TECHNICAL DOCUMENTATION

NORTHEAST STATE COMMUNITY COLLEGE
ELITE ACADEMY
BOUNTVILLE, TN

TEAM MEMBERS

Issachar Wine
Mason Ramsey
Kayla Keene
Derek Tapp
Isaac Carr
Jerrod Perkins
Dwayne Arnold
Joe Frazier
Matthew Hickman
Charles Hall

NORTHEAST STATE

Abstract

This was Northeast State's first ROV and it has passed our expectations. Northeast State used the Eagle Ray kit provided by Mate as the base but included some modifications. The ROV was designed to effectively manipulate the props to complete the tasks. The ROV is controlled by a computer on the surface and utilizes 48V to power the ROV.

Northeast State Robotics has truly come together as a team this year. Starting as a group of students of all ages and backgrounds to become a team that works together effectively to overcome challenges was no small task. With the majority of team members not having any experience with MATE or Robotics in general the team had to overcome challenges and achieve unity in order to support one another and accomplish the completion of the ROV.

Teamwork

Project Management

Northeast State Robotics was founded this year. The team was set up in conjunction with the Elite Academy program at Northeast State. This program acts as a capstone project for many of the participants and provides funding for the ROV.

The team met on Mondays and Wednesdays from 3-5 as a class time to complete the ROV. Additional time was utilized outside the class to complete assignments to complete the systems when needed. After the school year

ended the team met on Mondays and Wednesdays from 12 to 6 to practice and tune the ROV.

Northeast State utilized Microsoft Teams to communicate and share needed files. This allowed for the team to have a dedicated place for finding the files needed.

The team's biggest problem was time. With having only a semester and less knowledge of robotics in general and specifically of the MATE program, they leaned on each other and the resources at their disposal at their school to come up with solutions to problems that arose.

Team Members

Issachar Wine	CEO
Derek Tapp	Pilot
Mason Ramsey	General Assistant
Kayla Keene	Programing Team
Isaac Carr	Programing Team, Research Expert
Jerrod Perkins	Safety Officer
Dwayne Arnold	Electrical Engineer
Joe Frazier	Pool-side ROV Manager
Matthew Hickman	General Assistant
Charles Hall	Tether Manager

Design Rationale

Engineering Design Rationale

Northeast State's ROV is based on the Eagle Ray kit provided by MATE and purchased through the Seamate store. The ROV has a water tight enclosure to house the onboard electronics. The frame is made out of HDPE marine-grade plastic sheet and ABS 3D printed parts. For propulsion the ROV has 4 T200 thrusters from Blue Robotics which are reliable and easy to work with. The ROV also has a Newton Subsea Gripper that easily fits in the Eagle Ray control board. The team took the provided kit and worked together to assemble it until they ran out of instructions, due to the eagle ray still being in development, then used logic and brain storming to finish and add to the ROV as the need showed itself. Assembling the kit provided new

opportunities for many team members, giving new experiences with electronics, soldering, etc. All team members participated in the build, allowing for team building and cooperation.

Innovation

Northeast State Robotics had many resources at their disposal to help innovate. The school has gotten a Stratasys F370 CR 3D printer which the team used for all their 3D printing needs. This printer is known for its accuracy and ability to print in an industrial setting which proved useful in the need for accurate parts created promptly. The team used their resources to innovate their design by swapping frame parts that were too difficult to CNC with parts that were machined. This includes the handles and the middle piece.

Problem Solving

Northeast State Robotics was no stranger to problem-solving on the go, from issues with design to missing parts to catastrophic failures. The team would regularly come together to discuss problems and how best to combat them. On one occasion the power regulator to two of the thrusters had a power failure that required it to be replaced. The team came together and brainstormed a method to power the two thrusters with ports

on the main control board until the new parts could come in. This was then able to be implemented and the team was able to complete the day's tasks.

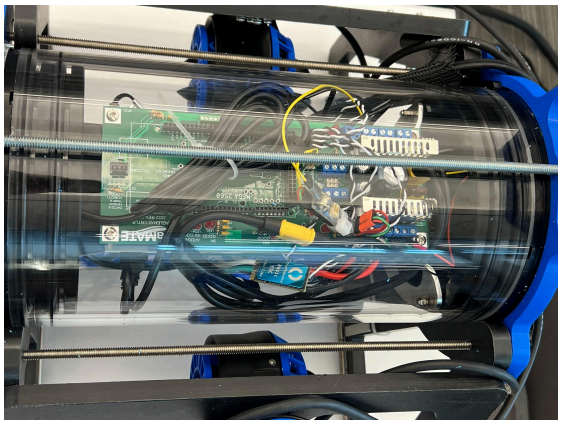
Vehicle Systems

Frame

The Frame of the ROV was made out of HDPE marine grade plastic sheet and 3D-printed parts. Most of the frame is Marine grade plastic which was chosen for its strength and because it is lightweight in the water. The Frame was machined in the Northeast State machining lab by some of the instructors there. The rest of the frame was 3D printed out of ABS. This was done for the parts that would have been difficult for the CNC to do with its current setup; the frame was then fitted together with bolts and three pieces of thread to hold it all together.

Electrical Systems

Electronics



Most of the electronics were housed in a 6in water tight enclosure and they consist of a control board, two power boards for the thrusters, and an Ethernet to USB converter. The control board has an Arduino Mega and the necessary ports for attaching the components to the Mega. In addition there are two voltage regulators, one 48V to 5V and one 48V to 12V. These were used to power the Arduino, claw, and the USB converter.

For SID See Appendix A

Controls

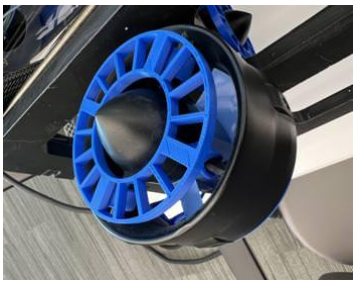
The ROV uses LabView 2021 with the code provided by MATE ROV. The included windows camera app is used for the USB camera mounted on the ROV. The webcam viewer provided by MATE may also be used. It is controlled by a Dell Precision 7680 laptop using an Xbox One controller hooked up to the computer using USB-C. The computer is then connected to the ROV by a USB cable which is converted to ethernet and then back to USB.

The ROV's tether is made up of one 48V power wire, one ethernet cable, and flotation. The tether is contained in a sheathing to protect it from damage and to keep the tether together. Strain relief was added on both ends to protect the connections from being damaged.

Tether

The ROV's tether is made up of one 48V power wire, one ethernet cable, and flotation. The tether is contained in a sheathing to protect it from damage and to keep the tether together. Strain relief was added on both ends to protect the connections from being damaged. The Fuse is 10 cm away from the connector.

Propulsion



For propulsion the team used four T200 thrusters from Blue Robotics. They are positioned in a way to allow the ROV to Complete the tasks at hand. Two thrusters are pointing forward and back, two more are facing up and down to allow stabilization for the ROV when maneuvering.

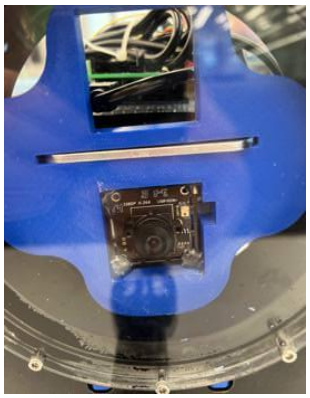
Buoyancy

Before adding anything the ROV was already positively buoyant. This was from the water-tight enclosure and utilizing a lightweight frame material. To get the ROV neutrally buoyant the team attached magnets to the bottom edge of the frame, they then were able to attach steel weights and where able to fine-tune the weight distribution. Then the team used zip ties to permanently attach the weights so they won't fall off in the pool.

Tools

Claw

To manipulate the props and complete the real-world tasks, the team chose a Newton Subsea Gripper from Blue Robotics. This was chosen for its high quality and ability to plug and play into the controls. The claw is mounted in the center of the frame to minimize the ROV becoming off balance when holding objects.



Camera

For visuals, the team used small USB cameras mounted in the waterproof canister. This allows the pilot to see the tasks and how best to complete them. The camera is displayed on the laptop at the surface.

Buy vs build

Due to the time crunch and the fact that most members are new to robotics and engineering, the team relied on funding from several grants to buy materials to lessen the time of the build and to overcome the challenge of lack of experience necessary to complete the ROV. For instance, the team bought a Newton Subsea Gripper instead of developing their own design for the claw in order to focus on other parts of the ROV.

Safety

We implemented many safety features for our robot. One of the main concerns was making sure that the electronics were safe to prevent shock to any of the members of our team or anyone else. We did this by constantly checking the tether, all of our electronics, and the power connections to the computer and the power cables. We performed a leak test before powering the robot on by placing it in the water, pulling it out and checking for leaks. We perform a pressurized test as well to check for any types of leaks. We use a 3-step process to power the robot on. We first make sure everyone is clear of the robot and not touching it. We then plug the robot into the power box and turn the first power switch on. Lastly, we turn the last power switch on to fully power on the robot. We 3D printed guards in order to cover all the propellers for the

robot to try and prevent hand and finger injuries. We have placed strain relief for the tether on the bottom and on the control box as well. We have covered all of the sharp edges on the robot by using 3D printed screw caps and tape. The plug is only 10cm from the cable to the control box.

Critical Analysis

Testing and Troubleshooting

The team purchased a small pool for testing the ROV. Northeast State allowed the team to set this pool up on campus which allowed the team to test the ROV in a time efficient manner. The team was able to run tests on the ROV and still be close enough to the workshop to run in and do repairs. When the team implemented a new design they would test whether it worked with the rest of the ROV before testing in the water and then after checking seals, they would do wet tests ensuring that the ROV would perform accurately.

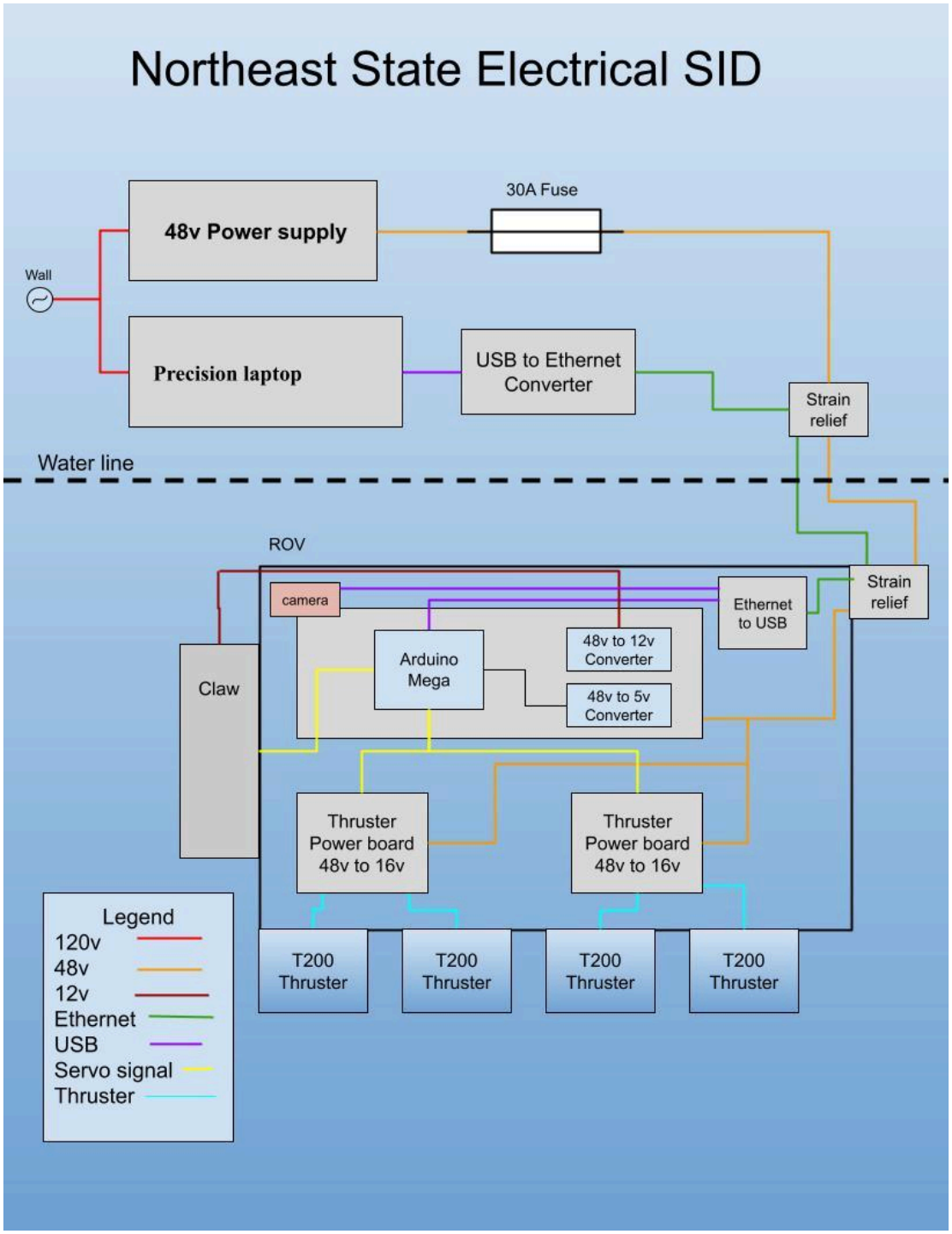
Accounting

Budget

For budget See Appendices

Appendices

Appendix A: System Integration Diagram



Appendix A: Budget

Northeast State Community College

Date	Type	Category	Description	Notes	Cost	Running Balance
12/5/2023	Donated Parts	Eagle Ray ROV Kit	48V Power Supply, Enclosure	Donated by MATE ROV	$ 2,355.18	$ 2,355.18
2/16/2024	Purchased	Hardware	PVC, Paint, Hooks, Bolts	Purchased from Lowes	$ 544.09	$ 2,899.27
2/20/2024	Purchased	Individual Components	Newton Subsea Gripper	Purchased from Blue Robotics	$ 640.00	$ 3,539.27
3/15/2024	Purchased	Filament	Blue ABS Filament	Purchased from Stratasys	$ 160.00	$ 3,699.27
3/27/2024	Purchased	Individual Components	USB Over Ethernet	Purchased from Amazon	$ 62.26	$ 3,761.53
4/3/2024	Purchased	Individual Components	Voltage Converter, O-Rings, Penetrators	Purchased from Blue Robotics	$ 46.50	$ 3,808.03
5/8/2024	Purchased	Individual Components	Capacitors	Purchased from Amazon	$ 9.13	$ 3,817.16
5/13/2024	Purchased	Individual Components	Replacement Capacitors	Purchased from Amazon	$ 29.32	$ 3,846.48
					Total Spent	$ 3,846.48
					Final Balance	$ 3,846.48