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Abstract

Mammoth Cave contains a number of partially explored bodies of water. While some of the hydrology is known, and some unique aquatic species have been discovered and described in these environments, the difficulty of accessibility has discouraged more thorough investigation. This project has two aims. The first aim is to provide a unique educational opportunity for high school students to take the ecological knowledge and engineering skills they have learned and used in the classroom and apply them to original research in the cave. The second aim is to expand the existing knowledge about the aquatic community ecology and geology of the cave system by using a remotely operated submersible to increase accessibility.

Students at Mercy Academy in Louisville, KY built and learned to operate a fully submersible, tethered, remotely operated vehicle (ROV) based on open source plans (OpenROV, www.openrov.com). After initial testing of the design in small enclosed aquatic environments, practical operation of the vehicle and its video capture capabilities was tested in Mammoth Cave's underground pools and rivers.

The ROV is equipped with on-board high-definition video recording capability, as well as a sensor suite that can monitor heading, depth, and temperature. Students learned to troubleshoot assembly and design issues, and, based on their in-cave experiences, have also begun to consider designing and producing modifications to the ROV at school using 3D-printing and laser cutting manufacturing techniques.

Survey of pools and other aquatic sites consist of two phases. The initial phase consists of free-piloting exploration of potentially interesting research sites. Then having decided upon areas for more intensive study, the ROV can be used to perform more exhaustive and systematic surveys of specified areas of the pools at specified depths, allowing a comparison of populations in different parts of the pool (e.g. source vs exit, or shore vs center) and of populations in the same area of the pool, but at different depths.

We have performed initial explorations of parts of the River Styx (adjacent to Charon's Cascade) and the Dead Sea, doing some troubleshooting along the way, primarily with respect to managing the tether in an environment filled with potential snag points and in minimizing the disturbance of sediment, which can make video data collection difficult.

We have also begun the process of more systematically mapping the River Styx area, gathering bottom depth and video data at approximately ten points in the pool mapped by triangulation. This allows us to begin creating a 3D map of the pool. We are also examining the video for the presence of stygobites such as cave fish and cave crayfish.

From this point, continuation of the project is directed at completing a 3D underwater map of this part of the River Styx, describing the ecological characteristics of this section, and finally, to continue improving the ROV through design and engineering of enhanced sensors, chassis designs, and tools.