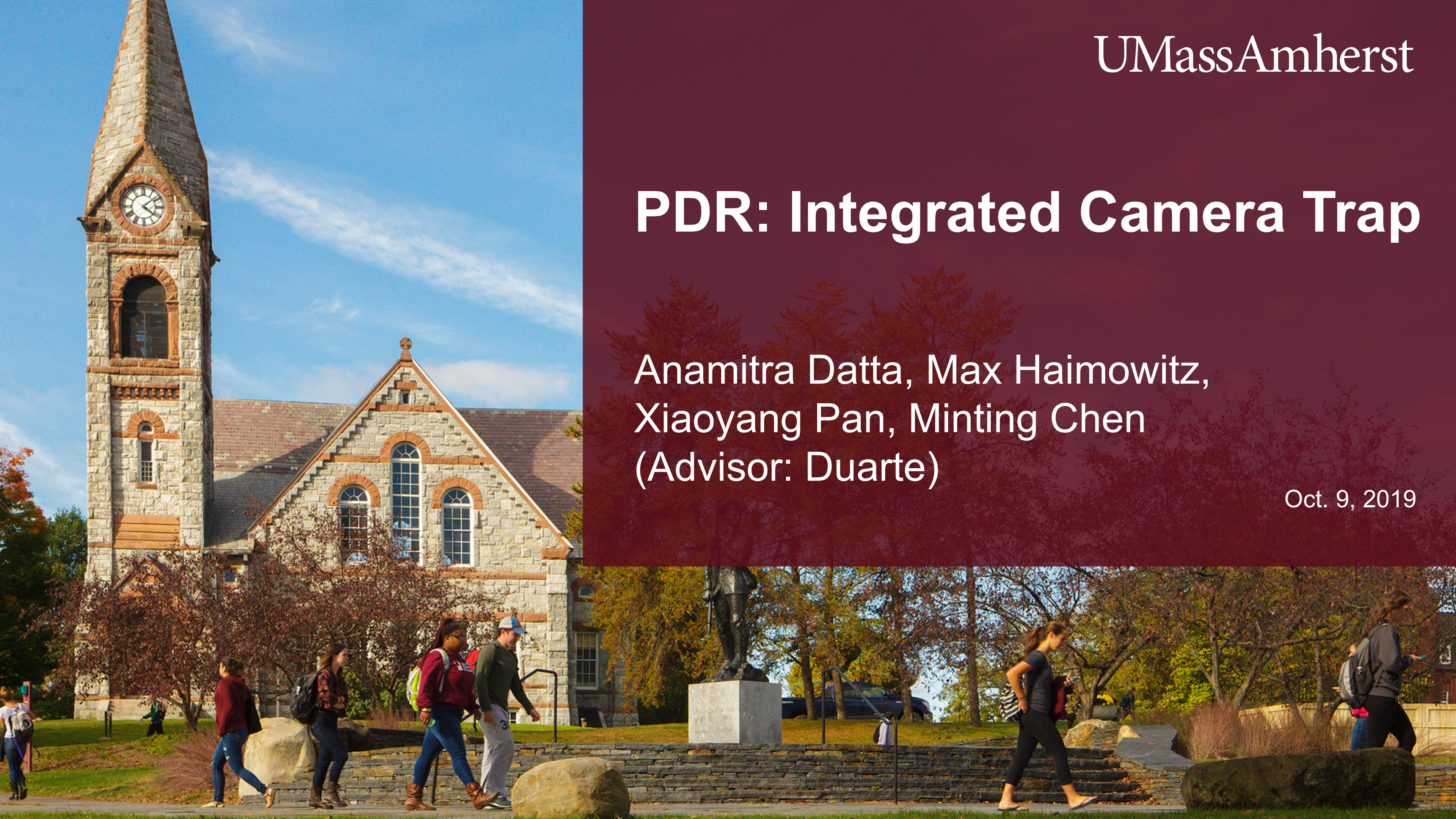

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PDR: Integrated Camera Trap

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Xiaoyang Pan, Minting Chen
(Advisor: Duarte)

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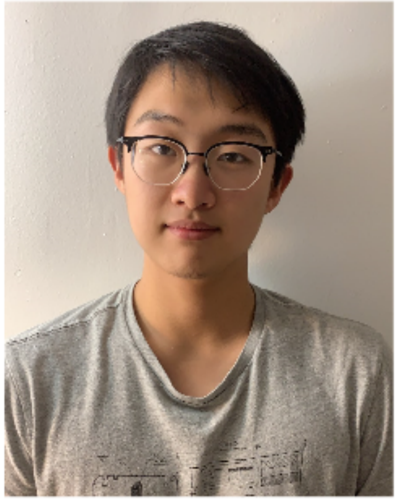
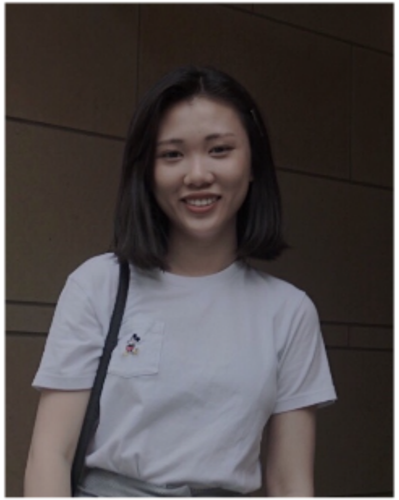
Team Members

Anamitra Datta
CSE and CS

Max Haimowitz
CSE and Team Manager



Xiaoyang Pan
CSE and PCB Lead



Minting Chen
CSE

Our Advisors

Professor Marco Duarte

Professor Duncan Irschick,
Biology Dept.

Professor David Schmidt,
MIE Dept.

Assessing Needs

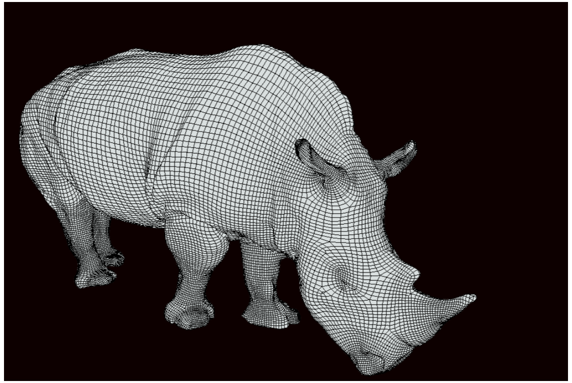
- Biologists have limited tools for studying animals
- One common method is tranquilizing animals

Problem Statement

1. Biologists are limited in collecting data and studying health of endangered animals
2. Non-invasive methods of data collection are preferable
3. Many current research methods may be manpower intensive or require specialized training
4. Camera traps only take 2D photos which are of limited use to researchers

Project Overview

- A Network of camera traps for creating 3D Models



Design Requirements

- Simple and robust
- Open source software, easy to assemble hardware
- User-manual that can be read and understood in less that 45 minutes (easy for non-expert)
- Scalable network
- Good battery life

3D Turtle

Significance

- Helps in study of endangered animals
- Health and weight information about animals
- Open source: Can be replicated and shared with broader research community

Design Alternatives (Current Products)

- Camera traps usually not networked
- Networked camera traps do exist, but they are expensive and not suitable for synchronization
- Cameras use proprietary software and interfacing with them would be difficult

4G Connected Hunting Camera Set ($750)

Design Alternatives (Current Products)

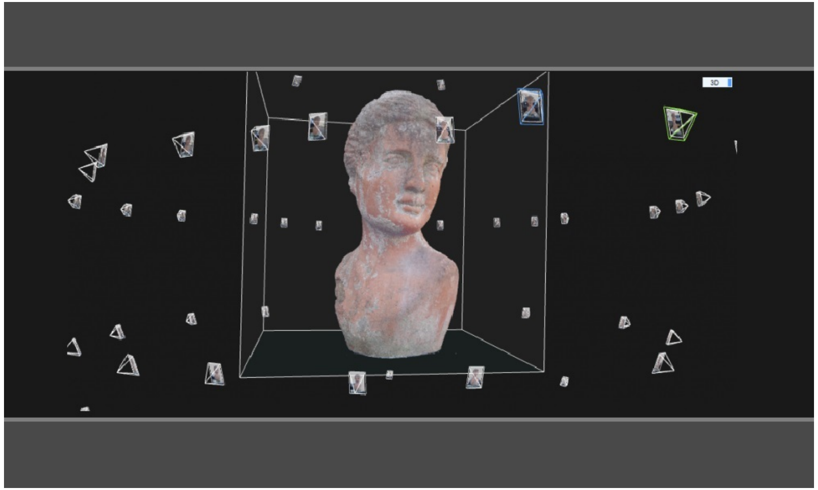
- Camera synchronization used in film and TV
- Not scalable or robust enough to deploy in remote environments

Camera with real time clock

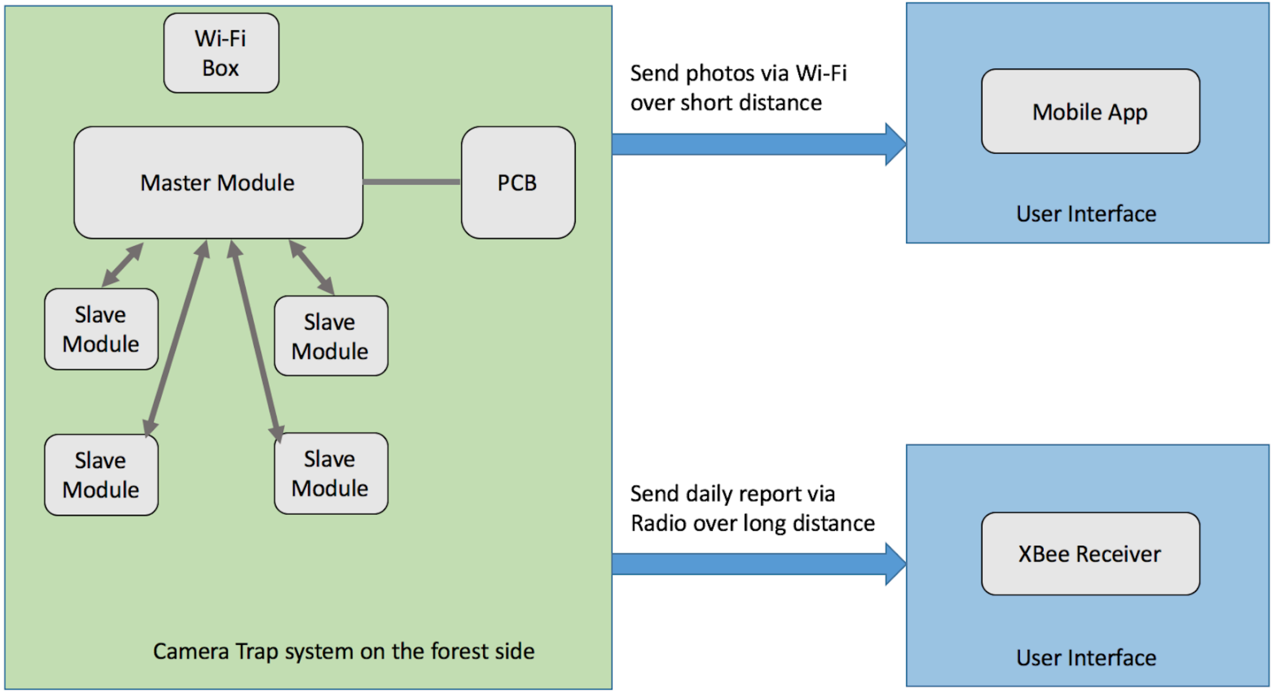
Complicated Camera Array

Photogrammetry (3D models from 2D photos)

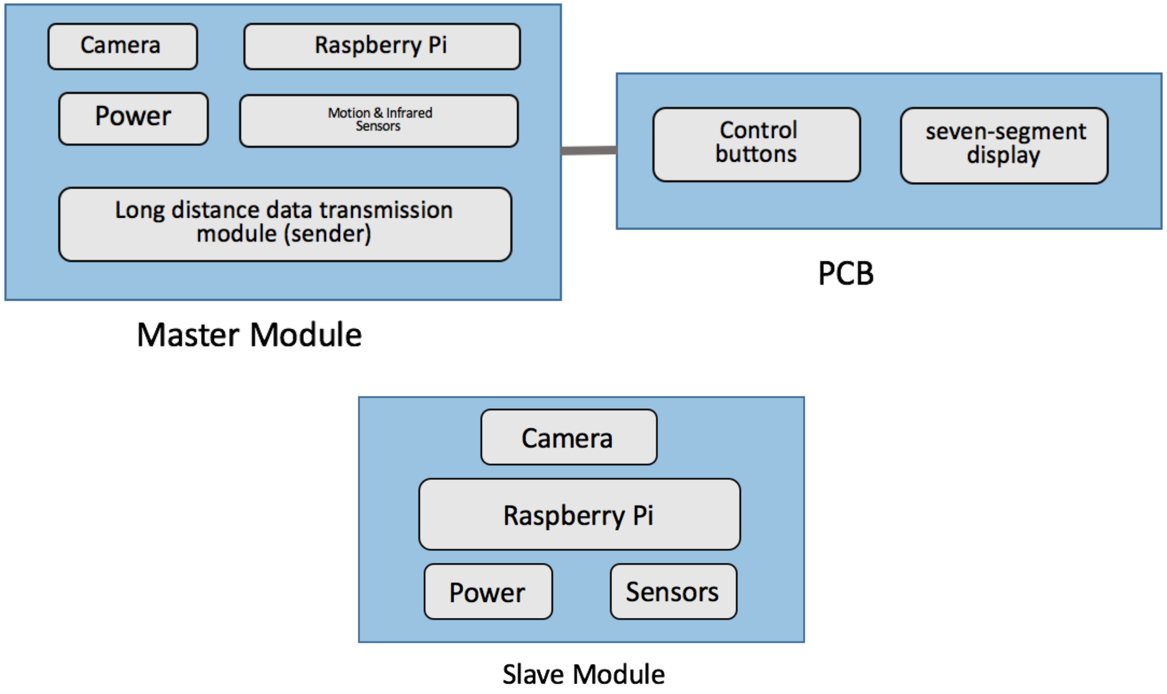
- Number of photos needed depends on how complicated object is
- Roughly 25 or 30 photos for an animal
- Software applications to create 3D reconstructions (Meshroom, Blender etc.)



Block Diagram (Big Picture)



Detailed look at Master Module, PCB and Slave Module)



Specifications

1. Scalable system of up to 25 camera modules (quantity can be increased without affecting performance in any of the other requirements)
2. Network latency allows for cameras to take photos within .1 seconds
3. Appearance of animal (or similar object) with 1 to 5m will automatically trigger system
4. Cameras can be up to 8 meters apart
5. Able to store up to 50 photos per camera which can be viewed with a smartphone
6. Lasts for over 72 hours with a sufficient power source (in a remote area)
7. Photos are in good resolution (4MP) and animal is centered in frame
8. Portable and reasonably sized (can fit within Tupperware)
9. Long-distance transmission within 2 miles (enough data for small text message)

Team Roles

- Anamitra: Networking
- Max: Software UI and Power Consumption
- Minting: Long Distance Transmission and Website
- Xiaoyang: Hardware Controls and PCB

Subsystem: Networking (Anamitra)

- Raspberry Pi gets IP address from DHCP server (easily configurable and scalable)
- Every camera can send a signal to the master when it detects an animal. Master module can broadcast a message to all slave modules (by name or IP address) when to take a picture
- The master runs an MQTT (Message Queuing Telemetry Transport) broker/publisher which slaves modules can subscribe to so they can send messages between each other. This will be done using Python with Mosquitto software

Goal: Low power consumption (Max)

- Raspberry Pi Zero has much lower power consumption than full Raspberry Pi.
- Ways to limit power consumption (limit processing, disable I/O)
- Expected average current is around 150mA

Power Brick (26800 mA hours)

Raspberry Pi Zero W

Subsystem: Mobile UI (Max)

- Android Application
- Allows for viewing photos, seeing battery life, and statistics on animals
- Lots of different options (Node.js, MATLAB etc.)

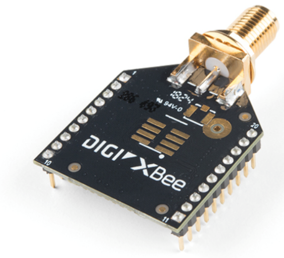
Android Smartphone

Subsystem: Significant Hardware Component (Xiaoyang)

- PCB includes 6 toggle switches, seven segment display
- Distinguish each camera by its assigned binary value (four bits)
- Wire to Master Module of Raspberry Pi(RP). (Transmit/receive information to/from each other)
- Manually trigger buttons
- Send signal to Master Module of RP to activate single camera and test its functionality, or trigger or disable all motion sensors and all infrared sensors
- Users can easily determine the ‘problematic’ node

Subsystem: Long-distance Transmission (Minting)

- Xbee RF Modules that covers up to 2 miles
- Transmit the data (number of pictures taken and remaining battery life) from the master node via radio
- User will receive the message on the Android phone (One way communication)
- User will be promoted to collect data/ exchange batteries as needed daily



MDR Deliverables

- Three synchronized cameras triggered by motion of large animal-like object (Moose on Skateboard?)
- Photos are accurate to within .1 seconds (can test by taking photo of clock)
- Android app prototype can view photos and interact with system
- User can enable/disable cameras using hardware controls
- Camera photos with sufficient resolution to create 3D reconstruction
- Able to transmit a simple message (couple dozen bytes) in a range of 1 mile

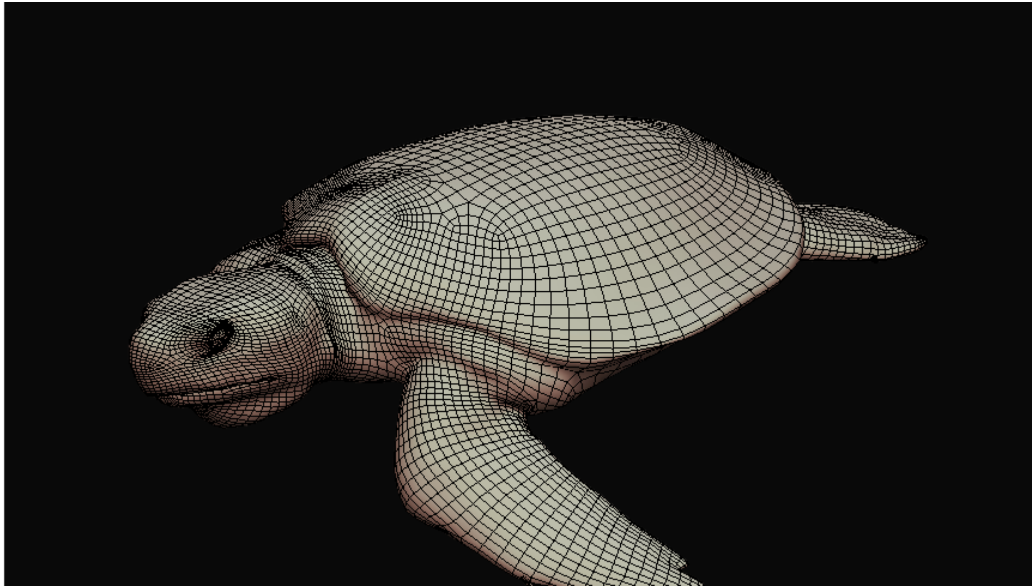
Budget

Component (Subsystem)	Price
RP Zero W (Module)	$20
RP 5MP Cam (Module)	$11
16 GB SD Card (Module)	$6
Power Brick (Module & WIFI)	$45
TP-Link N300 Router (WIFI)	$25
PCB (PCB)	$50
7 Segment Display (PCB)	$5
Push Buttons (PCB)	$5
Xbee3 Module/Antenna (PCB)	$40

Subsystem	Quantity	Total Price
Camera Module	5	$325
WIFI	1	$70
PCB	1	$100
Total		$495

Question Time

- Thanks for coming to our presentation!



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FAQ Section: Why Use a Raspberry Pi?

Pros

- Integrates with 5 MegaPixel Camera, with Arduino we have to buy chip that connects with 2 MegaPixel Camera, a separate networking module (no in built WIFI card on Arduino), and a module for attaching an SD card
- Flexibility (add image processing and thermal/motion detection)
- Easy to assemble

Cons

- High Power (also no low-power mode)

FAQ Section: Wifi vs. Bluetooth

Bluetooth

- Pros
  - Less power consumption
  - No Wifi Box or extra hardware needed
- Cons
  - Connects via serial port (one-to-one communication). No TCP/IP stack to run software/programs
  - Cannot connect multiple devices, only up to 7 or 8 (scalability problem)
  - Limited range, up to 30 ft
  - Slower compared to Wifi
  - Latency will increase with bigger network

Wifi

- Pros
  - Can use DHCP server to assign IP addresses to each RP
  - Can connect multiple devices together
  - Faster than Bluetooth
  - Huge range, up to 300ft
- Cons
  - More power is needed

FAQ: Peer-to-Peer vs. Master Slave Paradigm

Problems with Peer-to-peer

- Multiple connections required, difficult to add new devices to network
- IP addresses must be given manually
- No TCP/IP stack to run software such as MQTT
- Increased latency with increasing number of devices
- Synchronization becomes more complex