

VISION MAPPING SOFTWARE

TEAM VESPUCCI

Clients:

Dr. Courtney Conway

Dr. Janet Rachlow

Instructors:

Bruce Bolden

Joel Perry

Members:

Xihua (Jake) Chen

Stephen Hanes

Tyler Jaskowiak

Brett Menzies

Lance Wells

PROBLEM

There is no non-destructive method for measuring and mapping the burrows of the declining Pygmy Rabbit population.



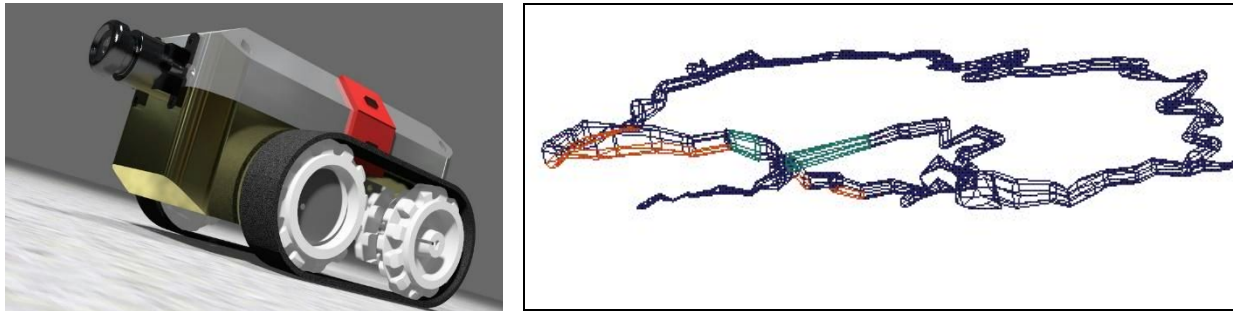
Pygmy Rabbit (Brachylagus idahoensis)

■ In 2014-2015, Team Rabbotix designed a robot
■ small enough to navigate the burrows.

■ The latest version of the robot does not have a
■ control system or the ability to recover the
necessary data.

GOAL

Deliver an easy-to-use robot to map and record animal burrows.



A.L.I.C.E. Robot Render (left) and sample tunnel render (right)

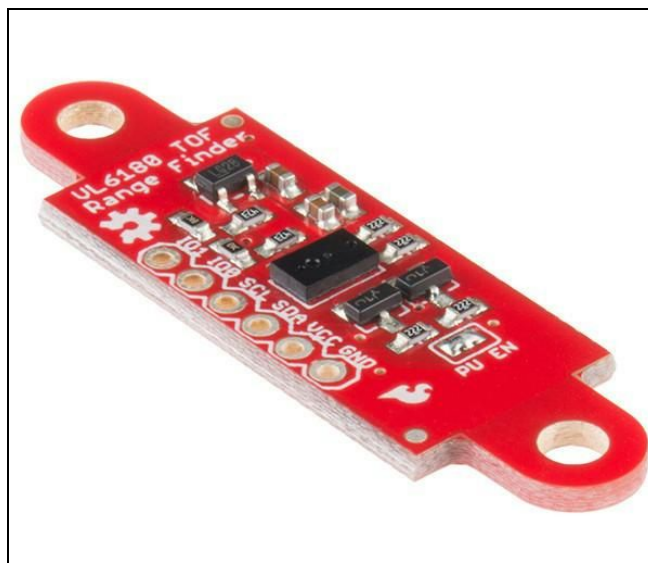
■ Our plan is to modify the existing A.L.I.C.E. robot ■
to easily capture video and burrow measurements
remotely.

■ From there, we can use the modified A.L.I.C.E. ■
robot's data to create a
3-dimensional visualization of animal burrows.

PROCESS

Develop robot and desktop software to achieve our goal.

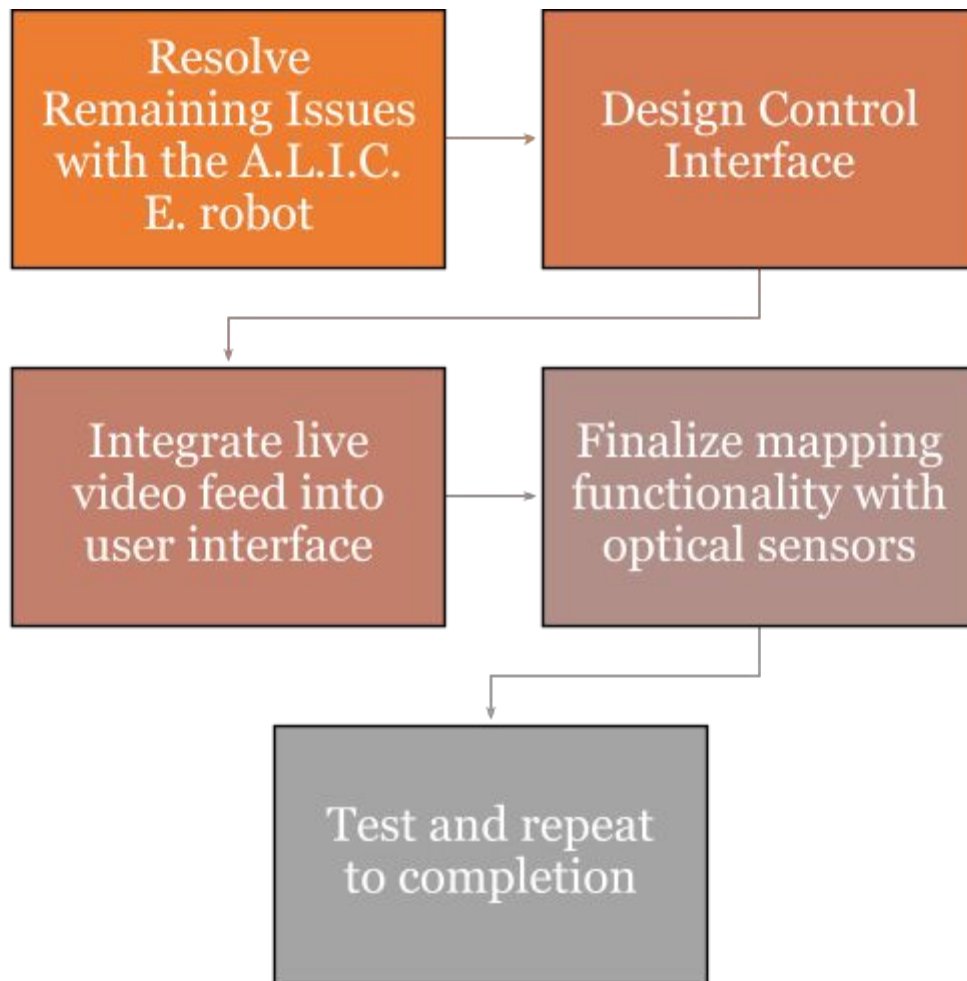
- Data collectors will be installed on the outside of the robot to take measurements of the burrows. ■
- Video, controls, and measurements will be communicated via a cable between the robot and the user. ■



SparkFun "Time of Flight" vl6180 Range Finder Sensor

TASK SEQUENCE

Resolve remaining tasks with the A.L.I.C.E. robot's functionality before finalizing the necessary software

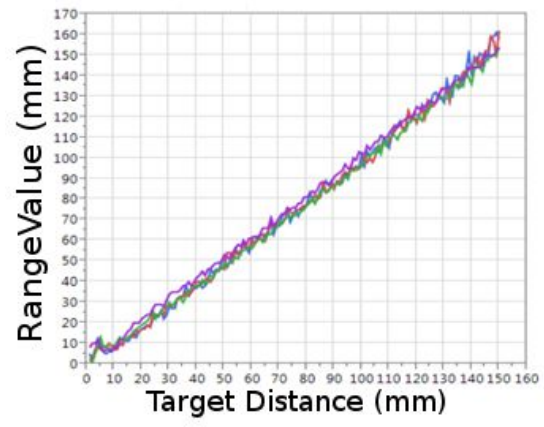


TARGET SPECIFICATIONS

Priority	Parameter	Metric	Acceptable	Target Value
Very High	Robot Control	Robot control accessibility	The robot can be controlled via user interface.	The robot can be controlled via user interface.
Very High	Video quality	Video quality	The video quality is sufficient enough to navigate burrows and showcase to interested parties.	The video quality is sufficient enough to identify individual eggs and owl characteristics (including age).
Very High	Camera Functionality	Camera video feed accessibility	The interface can display video feed from both cameras interchangeably.	The interface can display video feed from both cameras interchangeably.
High	Camera Visibility	Range	6 in.	12 in.
High	Control ease-of-use	Control accessibility	The controls are functional and require little effort to learn.	The controls are functional, easy to learn, and self-explanatory.
High	Maneuverability	Average Response Time	<100ms	<10ms
Low	Robot Charging	Charging accessibility	Charging is accomplished without opening the robot.	Charging is accomplished in the field.
Low	Camera label interface	Camera label accessibility	The interface accurately labels the active camera.	The interface accurately labels the active camera.
Very Low	Mapping Functionality	Generated map quality	The included software is capable of generating a post-processed or line map of the burrow.	The included software is capable of generating a real-time map of the burrow.
Very Low	Volume Estimate	Relative error	No volume estimate.	<10% relative error.
Very Low	Control Device	Program accessibility	The software operates on a laptop.	The software operates on a tablet.

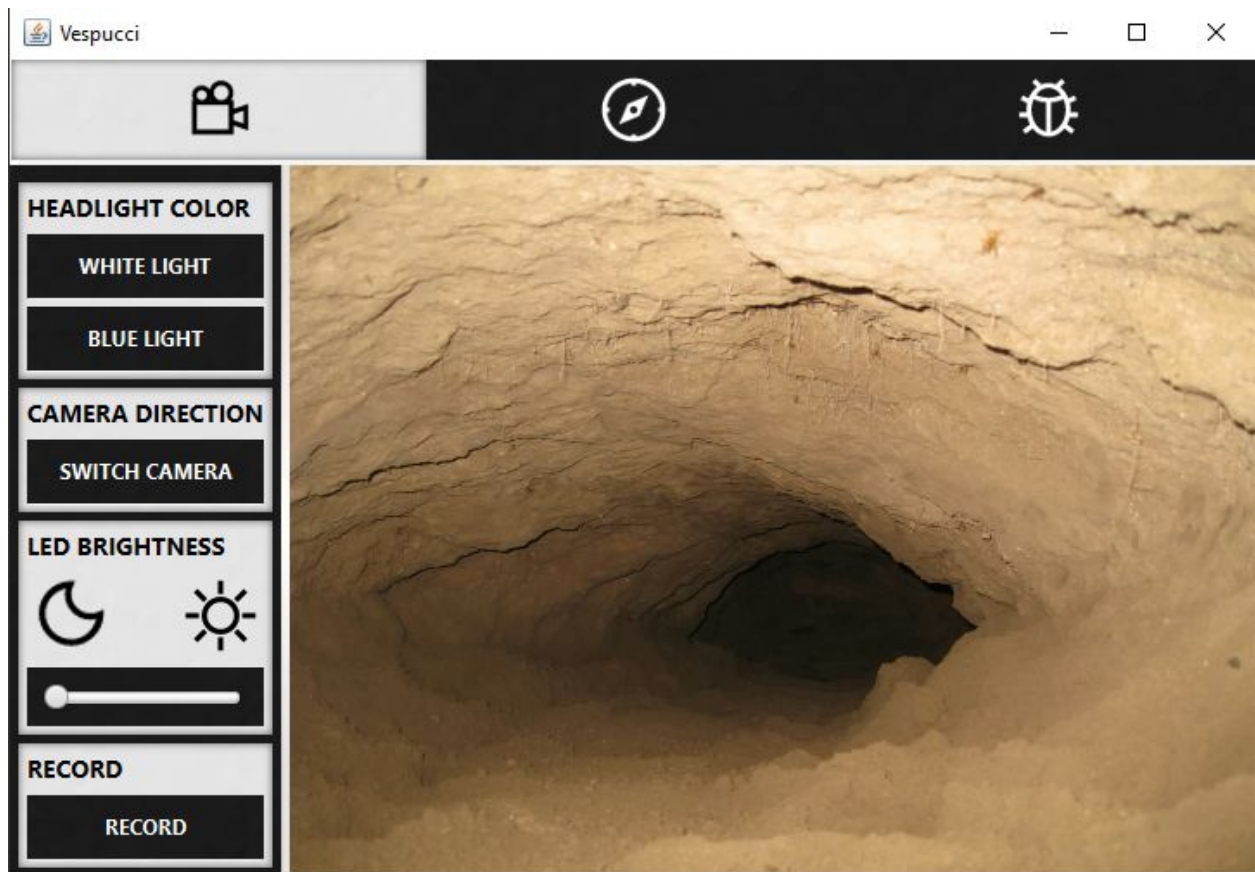
PROJECT LEARNING

- We have thoroughly investigated Team Rabbotix's portfolio. This has revealed previous hardware failures and electrical problems that will need to be fixed before the robot can become operational again.
- We have researched prior work on similar projects like *Ultrasonic Cave Mapping* (Sellers, Chamberlain) and *Spatial cave mapping in Bulgaria* (Slavova, Kamburov, Rusev). These methods largely focused on mapping larger caves and involved human operators.
- We have gathered information on using optical flow sensors to improve the robot's dead reckoning based position estimation.
- Our testing indicates that the robot's distance sensors are capable of taking 100 readings per second, with 1mm accuracy, and a range of ~150 mm in standard lighting.

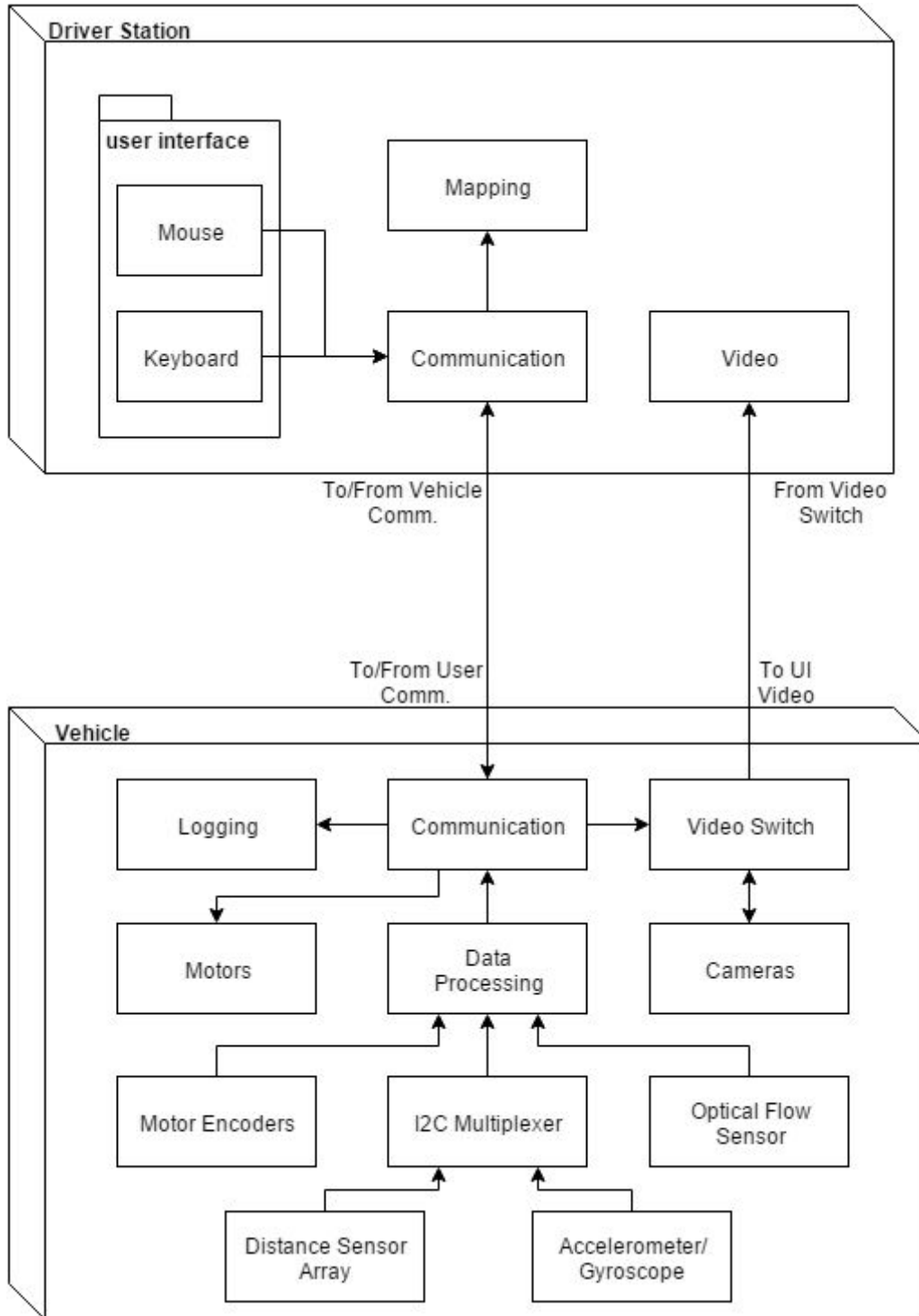


USER INTERFACE

From there, we can use the modified A.L.I.C.E. robot's data to create a 3-dimensional visualization of animal burrows.



COMPONENTS



CAMERAS

The robot will be equipped with a pair of cameras; one facing forward and one backward.



Front Camera with Converter and Memory

■ The front camera has higher resolution and records video to a memory card. ■

■ The rear camera is used for help with backing up. ■

SENSORS

The burrow map will be constructed from sensor readings taken by the robot.



Rangefinder Layout

■ Rangefinders arranged around the top of the chassis can be used with an I2C multiplexer to access each sensor to calculate the volume. ■

■ An accelerometer can be used to measure the rotation and attitude. ■

■ An optical flow sensor can track the robot's progress so that the relative position can be calculated. ■