Robotic Echolocation Test Platform

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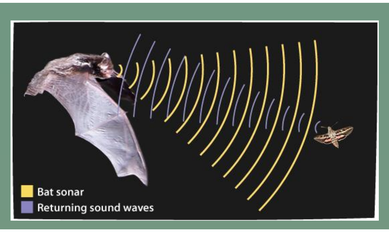
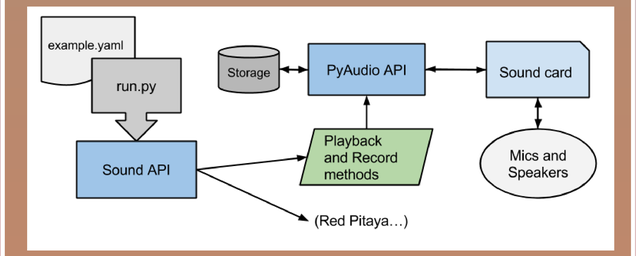


Introduction

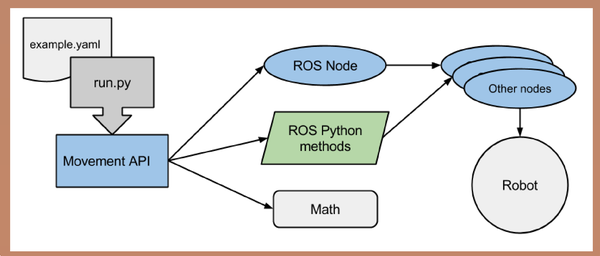
A bat can identify its position within an environment using ultrasound chirps to perform echolocation. The biology of this process has been studied in depth, and engineers have applied ultrasound ranging in mapping and object detection. In this project, a mobile system was developed that can precisely and reliably carry out echolocation experiments (data collection) for later analysis. A YAML-based specification for representing experiments was developed, so that researchers can create and execute experiments with simple, human-readable text files.

APIs

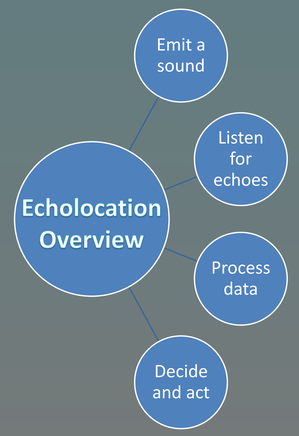
Sound API



Movement API



Methods & Hardware



In this project, a mobile system was developed that can precisely and reliably carry out echolocation experiments (data collection) for later analysis. A Kobuki robot was used as a base unit, providing mobility and accurate odometry. Custom shelving and mounting hardware were designed for the robot to accommodate a laptop for controlling the robot, along with a Microsoft Kinect sensor and ultrasonic transducers for taking experimental measurements.

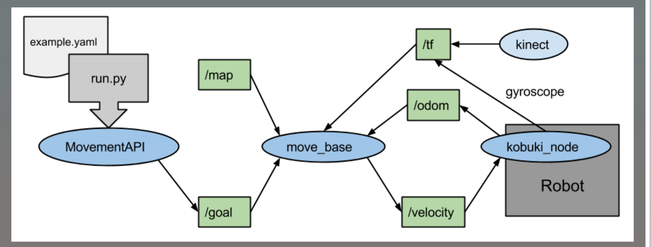
Overall project goal

Better understand how bats process echolocation data

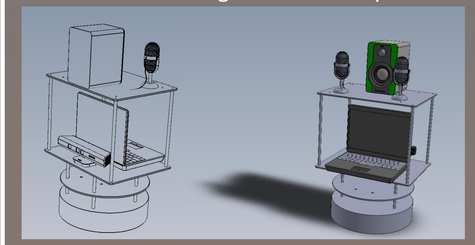
Short-term goal

Create a mobile system that can precisely and reliably collect data, then perform various data-collection experiments

ROS Graph of system in action

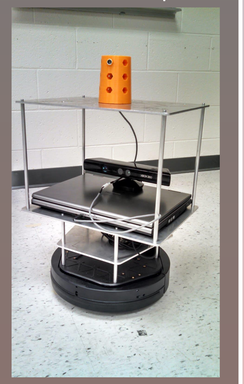


3D Rendering of Robot Setup

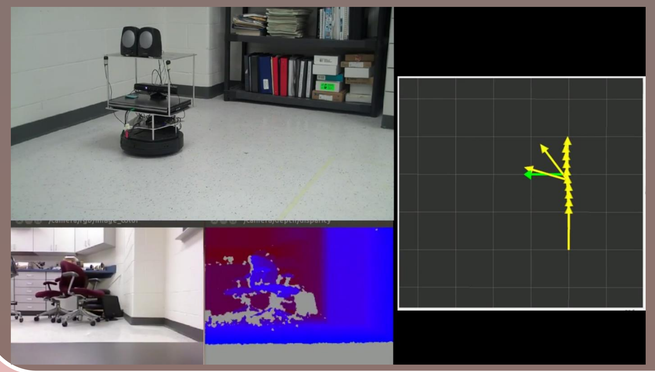


A Python based software package was designed to provide simple control of the robot and its sensors. This software was designed to work within the Robot Operating System (ROS) framework, and includes high-level interfaces for controlling robot movement and for the simultaneous playing and recording of sounds.

Robot Setup



Real-time Image of Laptop Camera and Kinect Sensor



Why Ultrasonic?

- Most bats: 70 kHz down to 40 kHz
- For high frequency range: Less noise
- Smaller sound waves can detect smaller features to get better resolution.

Conclusions

This research designed a custom software package to control the robot and its sensors. Each data-collection experiment consists of a sequence of movements and measurements that the robot should perform. The system we have developed will make future data collection simple, allowing us to focus on the study and analysis of echo signals.

Future Efforts

- Replace sound-card with custom ultrasonic hardware
- Data collection
- Data analysis

References

Ben-Kiki, Oren, Clark Evans, and Brian Ingerson. "YAML ain't markup language (YAML)(tm) version 1.2." YAML.org, Tech. Rep., September (2009).

Acknowledgements

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