The Typewriter Repairmen

2023 National Underwater Robotics Challenge

Technical Report

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Tucson and Sierra Vista, AZ
Adult Team

selectric.org/nurc11

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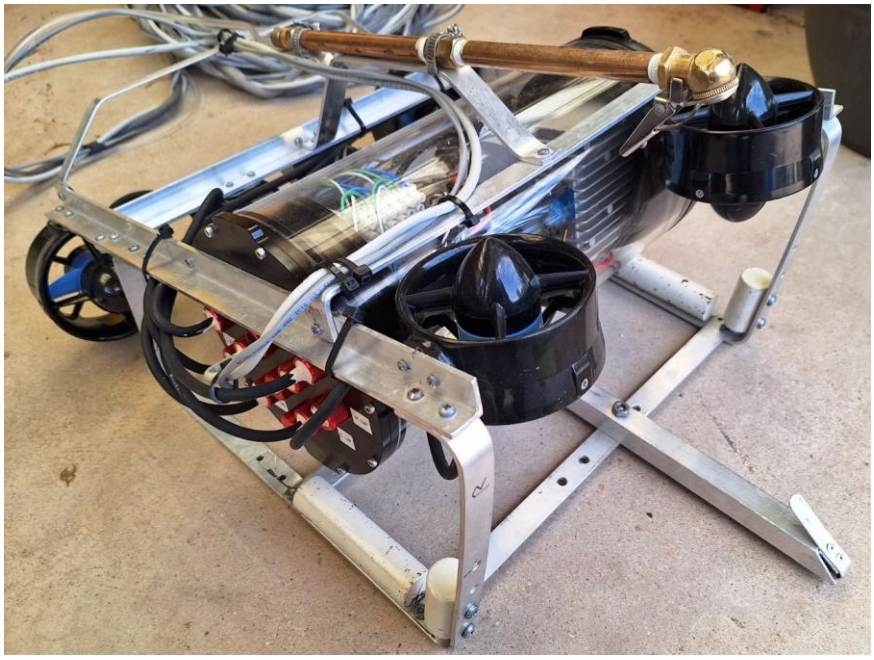

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Abstract

The Typewriter Repairmen is a family adult team. Several team members have vast experience in high school robotics, both with FIRST and NURC. This is the team's seventh year of competition in NURC.

The Typewriter Repairmen underwater robotics team has been revived after competing in NURC from 2009 through 2013, and again in 2019. The team was building a robot for 2020 competition, which was postponed. We are a family team, and compete for fun. In past years we made three ROVs, notBob, Babs, and Casper. The ROVs notBob and Babs used mostly fabricated parts. In 2019, we decided to build a new ROV, Casper, using mostly off the shelf technology. We purchased thrusters, control system parts, and a waterproof enclosure from Blue Robotics. We made our own frame and power distribution system. For 2020, we planned on expanding on that build but it was not completed due to the competition postponement. This year we are reviving Casper and completing its build. Our analysis of the mission led us to decide to build a robot that is highly maneuverable, with good all-around vision and lighting, and a simple static manipulator.

Team Goal

The Typewriter Repairmen is a family team. Our goal is to have fun and enjoy each other’s company while doing a very good job of completing the requirements of the NURC competition and sharing our experiences with the other teams.

Mission Analysis

We built a spreadsheet of the mission tasks, estimated execution time, and point rewards to create a ranked list of the reward/effort ratio for each task. Based on this spreadsheet, we have decided to attempt to perform all tasks in the mission, although we have not devoted much time to building special robot hardware for each task. We did have to modify the ROVs to accomplish some of the tasks. For example, the retrieval of the ruin fragments led us to develop a system to assist with buoyancy (addressed in the ROV section).

	Points	Max	Estimated completion time (min)	Percentage total points	Percetange total time	points/min
Illuminate Ruins		20	1	4	5	20
Activate illumination lever	20					
Retrieve Ruin Fragments		150	6	30	30	25
Remove 2 lbs fragment from starting location	10					
Recover 2 lbs fragment to surface	20					
Remove 5 lb fragment from starting location	10					
Recover 5 lbs fragment to surface	40					
Remove 10 lbs fragment from starting location	10					
Recover 10 lbs fragment to surface	60					
Measure Distance to Ruin Fragments		50	1	10	5	50
Measure distance from Ruins to fragment	50					
Find Access Code		20	1	4	5	20
Open chest and revel access code	20					
Enter access code and enter Ruins		30	2	6	10	15
Enter access code	20					
Enter Ruins through entryway	10					
Read accient text from Ruin library		60	3	12	15	20
Activate lever to revel text	20					
Activate lever to revel text	20					
Activate lever to revel text	20					
Measure pressure in Relic chamber		50	2	10	10	25
Measure pressure in Relic chamber	50					
Retrieve Atlantean Relic		80	3	16	15	26.67
Remove Relic from pedestal	20					
Recover Relic to surface	60					
Escape Ruins Collapse		40	1	8	5	40
Escape Ruins before collapse	40					
Totals		500	20	100	100	

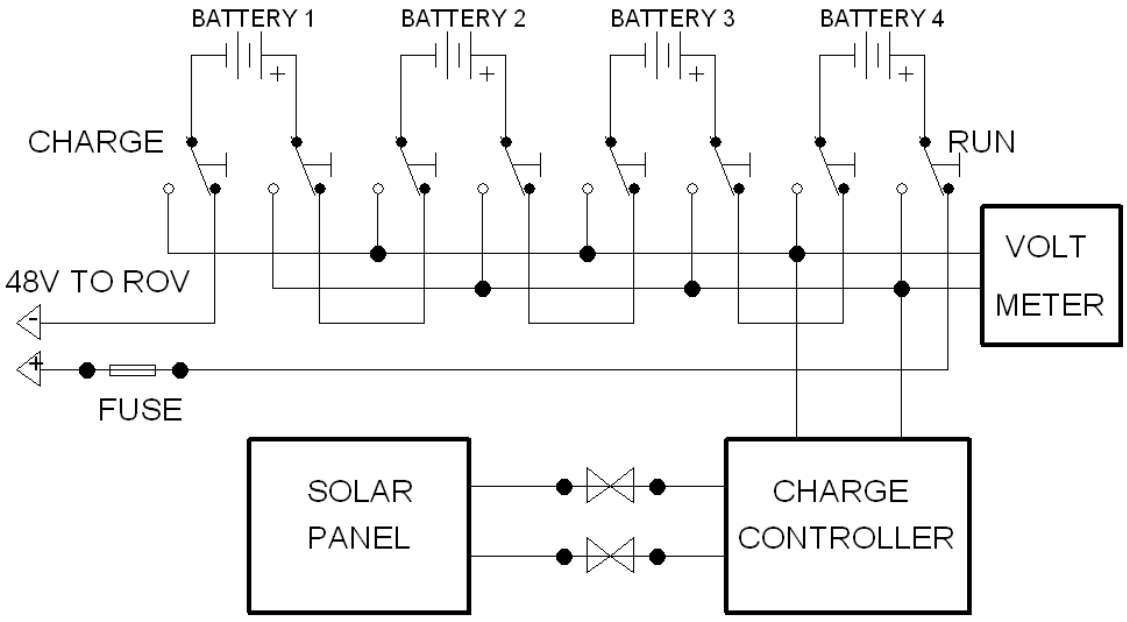
ROV System

Casper, our 2019 ROV, is being updated for this competition. Casper was built primarily from commercially available components. However, we were not satisfied with its operation and decided in 2020 to work on finalizing and updating its capabilities. Since the update was not completed due to the competition postponement, we are finishing the update for the 2023 NURC.

The main problems with the ROV were with the control and vision systems. Since the control system included a computer running a commercial operating system, and worked over a network, it had unacceptable latency. We decided to go to a control system more like what we made for Babs. The new vision system is a high definition analog camera connected through a converter to an HDMI display. The new control system uses the shore control from Babs, called the Rovotron. It uses a new onboard system on the ROV, consisting of a Teensy microcontroller, programmed to emulate the PIC based system in Babs.

One of the most challenging tasks for the 2023 NURC, is retrieving the 2, 5 and 10 lb artifacts and bringing them to the surface. We are planning to use an inflatable lifting bag, to aid Casper in lifting these objects. An inner tube for a small tire will be strapped on to the top of the ROV, and after securing the weight with the manipulator, we will run a shore mounted compressor, which will inflate the inner tube, through a hose on the tether.

Battery Charging. Our post use of solar charging for our ROV batteries has worked well. No changes are being made to this part of our system. Our 48V battery box was allows storage of the controller, transmitter and associated cables inside the box. The battery box has four 12V 7AH lead-acid batteries, and a set of four center-off toggle switches to enable solar charging in parallel and ROV operation in series. The box also includes a digital panel voltmeter, to monitor charging voltage, and allow quick checks of the voltage of each battery.



Testing

The 2023 mission requires the ROV to retrieve fragments from the sea floor and bring them to the surface. Lifting the heavy fragments required a new capability. We tested the use of a balloon to assist Casper in lifting the fragments to the surface. With a small inter tube attached to Casper, we were able to lift hook the weight with Casper's arm and then inflate the inter tube. This worked for retrieving a 5 lb weight from the bottom of a pool. Since the concept worked, we decided to proceed with this concept for the build.

New skills

New skills for this ROV include the incorporation of the Teensy Arduino compatible microcontroller into the control system and the use of pneumatics to inflate the inner tube for artifact retrieval.

Acknowledgements

We would like to thank Si Se Puede Foundation, and the judges and other volunteers, for their hard work in putting on this competition.

Bill of Materials

Casper had already been partially built for the 2020 competition. The estimated cost of that build was $2,168.65. Additional costs were expended to update Casper. These costs totaled $294.76, making Casper's cost for the 2023 NURC a total of $2,463.41.

Casper 2023 Modification Costs

Source	Part description	Unit Cost	Quantity	Total Cost
pjrc.com	Teensy 4.1 Development Board	31.50	1	31.50

usbfirewire.com	USB connector	14.85	1	14.85
adafruit	distance sensor	14.95	1	14.95
Lowe's	20 ft 1/4" PVC Tubing	11.96	2	23.92
Lowe's	Brass Barb Fitting	8.96	2	17,92
Lowe's	Brass 1/4 NPT Adapter	6.18	1	6.18
Harbor Freight	Inner Tube 13"	5.99	2	11.98
Harbor Freight	Tire Chuck	4.47	1	4.47
ebay	HDMI Video Converter	59.99	1	59.99
Bluecctv	TVI HD Camera	109.00	1	109.00
Total				**$294.76**

Casper 2019 Original Costs

Source	**Part description**	**Unit Cost**	**Quantity**	**Total Cost**
External Parts				
Blue Robotics	T100 Thruster T100-THRUSTER-R1-RP	119.00	6	714.00
Blue Robotics	Basic ESC BRDC30-R3	25.00	6	150.00
Blue Robotics	Newton Subsea Gripper NEWTON-GRIPPER-ASM-R1-RP	329.00	1	329.00
Ace Hardware	Angle 1/8x3/4x8 Alum 51420	16.99	1	16.99
Ace Hardware	Bar Flat 1/8x3/4x4 Alum 5117973	5.99	3	17.97
Lowe's	MD 3/8-IN x 20-FT Backer 41298	3.46	3	10.38
Lowe's	1/16-IN x 1/-1/2-IN x F-F 215753	15.99	1	15.99
Lowe's	1/16 x 1-8 Alum Angle 8-B2 55970	14.48	1	14.48
Lowe's	3/8-IN MIP x 1/8-IN FIP B 877200	3.88	1	3.88
Walmart	Game pad controller 61788501135	14.96	1	14.96
NEWEGG	100FT Gray CAT5E UTP Patch Cable STA-45PATCH100GR	17.15	1	17.15
valuebuybattery	USB to LAN adapter USB3.0-LAN	8.59	1	8.59
		Subtotal		$1,304.80
SCULL				
Blue Robotics	Bar 30 High resolution 300m Depth Sensor	86.00	1	86.00

	BAR30-SENSOR-R1-RP			
Blue Robotics	M10 Cable Penetrator for 6mm Cable PENETRATOR-M-BOLT-6MM-10-25-R2-RP	4.00	7	28.00
Blue Robotics	Micro-USB to USB-A Cable MISC-CAB-USB-MICRO-STRAIGHT-6IN-R1	8.00	2	16.00
Blue Robotics	Potting kit (x 10) TOOL-POTTING-KIT-R1-RP	10.00	1	10.00
Blue Robotics	Camera Tilt System CAMTILT-ASM-R2-RP	29.00	1	29.00
Blue Robotics	Loctite Marine Epoxy LOCTITE-MARINE-EPOXY	6.00	2	12.00
Blue Robotics	Aluminum End Cap (6" Series) WTE6-M-END-CAP-R1-RP	34.00	2	68.00
Blue Robotics	Cast Acryllic Tube - 11/75" x 6" WTE6-P-TUBE-12-R1-RP	90.00	1	90.00
Blue Robotics	Pixhawk PIXHAWK-R1-RP	120.00	1	120.00
McMaster Carr	Aluminum Sheet 0.060" x 12" x 12" 88895K101	7.69	1	7.69
adafruit	Raspberry Pi 3055	35.00	1	35.00
spinel	Camera UC20MPG_L36	6.99	1	6.99
Blue Robotics	O-Ring Flange (6" Series) WTE6-M-FLANGE-SEAL-R1-RP	59.00	2	118.00
Blue Robotics	Enclosure Vent and Plug VENT-ASM-R3-RP	8.00	1	8.00
Blue Robotics	M10 Cable Penetrator Blank (No Hole) PENETRAOR-M-BLANK-10-25-R3-RP	4.00	3	12.00
		Subtotal		$646.68
Power System				
DigiKey	Jumper Barrier BLK 2POS SPADE WM9711-ND	.27	4	1.08
DigiKey	Conn Barrier Strip 6CIRC 0.375" WM5763-	4.70	2	9.40

	ND			
daygreen	48vDC-12vDC Converter B30-3648-12A	32.00	1	32.00
DigiKey	Conn Term Strip 12CIRC 0.315" WM16251-ND	4.52	2	9.04
monoprice	USB Car Charger 14160	6.99	1	6.99
Griffin	USB Car Charger GC-23089-2	9.99	1	9.99
Shumacher	Battery Charger XC60CA	28.95	1	28.95
DigiKey	Cable 2COND 16AWG Gray 100' BEL1266-100-ND	39.73	1	39.73
Direct Voltage	10W LED + 10W Driver Set of 5 252534941464	21.99	1	21.99
Expert Battery	Battery, 12V 8Ah SLA (4 pack) Q04BLMFM12_8	58.00	1	58.00
		Subtotal		$217.17
Total Original Cost				$2,168.65

References

Technical Report, 2009 NURC ROV: notBob, The Typewriter Repairmen

Technical Report, 2010 NURC ROV: Babs, The Typewriter Repairmen

Technical Report, 2019 NURC ROV: Casper, The Typewriter Repairmen