



Team Vespucci

Burrow Mapping
Solution



Presentation Overview

- Problem Definition
- Design Goals
- Design Solutions
 - Electrical
 - Software
- Risk Management
- Schedule
- Budget

Problem Definition & Background

- Burrows have impact on environment
- Columbia River Basin pygmy rabbits endangered
- Burrowing owls also of interest
- Lack of burrow exploration methods



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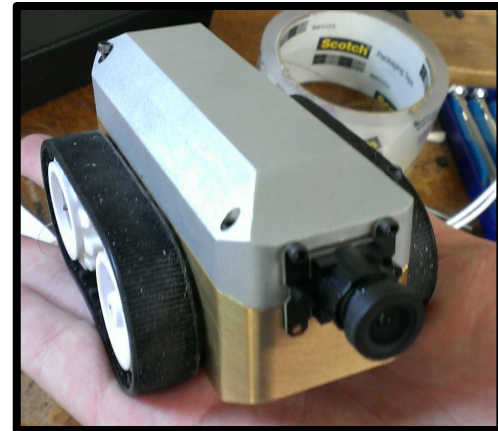
Problem Definition & Background

- Current methods
 - Digging
 - Camera on flexible rod
- Burrow properties
 - 7 - 46 cm (3 - 18 in) diameter
 - 1 - 1.5 m (3 - 5 ft) underground



Design Goals

- Control vehicle remotely
- Record video of burrow interior
- Live video sufficient for navigating
- Map burrow interior
- Estimate volume of burrow
- Easy battery charging



Electrical Design

- Resolving Previous Design Issues
- Battery Replacement
- Camera Rewiring
- Position Tracking Design
- Sensor Configuration

Battery

- Originally used 11.1V Lithium-ion 3 cell 1350 mAh Prolite Power
 - Unusable due to damage
- Replacement battery has similar dimensions and performance

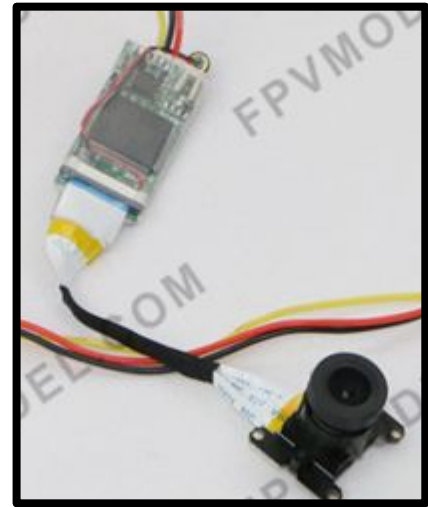


Battery Charging

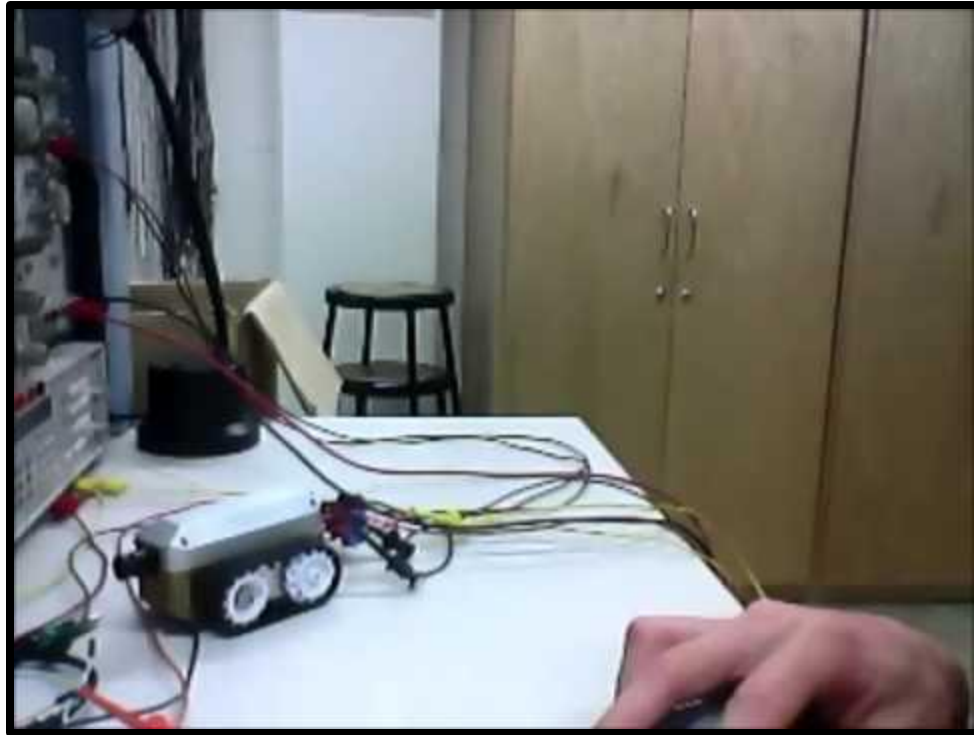
- Current design uses 6 wires
 - 4 balance wires on main plug
 - 2 power taps inaccessible
- Redesign
 - Separate charging wires from data wires
 - Add additional port for charging

Cameras

- 2 cameras
 - Front camera
 - Built-in memory
 - Manual ON/OFF button
 - Back camera
 - Damaged
- Implement video switch



Cameras



Position Tracking

- Accurately track vehicle position
 - Volume Estimation
 - 3D Mapping
- Hardware Utilized
 - Motor Encoders
 - Optical Flow Sensor
 - Accelerometer
 - Gyroscope

Position Tracking Recommendation

- Optical Flow Sensor
 - Best balance of cost and effectiveness
 - Robot's chassis is already low enough



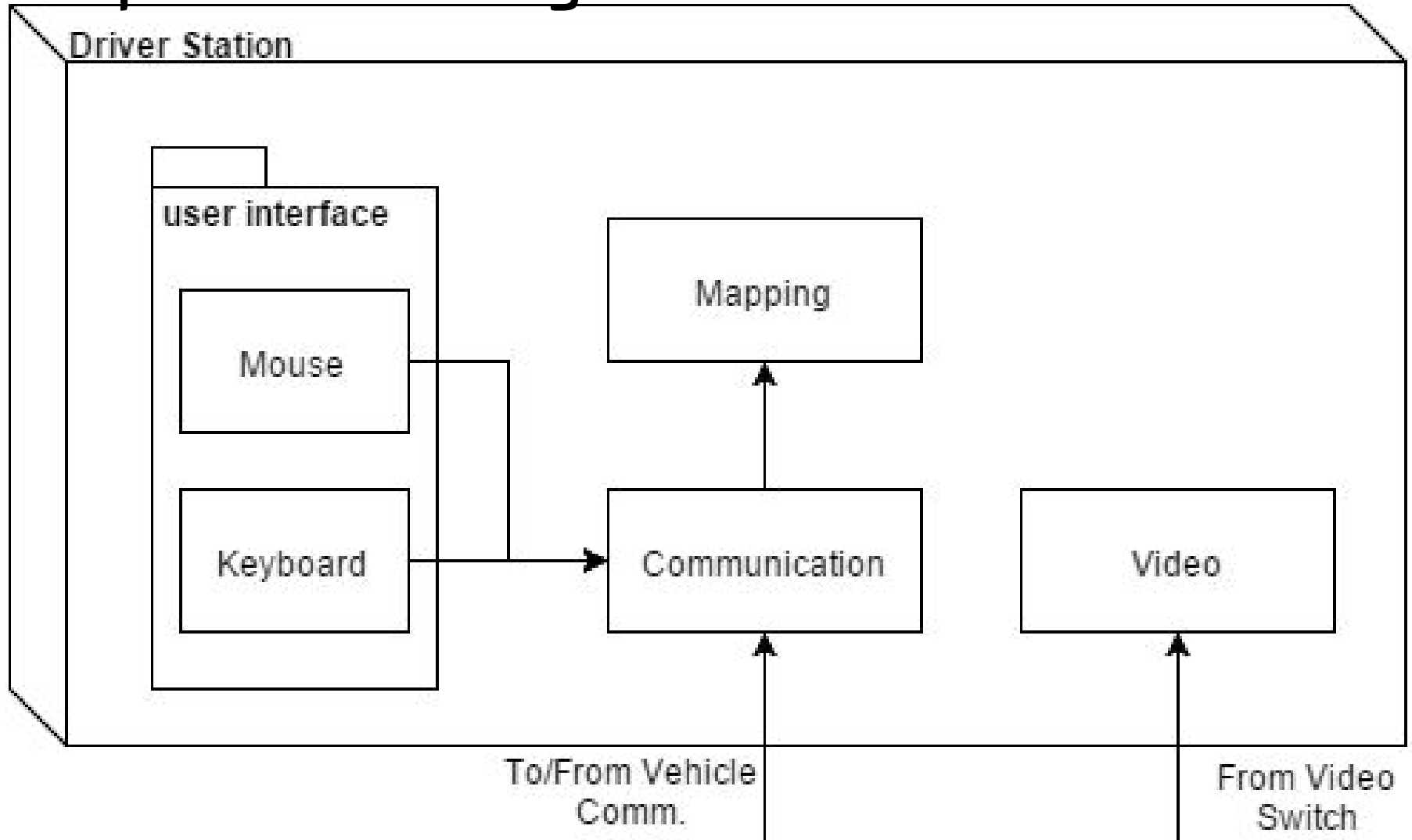
- Motor Encoding Dead Reckoning
 - Cheapest
 - Rough estimate

Sensor Configuration

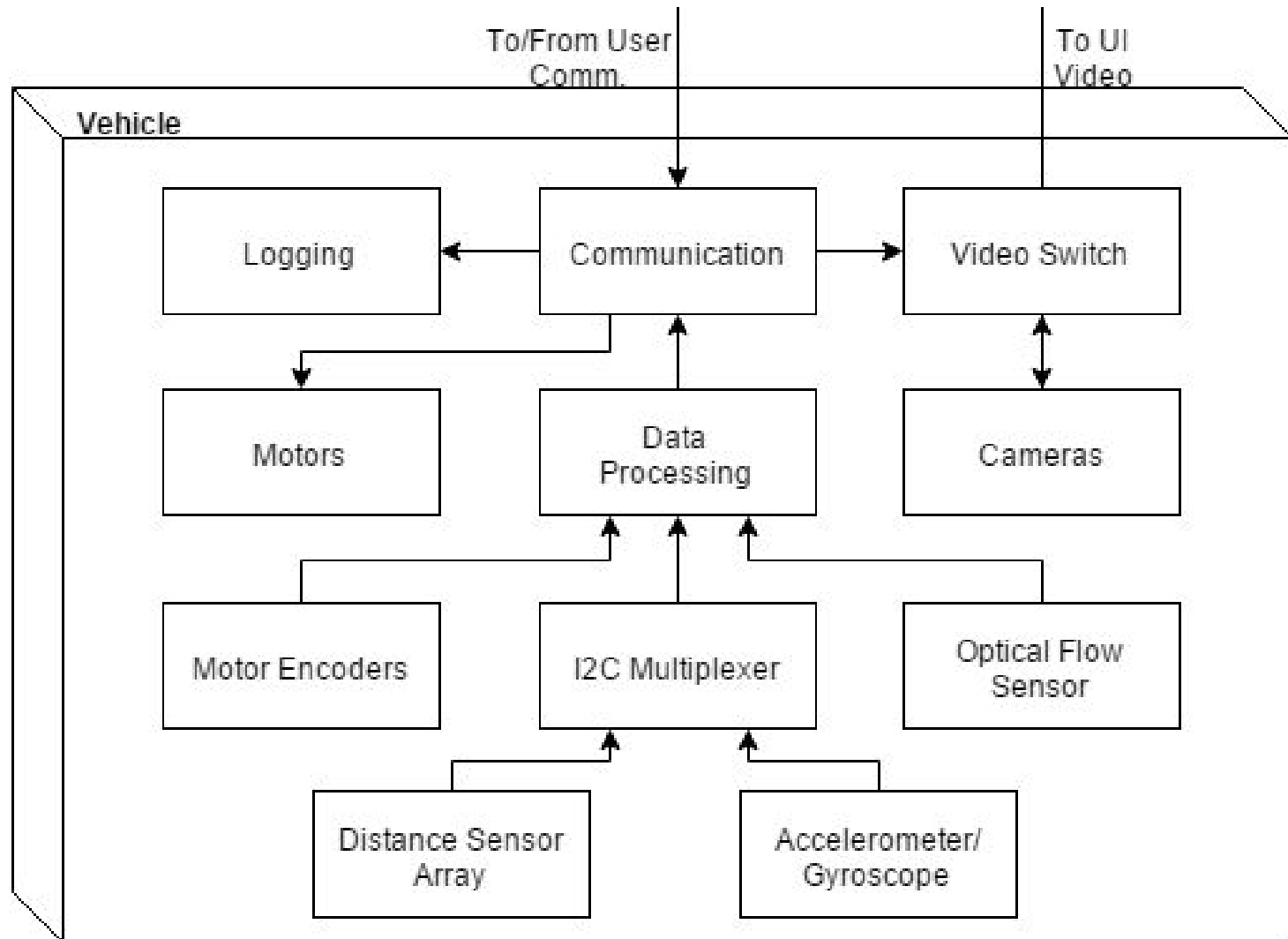
- Rangefinders measure cross-section of tunnel as robot travels
 - 2-6 external sensors
 - Calculate volume
- Multiplexer
 - Rangefinders share address
 - I2C Multiplexer



Software Design



Software Design



PC <-> Robot Communication

The PC and Robot will communicate using UART serial at ~960 bytes/second.

Message types:

Robot command:

PC => robot

Sets left, right motor speed

Selected camera

Headlight toggle

Position data:

Robot => PC

X,Y,Z position

Rotation information

Distance sensor data:

Robot => PC

Contains a reading from each distance sensor

PC <-> Robot Communication

The PC and Robot will communicate using UART serial at ~960 bytes/second.

Message format:

<Header> <Type> <Data> <Checksum> <Footer>

Header: Byte string signifying message start

Type: One byte indicating data type and length

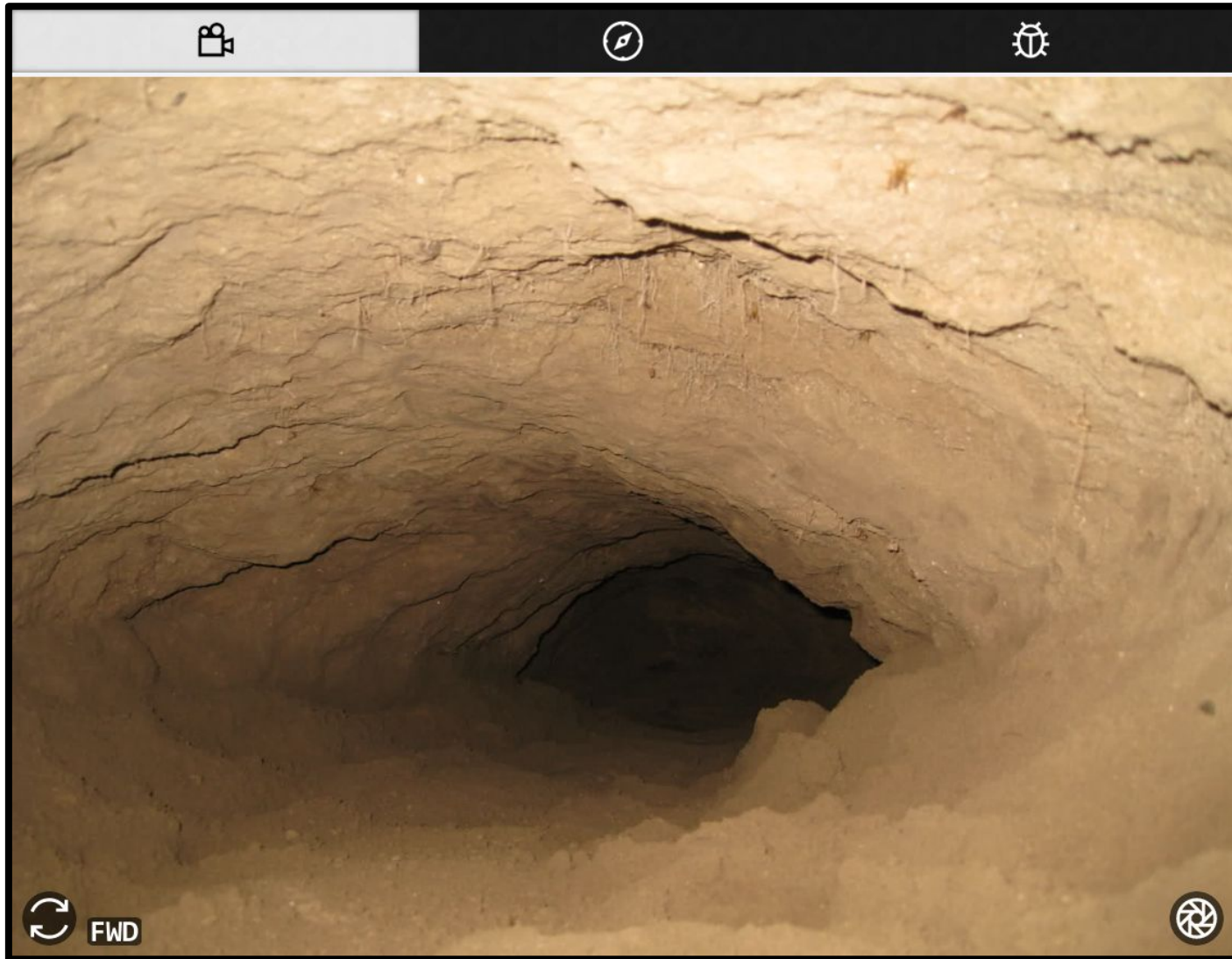
Data: Byte string Payload associated with this packet

Checksum: XOR of <Type><Data> segment bytes; used for error rejection

Footer: Byte string signifying the end of a message

...HHThehello_from_robotCCFF...

UI Mockup



Risk Management

- Robot lost in burrow
 - Leash
- Dirt blocking camera/sensors
 - Secondary camera
 - Multiple sensors
 - Data rejection algorithm

Schedule

- By Spring:
 - Mobility
 - Charging
 - Communication
 - Record Video
 - User Interface
- By the end of next semester:
 - Mapping
 - Full Field Testing



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Budget

Item	Price
Battery	\$30.80
Machining	\$0
Tether	~\$200
Multiplexer	~\$5
Flow Sensor	~\$10
Rear Camera	~\$20
Total	~\$265.80

Questions?

