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Research Article

Robot competition for underwater technology researchers and students

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ABSTRACT

To promote the research of oceanic engineering technology, an underwater robot competition has been held since 2016. The seventh competition this year consists of AUV leagues, in which vehicles developed by university teams automatically cruise in the field, and junior leagues that participate in making underwater craft. This paper presents the competition regulations for the AUV and junior leagues and the results of the competition held in October 2019..

1. Introduction

To advance underwater technology, the non-profit organization Japan Underwater Robot Network regularly organizes three annual competitions: the Underwater Robot Convention, Underwater Robotics Competition, and Underwater Robot Festival. To focus on creating new technology, the Underwater Robot Convention consists of free-style leagues with original vehicles and an AI challenge league with vehicles implementing front-line learning algorithms. The purpose of the Underwater Robotics Competition is to improve practical underwater technology in which the competition takes place in the ocean. Finally, the objective of the Underwater Robot Festival is to spread the concept of underwater technology and inspire an increase in underwater research.

he Center for Socio-Robotic Synthesis of the Kyushu Institute of Technology often hosts various tournaments such as the Tomato Harvesting Robot Competition [1], [2]. In October 2019, the center also co-hosted the 7th Underwater Robot Festival with the Japan Underwater Robot Network where AUV and junior leagues participated in the competition. This paper explains the regulations for the AUV and junior leagues and describes the details of the competition that was held at the Aso Sports Center in Kitakyushu on October 19th and 20th.

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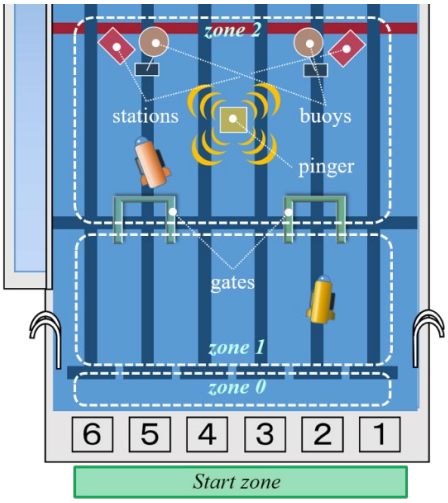

Fig. 1. Competition field for the AUV league

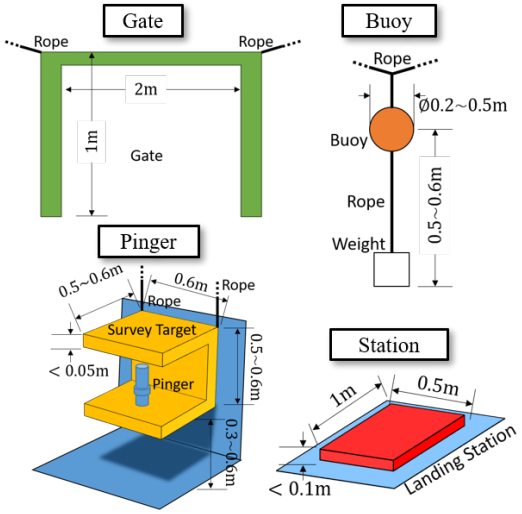

Fig. 2. Field items for the AUV league

2. Outline of the competition

2.1. *Committee members*

The committee members of the competition consisted of professors from the university near Kitakyushu with Associate Prof. Nishida from the Kyushu Institute of Technology, the hosting university, as the executive chairman. The AUV league was managed by Associate Prof. Sato from the Nagasaki Institute of Applied Science and Associate Prof. Sonoda from the Nishinippon Institute of Technology. The regulations for the leagues were defined by the executive committee based on last year's regulations. Associate Prof. Matsuo from the National Institute of Technology and Associate Prof. Takemura from the Nishinippon Institute of Technology managed the junior league and created the USV (Unmanned Surface Vehicle) platform for this league and prepared the lecture. Associate Prof. Yasukaw from the Kyushu Institute of Technology created the home page for the competition.

2.2. *AUV league regulations*

Participants of the AUV event developed AUVs for the competition of the AUV league, of which the qualifier was judged based on three evaluations that include presentation (40 points total), wet test (430 points total), and deployment technology (30 points total). In the presentation assessment, university professors evaluated the participants' presentation with regard to stance, speaking skills, explicitness, technology, ability to answer the questions, and presentation time.

The wet test evaluation was performed in the field as shown in Fig. 1, and the items that are shown in Fig. 2 were used to judge the AUV functions and technologies. The participants were required to prepare the AUV within five minutes after which the AUV had to perform six underwater missions in ten minutes. In the first mission, called Gate Pass, the AUV was required to pass the green gate (max. 20 points) and then touch an orange ball for the second mission, called Buoy Touch (max. 80 points). In the third mission, called Station Landing, the AUV was required to descend to the bottom where there was a red station located near the buoy (max. 200 points) and then drop a marker on the station for the Drop Mission (max. 20 points). After, the AUV had to search for and touch the pinger in the yellow box (max. 100 points) in the Pinger Investigation mission and then return to the starting point through the gate in the Return Back mission (max. 10 points).

The deployment technology evaluation assessed the deployment method, which is the most important aspect of the actual AUV evaluation. When the AUV is placed in the water using a developed deploy device without diver support, the team obtains points associated with the deployment technology aspect. However, even with a successful AUV deployment, if an error occurred during the competition or the deployment method was a hazard, 100 points were deducted from the score of the team.

2.3. *Junior league regulations*

To acquire the basic knowledge and techniques required for the development of an underwater vehicle, the university professors in the committee gave lectures on

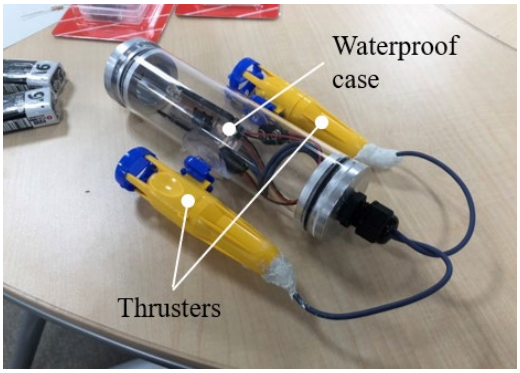

Fig. 3. Waterproof platform for the junior league


Fig. 4. Presentation evaluation for the AUV league

mechanics and electrical circuit and programing to the junior league participants. All teaching aids and tools for the lectures were provided by the committee, and teaching assistants from the university diligently supported the lectures. After all the lectures, the participants installed floaters and fins on the waterproof platform shown in Fig. 3 to build the surface vehicle. The platform has two thrusters for the heading and surge controls and a microcomputer with a wireless module to enable the remote control of the thrusters, for which its remote programming was developed by the participants based on the knowledge obtained in the lectures. The participants competed to navigate the surface vehicle and avoid obstacles.

3. Competition results

3.1. *Competition participants*

Six university teams for the AUV league, 14 teams for the junior league, and 40 people for the tour of the tournament joined the competition with 15 staff members in addition to the committee members who managed the competition. A total of 130 people, which has been the largest number of people in the last few years, came to the competition venue, making it full and lively. In addition, usually, the same university teams take part in the AUV league every year due to the high costs associated with developing an AUV to participate in the AUV league. However, this year, new teams such as those representing the Hiroshima Institute of Technology and Osaka Prefecture University were present. The same schools for the junior league participated as usual, but many teams entered the competition and attended the lectures enthusiastically.

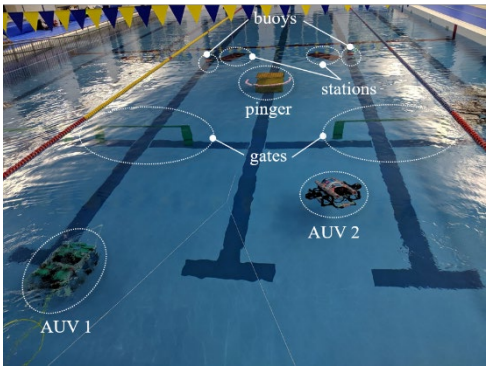

Fig. 5. AUVs that cruised in the competition field

3.2. *AUV league results*

Last year, teams played a round-robin tournament with a few qualifying participant teams. In the 7th competition, the qualifying teams were separated into two leagues and the final tournament was a round-robin tournament that consisted of the top four teams of last year with six participant teams. The methods that were applied for the wet test evaluation, which were all diverse and reflected the improvements in underwater robot technology, were explained by each team, as shown in Fig. 4, in addition to describing their original AUV technology and wet test strategy. The presenters were not able to answer the questions from the judges in some cases, but most presenters thoroughly presented their projects to the audience with the aid of their vehicle and movies. In the wet test evaluation, the AUVs of all teams cruised in the competition field, as shown in Fig. 5, where each team competed fiercely. Because only students are involved in improving the programming and the AUV system without the help of researchers and professors, each year in the past, the AUVs often encountered various problems. This year, however, most of the teams fine-tuned their AUVs for the competition without any problems. After all the evaluations, the winning team of

Fig. 6. The participants in the junior league during the lectures

the AUV league was from the Hiroshima Institute of Technology who developed a stable AUV rather than a high-tech AUV. The team from Kyushu Polytechnic College won second place and the teams from the University of Tokyo and the Tokyo Institute of Technology won third place.

3.3. *Junior league results*

Most of the participating students in the junior league were not used to building robots and there were problems such as electronic component failure, thruster failure, and surface vehicle damage. However, all teams enjoyed making the surface vehicle and were able to complete the vehicle with the help of the professors and the assistant staff, as shown in Fig. 6. Because the professors lectured on the principles of waterproof structures and the operational aspects of a surface vehicle, the vehicles of all teams were able to cruise on the water surface without encountering water leakages. After the lectures, the students actively participated in the competition with their vehicles, fine-tuning them each in their own way, as shown in Fig. 7. The champion of the junior league competition held on the last day was the team from the National Institute of Technology, Kitakyushu College and the teams from Jyoto High School won second and third place.

Fig. 7. Vehicle fine-tuning by the participants

4. Conclusions

Although it was challenging to arrange for a venue in which the competition could be held even in rainy weather, the Underwater Robot Festival was safely and successfully held thanks to the generous cooperation of Kitakyushu City and the facility staff. With the active support of the committee members and assistant staff, the competition was smoothly organized and all participants of the AUV and junior leagues enjoyed the competition. We were able to gather many participants through the help of the committee members; however, there were few spectators who observed the competition. Therefore, to bring together more spectators for the next year, glamorous events will be added to the competition.

Acknowledgments

This year, the Underwater Robot Festival was hosted by the Center for Socio-Robotic Synthesis, Kyushu Institute of Technology, Japan Underwater Robot Network, Japan Society of Naval Architects and Ocean Engineers, IEEE/OES Japan Chapter, Marine Technology Society Japan Section, and Techno-Ocean Network. Kitakyushu city and the Kitakyushu Convention & Visitors Association supported the competition. The staff from Aso Sports Center in Kitakyushu also cooperated in the competition. The authors would like to express deep gratitude to all of the above.

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