Technical Design Report Instructions

2020 RoboSub *www.robosub.org*

Paper Preparation Overview:

The format of the written paper shall adhere to the following guidelines:

- **5 page limit (excluding References and Appendices)**
- 8.5 x 11 in. page size
- Margins ≥ 0.8 in.
- Font: Times New Roman 12pt
- Header on every page including team name and page number
- Submitted in pdf format

Access all past competitor's papers at **robosub.org/past-programs** by clicking on the desired past year and scrolling to the Team list area.

Paper Contents:

The written paper consists of **six mandatory Sections and two mandatory Appendices**. Additional sections may be included; however, the overall limit of 5 pages applies (excluding References and Appendices). The editorial style for IEEE Transactions should be followed: https://www.ieee.org/conferences_events/conferences/publishing/style_references_manual.pdf.

The two column format is optional. If you wish to refine the use of English in your paper (encouraged), please collaborate with colleagues at your institution or on the event forum. Professional editing services are also available: https://secure.aje.com/en/default/submitb/select.

1. Abstract

The written paper should primarily describe how your overall competition strategy drove the design for autonomy and the associated system engineering. The abstract is a summary of the main points in the paper. Be specific about your vehicle's capabilities for autonomous underwater behavior and your creativity in system engineering.

2. Competition Strategy

This section should discuss how the team plans on maximizing its score by accomplishing a set of specific tasks and how the vehicle design supports this goal. **Enter your expectations in the Scoring Table, Appendix A.** Accomplishing all of the tasks requires a complex vehicle; accomplishing a subset of the tasks simplifies the design. In your project, did complexity compromise reliability? How were complexity and reliability assessed? Teams have a limited number of working hours to prepare for the competition; this time can be spent adding new hardware and software and/or testing and improving the reliability of an integrated system. How did you manage (balance) component development, system integration and in-water testing time?

3. Vehicle Design (Novel Aspects)

This section should describe the high-level vehicle design as a system (e.g., mechanical, electrical, and software). **Unique and creative elements of the design and approach should be highlighted.** Do **not** include detailed component descriptions and/or specifications not of original design. List off-the shelf components in Appendix B. For underwater autonomy, many creative elements will be software-related. How can you best communicate your innovative algorithms for vehicle navigation, perception, and control?

4. Experimental Results

This section should briefly describe how the team accomplished testing (*e.g.,* in-water, on the bench, in simulation) and provide an indication of how much testing has occurred and is planned. Discuss any studies, calculations, or estimates that the team has performed in the areas of reliability and robustness (e.g., failure analysis, reliability modeling, risk assessment, etc.). In testing, both failures and successes are valuable in developing a high-performance system. **Both time in-situ and lessons learned should be documented here.**

5. Acknowledgements

Fielding a vehicle in the competition, as in all research projects, involves marshalling resources and support beyond the efforts of the individual team members. Acknowledging such support is professional best practice and should be as comprehensive as possible.

6. References

As with any technical publication, original ideas and content that are not generated by the paper's authors should be properly cited. While there are many reference styles, the submitted paper should use the IEEE transactions citation template: http://www.ieee.org/web/publications/authors/transjnl/index.html.

Appendix A: Expectations

Below is the scoring table showing the points associated with each task. Enter the points you **expect to score** with the vehicle(s) that you have designed and engineered. At the end of the competition, enter the points you **actually scored** in the last column.

Subjective Measures			
	Maximum Points	Expected Points	Points Scored
Utility of team website	50		
Technical Merit (from journal paper)	150		
Written Style (from journal paper)	50		
Capability for Autonomous Behavior (static judging)	100		
Creativity in System Design (static judging)	100		
Team Uniform (static judging)	10		
Team Video	50		
Pre-Qualifying Video	100		
Discretionary points (static judging)	40		
Total	650		
Performance Measures			
	Maximum Points		
Weight	See Table 1 / Vehicle		
Marker/Torpedo over weight or size by <10%	minus 500 / marker		
Gate: Pass through	100		
Gate: Maintain fixed heading	150		
Gate: Coin Flip	300		
Gate: Pass through 60% section	200		
Gate: Pass through 40% section	400		
Gate: Style	+100 (8x max)		
Collect Pickup: Crucifix, Garlic	400 / object		
Follow the "Path" (2 total)	100 / segment		
Slay Vampires: Any, Called	300, 600		
Drop Garlic: Open, Closed	700, 1000 / marker (2 + pickup)		
Drop Garlic: Move Arm	400		
Stake through Heart: Open Oval, Cover Oval, Sm Heart	800, 1000, 1200 / torpedo (max 2)		
Stake through Heart: Move lever	400		
Stake through Heart: Bonus - Cover Oval, Sm Heart	500		
Expose to Sunlight: Surface in Area	1000		
Expose to Sunlight: Surface with object	400 / object		
Expose to Sunlight: Open coffin	400		
Expose to Sunlight: Drop Pickup	200 / object (Crucifix only)		
Random Pinger first task	500		
Random Pinger second task	1500		
Inter-vehicle Communication	1000		
Finish the mission with T minutes (whole + factional)	Tx100		

Appendix B: Component Specifications

In the past, a detailed list of components constituted the bulk of many paper submissions. This practice is discouraged as it distracts from the underlying strategic thinking, system engineering decisions, or novel contributions. For the record, teams should list the components actually used in the vehicle in the table below.

Component	Vendor	Model /Type	Specs	Cost (if new)
Buoyancy Control				
Frame				
Waterproof Housing				
Waterproof Connectors				
Thrusters				
Motor Control				
High Level Control				
Actuators				
Propellers				
Battery				
Converter				
Regulator				
CPU				
Internal Comm Network				
External Comm Innterface				
Programming Language 1				
Programming Language 2				
Compass				
Inertial Measurment Unit (IMU)				
Doppler Velocity Log (DVL)				
Camera(s)				
Hydrophones				
Manipulator				
Algorithms: vision				
Algorithms: acoustics				
Algorithms: localization and mapping				
Algorithms: autonomy				
Open source software				
Team size (number of people)				
HW/SW expertise ratio				
Testing time: simulation				
Testing time: in-water				

Appendix C: Outreach Activities (optional)

A foundational purpose of RoboSub is to strengthen and enhance the community. Teams are encouraged to participate in educational outreach activities. The static judging score includes extra points for educational outreach.