Unmanned Aerial Systems to Fight Rhino Poaching

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A•R•E•N•D

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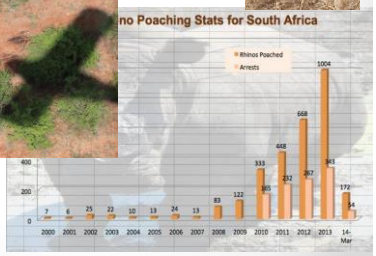
Helsinki Metropolia University of Applied Sciences

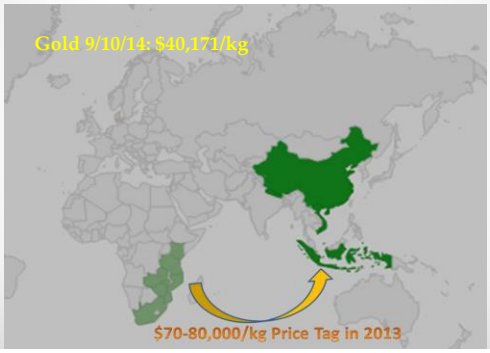
Universität Stuttgart

HELIOS Torque Fusion, Inc

African Crisis



Rhino horn trade route



Poaching Business

A•R•E•N•D

- Poaching Valuation
  - $10-$19 Billion
  - Estimated 2000 "jobs" (TBR)
- American Airlines
  - $12B; 62,000 jobs
- State of Florida Citrus industry
  - $9B; 76,000 jobs

Dangerous and Boring

Dangerous: Rangers can be ambushed. **Boring:** they miss passing poachers.

Drones increase play instinct which keeps them alert and gives them advantage.

SanWild Rhino Sanctuary

Poaching Time

- As many as 60 heavily armed groups of poachers entering KNP during full moon
  - ➢ Requires paramilitary training
    - ✓ Track
    - ✓ Ambush
    - ✓ Gather intelligence
    - ✓ Wage counter-assault ops
- Flash mobs from Mozambique

Rescue and Arrests

Veterinarians trying to save a poached rhino that survived

Photos: WO1 Noel Kloppers

Arrest success < 5%
Poaching success > 95%

Punishments easy to absorb with earnings of $3-400,000 per horn!

What we do NOT hear about

Back-Of-The-Envelope

KNP size: 7523 sq miles (19,485 km²)

650 Total Rangers

339 Rangers on shift

265 Total Soldiers

130 Soldiers on Shift

6 People team covering 250 square km

100 sq miles

UAS = Dual Use Technologies

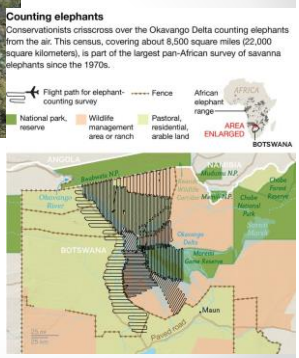
- UAS, or drones, are dual use technologies like the kitchen knife; and can be used
  - For or against people
  - For or against wildlife
- UAS can support rangers with added situational awareness and enhance their safety (safe distance)
- UAS are often less costly, more efficient, and more precise than traditional approaches

Rationale for UAS

- Light-aircraft crashes are the No. 1 killer of wildlife biologists in US.
  - D. Blake Sasse, Wildlife Society Bulletin, 2003
- UAS can support rangers
  - to estimate wildlife populations
  - Help firefighting efforts
  - Support rescue missions
  - Provide information about poaching
  - By being a deterrent to poachers

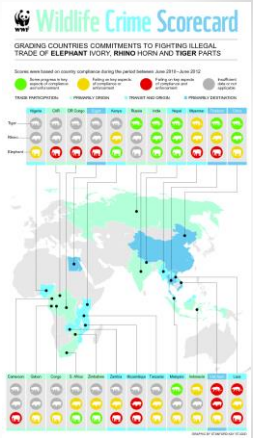
PHOTOGRAPH BY KELLY LANDEN

The Great Elephant Census adds Botswana's Okavango Delta



Rob Weaver, Stop Elephant and Rhino Poaching

http://conservationdrones.org/

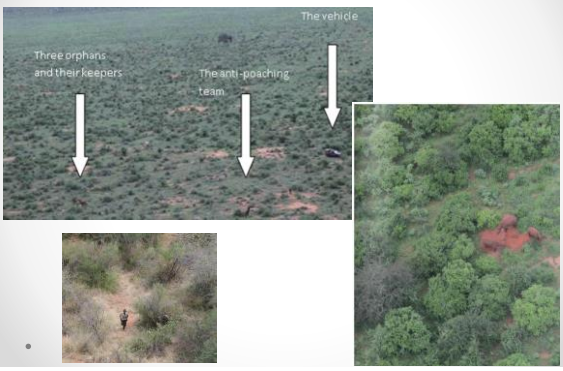


UAS as Deterrent

WWF announced 2013 that UAS and related systems can be effective in deterring poaching in Africa.

The WWF and MET anti-poaching team in Namibia, including Falcon UAV's fixed-wing unmanned aircraft.
Photo courtesy Helge Denker, WWF Namibia.

Aerial View Point



Remotely Piloted Aircraft taking off.

Mulero-Pázmány M, Stolper R, van Essen LD, Negro JJ, et al. (2014) Remotely Piloted Aircraft Systems as a Rhinoceros Anti-Poaching Tool in Africa. PLoS ONE 9(1): e83873. doi:10.1371/journal.pone.0083873
http://www.plosone.org/article/info:doi/10.1371/journal.pone.0083873

Images obtained with still photo camera.

Mulero-Pázmány M, Stolper R, van Essen LD, Negro JJ, et al. (2014) Remotely Piloted Aircraft Systems as a Rhinoceros Anti-Poaching Tool in Africa. PLoS ONE 9(1): e83873. doi:10.1371/journal.pone.0083873
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PLOS ONE

Frame extracted from HD video.

Mulero-Pázmány M, Stolper R, van Essen LD, Negro JJ, et al. (2014) Remotely Piloted Aircraft Systems as a Rhinoceros Anti-Poaching Tool in Africa. PLoS ONE 9(1): e83873. doi:10.1371/journal.pone.0083873
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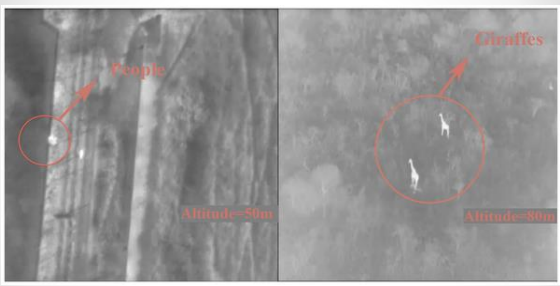
PLOS ONE

Frames extracted from thermal video camera.



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PLOS ONE

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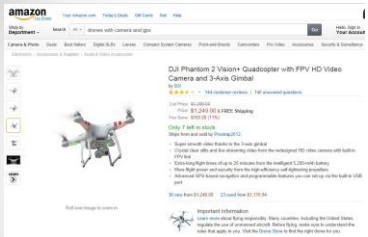
Poachers with drones?



Philip Moffett, Blue Atmos LLC

Today rhino hunters have turned to technology and social media to track down rhinos and they can do so thanks to geotagging.

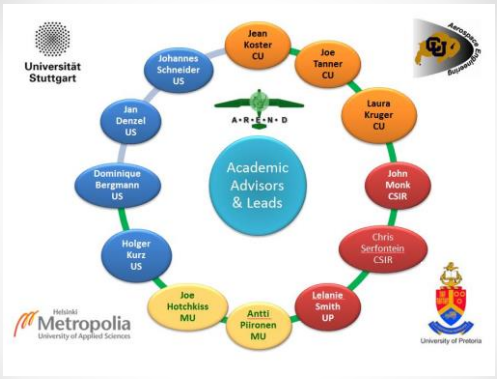
The use of flying drones with mounted cameras has been banned in May 2014 with immediate effect in South Africa by the South African Civil Aviation Authority (SACAA).

AREND Project Objectives

Find Poachers *before* they kill

Harsh Environment

AREND Global Team



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Many thanks to our advisors and contributors!

	Organization	
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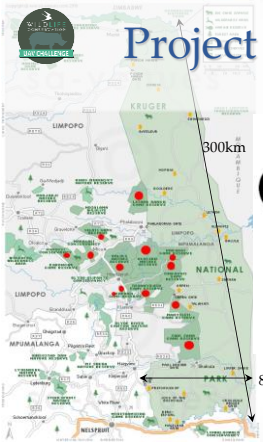
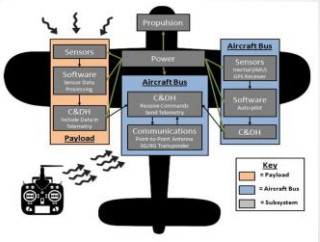
Project Objectives





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Technical Risks

Consequence \ Possibility				
		In-Flight Battery Failure		Damage Aircraft/ Components Upon Landing
		Deferred Launch Method Design	Final Aircraft Exceeding Budgeted Mass	Component Overheating
				Harsh Environment

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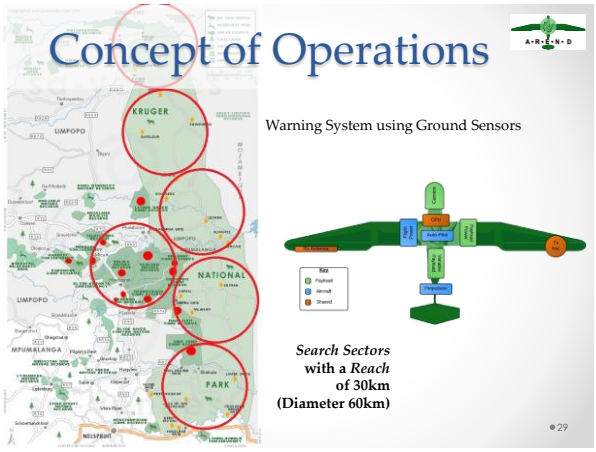
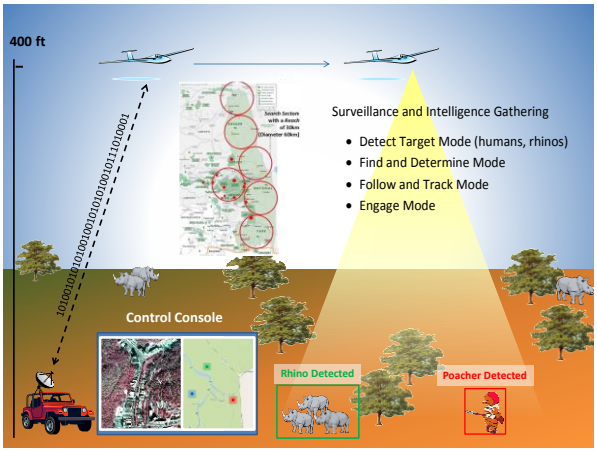
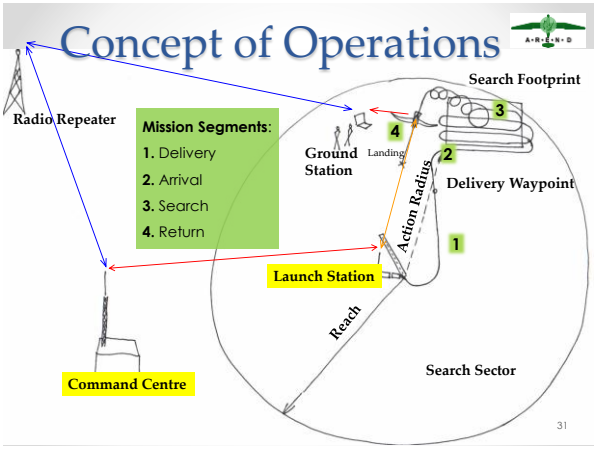
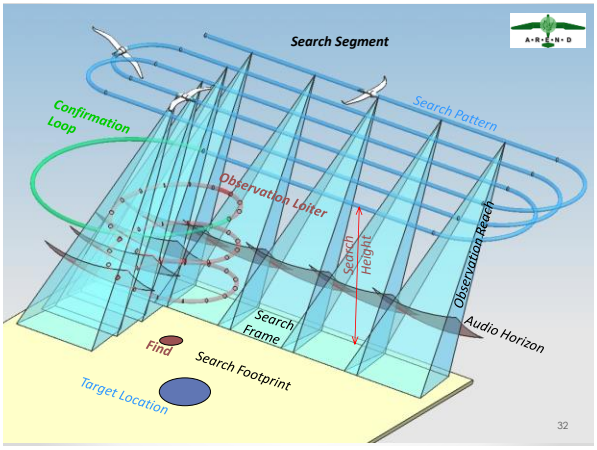

Concept of Operations
KRUGER
LIMPOPO
NATIONAL
PARK
Warning System using Ground Sensors
Search Sectors
with a Reach
of 30km
(Diameter 60km)
29


400 ft
Surveillance and Intelligence Gathering
Detect Target Mode (humans, rhinos)
Find and Determine Mode
Follow and Track Mode
Engage Mode
Control Console
Rhino Detected
Poacher Detected


Concept of Operations
Radio Repeater
Mission Segments:
1. Delivery
2. Arrival
3. Search
4. Return
Search Footprint
Ground Station
Landing
Delivery Waypoint
Action Radius
Launch Station
Reach
Search Sector
Command Centre
31


Search Segment
Confirmation Loop
Search Pattern
Observation Loiter
Search Height
Observation Reach
Search Frame
Audio Horizon
Find
Search Footprint
Target Location
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Design Objectives

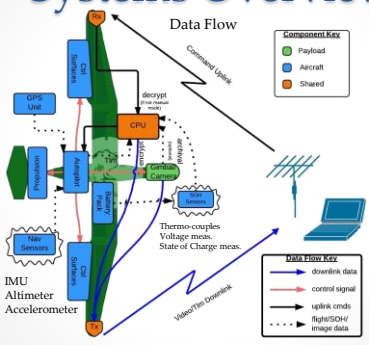
Long Range
Far Reach
Quick response Vehicle
Low Noise
High Resolution Sensor
High Data Rate Transmission (short-term)
(On-board Processing - long-term)
Autonomous Flight

Mission Objectives

Solution with UAV system:

1) **Provides large search footprint coverage**
2) **Provides novel sensor and processing system to identify humans through trees**
3) **Can be flown quickly to areas of concern**
4) **Can search area of concern with low noise**
5) **Eye in the sky to aid limited number of rangers/soldiers**

Systems Overview



Safety Considerations

- Academy of Model Aeronautics operational safety requirements
  - #105 - General Requirements
  - #560 - Autopilot Operational Requirements
- Take-off
  - Catapult launch preferred (human-assisted launch dangerous)
- Landing
  - Net capture option
  - Belly landing option

  } Both require large clearance area
- ITAR
- Ranger knowledge and education


(2)

(3)

UAS Security

Malicious activities against UAS:

- Recon (Intel collection – mission, system, Counter Intel)
- Penetrate (gain access to the UAS and Headquarters office)
- Enumerate the UAS (recon from within the UAS of all subsystems)
- Conduct Computer Network Recon (CNR) or Computer Network Exploitation CNE (collect data or destroy systems)
- Maintain Access to the UAS and network (import tools and install backdoors)
- Obfuscate (dust their tracks, stay hidden

Ref.: Tony Robinson communication

Fuselage Design Requirements

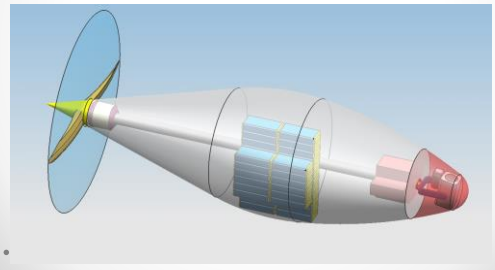
Fuselage design shall:

- have the **low possible drag characteristics***[CD < 0.035]*
- be **sufficiently sized** to house the required payload
- be **volumetrically efficient** *[Oval shape ideal]*
- allow for **sensor visibility** *[Nose cone = body of revolution]*
- have a **durable and lightweight** structure
- allow for easy **modular mounting** of sensors
- be easy to **assemble, maintain, and manufacture**
- be **low cost**

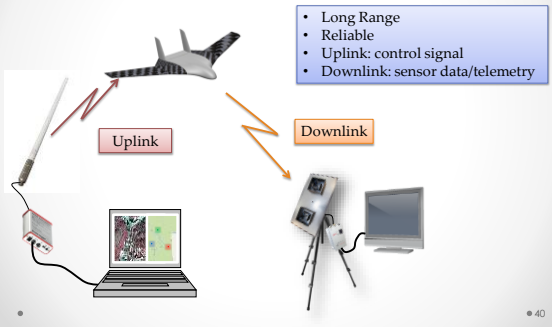
Payload Layout

Open pusher propeller configurations

- Low drag body (F2-49) sufficient to carry the payload
- Clean aerodynamic shape to reduce noise
- Propellers mounted the aftbody of the fuselage



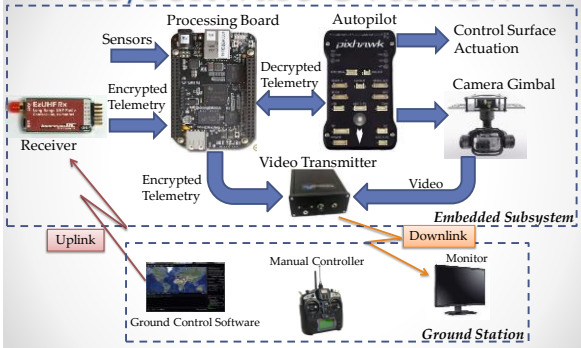
Comm Overview



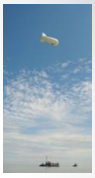
ES/Comm Conclusion

- On-board processor and autopilot support a variety of inputs and outputs for additional sensors
- Ground station software is user-friendly
  - Easy point-and-click control of UAV
  - Displays telemetry and state of health data from batteries
- Communication system allows for long-range streaming of HD video

ES/Software Overview

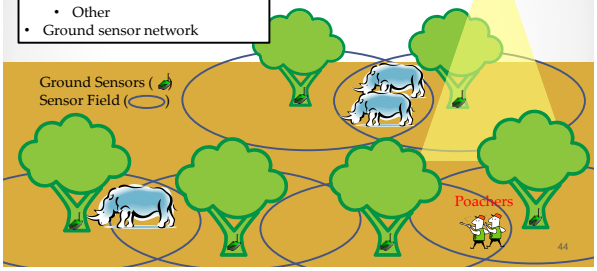


Mission Support



Sensors Overview

A combination of sensors
- On the UAV
  - Visual and IR cameras
  - RFID
  - Other
- Ground sensor network



Mission Support: Alert Sequence

1. **Detection**: possible poacher activity is detected by ground sensors
2. **Relay**: sensor data is relayed through network to central command for processing
3. **Processing**: data is processed off-network to determine threat level of activity
4. **Alert**: central command is alerted to high-level threats and their GPS positions
5. **Dispatch**: GPS positions are used to help determine and/or narrow UAV mission search footprint

AREND is unique in several respects:

- UAS vehicle designed around requirements for sensors/mission objectives
- Implementation of input directly from anti-poaching rangers
- Payload modularity for defined operations
- International collaboration providing students with experience in global design and manufacturing environment

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On a lighter note!

Drones cost Money

http://teamAREND.com

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