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Personal Information

Status:	**Undergraduate Student**
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RA Period:	**From 2017-09 to 2018-05**

Biography

I'm a senior business analyst at Activate Consulting. Before that, I was a research assistant in NYU Multimedia and Visual Computing Lab, advised by Professor Yi Fang. I am broadly interested in 3D Computer Vision, Pattern Recognition and Deep Learning.

Capstone Project: An Investigation of Coral Reefs

1 Description

Coral reefs in the UAE are under threat of disappearance due to rising sea temperatures. Despite the importance of studying the response of coral and marine life to the changing climate, marine researchers are not equipped with the personnel or time to survey the reefs on a large scale. Existing methods for coral monitoring are limited, compromising either on accuracy and detail, as with remote sensing, or time and efficiency of data collection, as with manta tows and SCUBA transects. The reefRover project aims to provide a solution to this problem in the form of an autonomous ROV that will perform transects along the reef and obtain high-quality images of the coral in the UAE. The ROV will be developed in a manner that enables community divers to deploy the device while ensuring data quality, and the reefRover project will be kept open-source, allowing anyone across the world to develop and deploy the reefRover and expand the available data on coral reefs. The team is divided into three main efforts—Underwater Positioning System, Image Processing, and ROV Integration—and the vision is to have a fully operational, autonomous ROV for deployment in May 2018.

2 Method

This project build an embedded system that can be integrated into the ROV platform. As displayed in Figure.1, the blackbox model demonstrates the communication and power connections that will be utilized to execute the reefRover device. The topside layer will require the user to input a selected area over which the ROV will conduct transects and will be wirelessly connected to the buoy at the water surface. This separation of buoy and topside will provide comfort for the user and flexibility in the position and distance between the ROV and laptop. The buoy will have a direct connection to the ROV beneath the water surface and will relay the mission commands sent from the laptop down to the ROV. The Underwater Positioning System will also operate at this level, with the pingers sending and receiving sounds to and from the ROV. At the ROV level, the Pix-

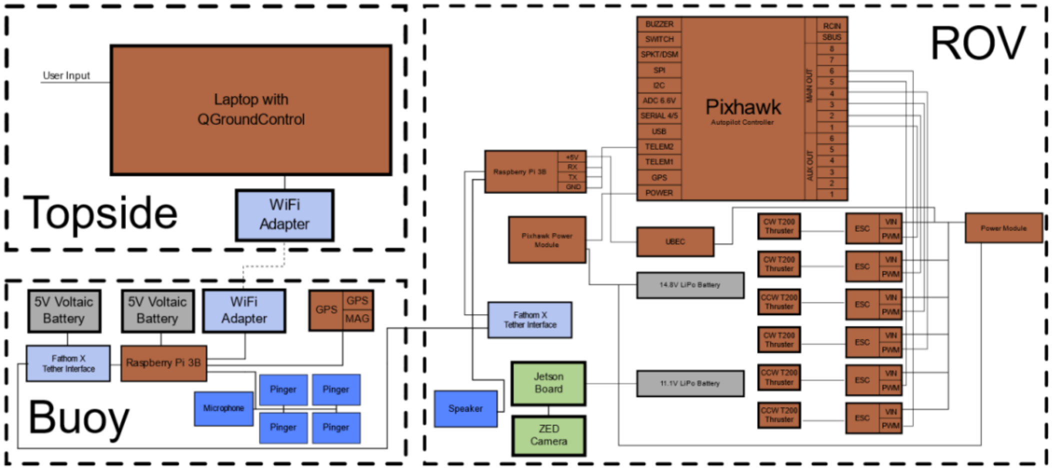

Figure 1: Interconnect of Proposed Final Design.

hawk autopilot will interpret the received directional commands and, in combination with the information obtained from the motion and position sensors, will send commands to the ESCs to activate the ROV thrusters. During transects, the ZED Camera will take pictures of the reef, and through post-processing provide a reconstructed map of the coral floor. The goal of the reefRover design is to reduce the input required from the user for device operation.

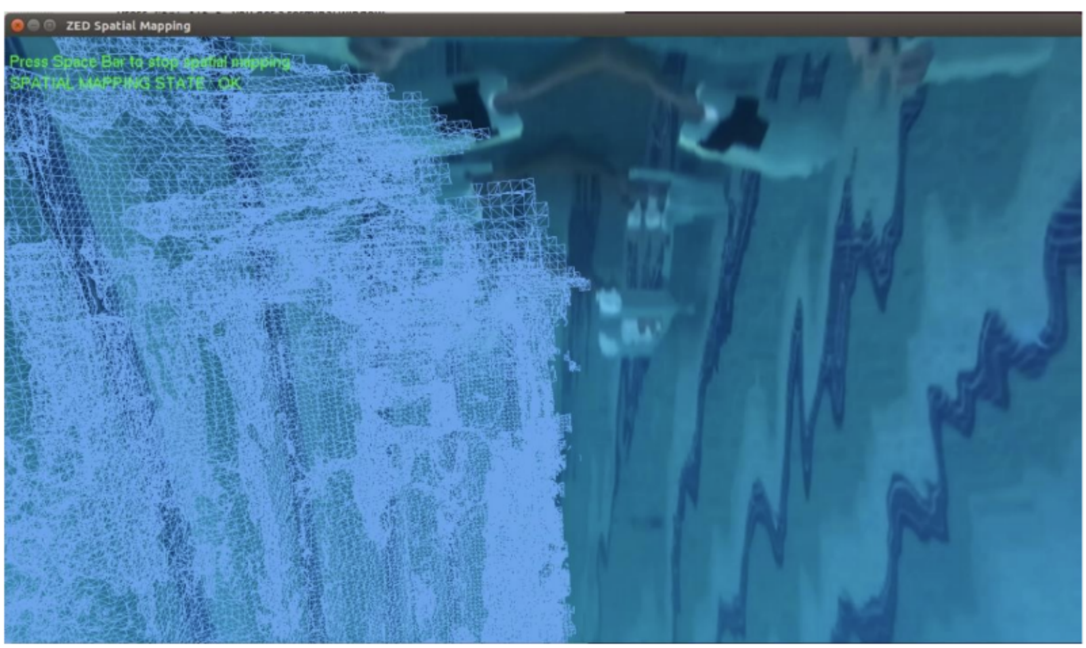

Figure 2: (Flipped for more clarity) Reconstruction of the pool entering stairs along with objects submerged from the surface.

3 Results

In this section, we conduct experiments to demonstrate the effectiveness of the proposed approach. At the beginning of the semester, we replicated the system onto a GPU-capable PC. In the architecture, the Jetson and Elroy boards were replaced by a GeForce GTX 960M graphics card, keeping all other layers the same. The takeaways from the initial tests are the following: 1. Surfaces are well reconstructed. 2. Closure is present, meaning that the algorithm recognizes that it sees a familiar patch for the second time. The blue surfaces (coming from the Meshlab viewer) denote the camera's path. These correspond to the reality and segments tie around it nicely. As closure is used as one of the main indicators of a SLAM solution implementation success, this is an important assessment point. 3. The resolution doesn't meet the strict constraints we imposed earlier. Though this is difficult to quantify, it leads us to believe that in underwater conditions, under worse lighting and on harder surfaces, the algorithm will not produce research-grade 3D data. However, since Stereolabs keeps improving their solution and updating the Github repository, we can be hopeful that the system proposed here will get finer data in one of the future project iterations. 4. The algorithm can become "disoriented" if there is too sudden of a change while in motion. Since it recognizes that this is the case, there needs to exist a feedback loop to signal that the rover should slow down, retreat a short distance, and follow the same path, only more slowly. The good news is that the algorithm is capable of a solid recovery and the reconstructed data is never lost. A possibility that will be implemented in parallel is the algorithm restart if the recovery is impossible, preceded by mesh saving. We observe similar results when testing underwater. Most notably, the system largely depends on the user's ability to see what the camera is seeing, so that the camera angle and distance from the reconstructed objects can be adjusted. For now, we have a proof of concept result to indicate that the ZED is capable of underwater reconstruction. Since the mesh was reconstructed over only a short time period, it was not dense enough to show in this section. Instead, we show screenshots of the process, where the ZED maps the underwater scene. Figure.2 shows the reconstruction of the pool entering stairs along with objects submerged from the surface. The camera was also just partially submerged within an enclosure. We replaced the provided heatsink-fan system by a larger heatsink. While in general a fan circulates and cools air down, in an enclosed space it adds heat to the system. As shown in Figure.3, the motor running the fan is small and inefficient; it there-

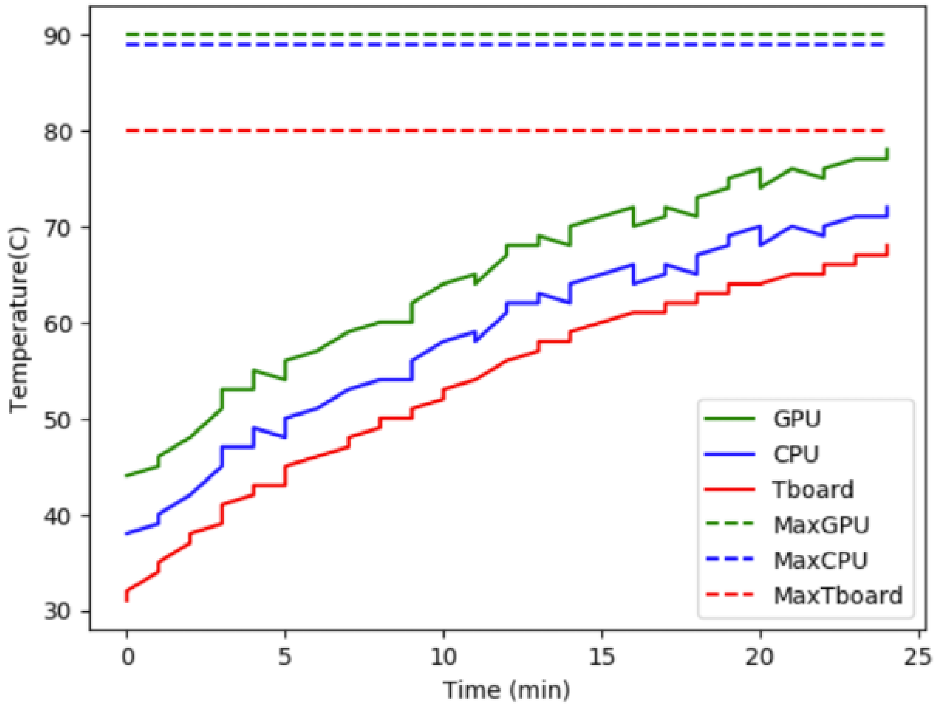

Figure 3: Key thermal point readouts during a 25-minute air test, along with their safe plateaus.

fore produces heat, which is blown into the enclosure and becomes the system's dominant contribution to the temperature change.