station installations
- Data can be independently verified and approved by members of the FK community through consensus
- FieldKit users can control permissions on who can access their data and that data is stored securely and sharing operations are encrypted end-to-end