9th Annual International RoboBoat Competition

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1. Abstract

TEAM P.O.S was born in this march. Team P.O.S is a kind of initial that means Pioneer Of the Sea. Our team members are interested in Unmanned Autonomous Navigation System. Also, Our professor suggested RoboBoat as a good competition for us. After that, we found a lot of information about RoboBoat Competition in online. That information helped us decide to apply for the competition. This is our second participation in RoboBoat. But, Our members have never made a ship that type of Unmanned Autonomous Surface Vehicle (ASV) before. Also, we only consist of undergraduate students, so we have a lack of ability at understanding about some of tasks in rules. In the future, we will study a lot about that and focus on how to organize the systems. In our vehicle, We use Labview from National Instrument(NI) for programming. Labview is a more convenient program compare to other programs. Because it is not a text base program but a graphic base program. Graphic base is easily accessible and observable to entire system. we will improve our programming code to find our best method continuously for RoboBoat.

2. Composition of unmanned autonomous Surface Vehicle system

GPS collects information of current position and delivers information to computer. Sensor observes a forward obstacle , and calculates the distance and angle between the obstacle and the vehicle. Vision camera recognizes shapes and color patterns. After Arrangement of these information, Labview navigates the proper path. And then cRIO which connects motors and computer gives voltage to motors. When we have to control directly , we control the vehicle by using remote controller which is linked with laptop via RF.

Table 1 shows our vehicle's principal dimensions.

Beam	1.4m
Overall hull length	1.57m
Payload	39kg
Full load displacement	
Draft	

Table 1 principal dimensions of vehicle

3. Equipment of maritime unmanned autonomous system.

1) Frame (aluminium profile) and Boat

Figure 1 main frame and boat

Figure 1 shows main frame and boat. Our frame consists of aluminium. The reasons that we chose aluminium profile are economical , solid , easily constructible and light. Especially , easily constructible is most important. Aluminium profiles can make many structures by fixing profiles and brackets. This system is easy to assemble and separate. So we can carry easily and modify structure after researching. Also, we made a catamaran. It has a good stability and floatability.

2) Propeller

Figure 2 Motor

Figure 2 shows the propeller KZ12-K Its weight is about 3KG, and current thrust is 12KG. It's dimension of blades is 110mm each.

3) cRio

Figure 3 cRio

Figure 3 shows cRio from National Instrument. It is one of the best important parts in our system. It receives information of Lidar and GPS as well as RF controller.
Also, it transmits signal of computer to motor in auto mode and signal of RF controller to motor in manual mode.

4) Vision Camera

Figure 4 shows acA2000-50gc from Basler. This device is used for the color and pattern recognition. It has 50 fps, 2046x1086 pixels and uses Gigabit interface.

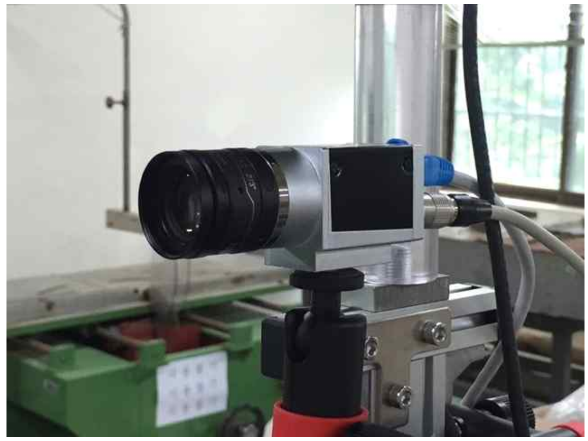

Figure 4 Vision camera

5) GPS

Figure 5 GPS

Figure 5 shows GPS VS330 from Hemisphere. This receives the signals through the two antennas. An error range of this is 0.7 meters but we found it is around 1 meters from the test.

6) Lidar

Figure 6 Lidar IS16

Figure 6 shows Sensor IS16 from LeddarTech. This device is used for the obstacle detection. It divides 45 degrees into 16 segments. The detection range of this is 50 meters maximum and this is water-proof.

7) Controller

Figure 7 Controller

Figure 7 shows the controller from FUTABA. This device is used for manual control of USV and is of wireless type. We changed the TCP type into the RF type because it is more suitable for the competition because of distance. TCP type's maximum distance for Internet is 100 m, but RF type is 4km so it can get the signal from the controller at far distance

4. Development of maritime unmanned autonomous navigation system

We have developed a maritime autonomous navigation system with Graphic User Interface using LabVIEW for our USV. Our program are devided by 5 Virtual Instrument(VI). GPS part , Sensor part , Task part and Main part.

1) GPS part

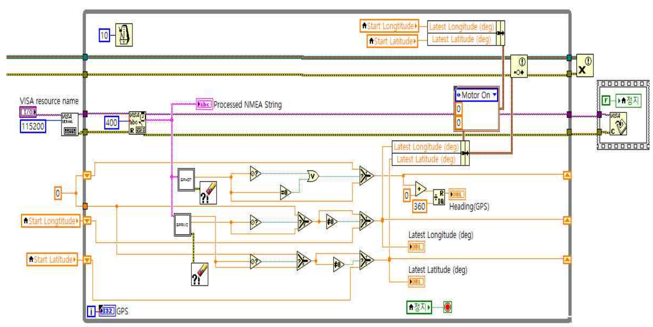

Figure 8 GPS part VI

Figure 8 shows GPS part VI. Location informations (longitude , latitude and heading) that GPS determines in real-time classify each data can use other VI. It hands the information to main VI.

2) Sensor part

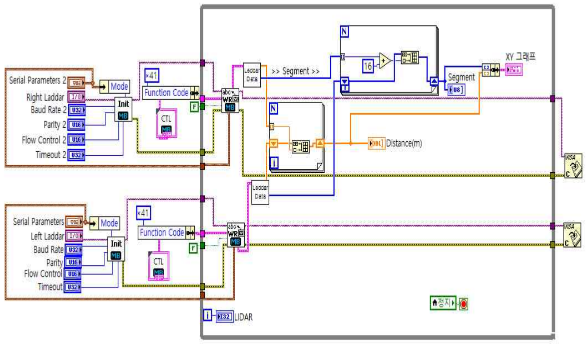

Figure 9 sensor part VI

Figure 9 shows sensor part VI. In this part, sensor recognizes forward obstacles and calculate the distance and angle between the obstacle and the vehicle. It also hands the information to main VI.

3) TASK part

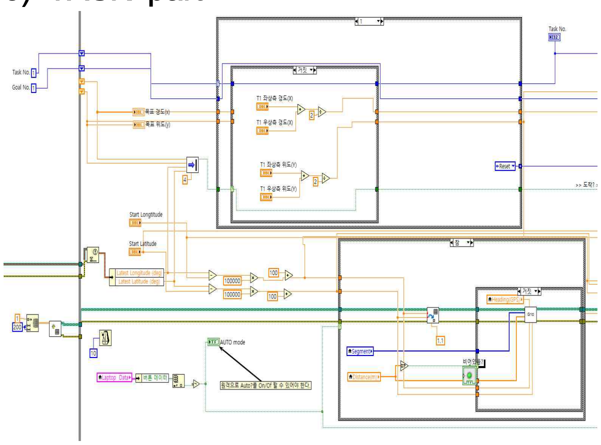

Figure 10 TASK part VI

Figure 10 shows TASK part VI. Each case has information of each task. So Each task control the motor suitably.

4) MAIN part

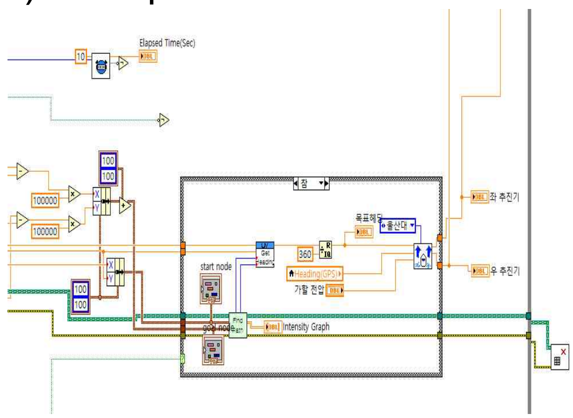

Figure 11 Main part VI.

Figure 11 shows Main part VI. This VI collects all of data about location and obstacle in the path. And then find the proper path and avoid obstacles.

5. ASTAR

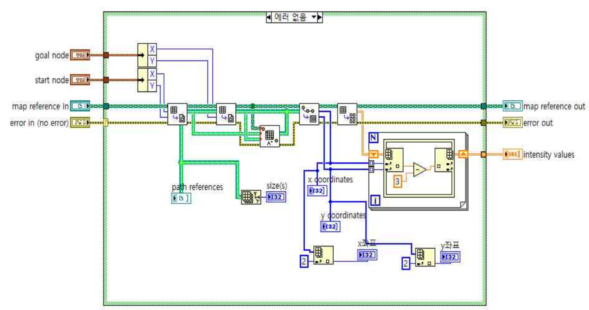

Figure 12 Astar Find Path VI

Figure 12 shows Astar Find Path VI in main part. This VI finds the proper path. It shows the path in grid like Figure 13. In the grid, black cell means obstacle and white cell means available area. When we select the start and goal of GPS location, VI a

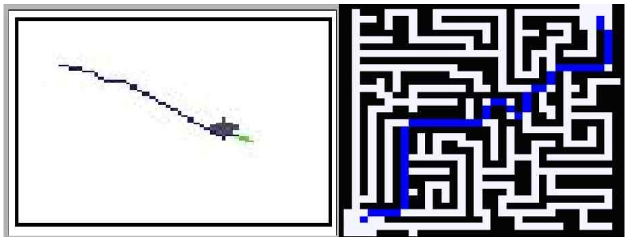

Figure 13 Result of Finding path.

blue line between points. And when sensor recognizes the obstacle, area of obstacle changes to black cell. And then, VI corrects and finds the proper path again.

6. TEST

This test is performed to develop the autonomous navigation system. The main purpose of the test is to make the vessel avoid the obstacle and arrive to the target position accurately. The tests were carried out both in the Ocean Engineering Wide Tank, UOU and in the Doohyun Water Reservoir near university.

1) Indoor test

Figure 14 Ocean Engineering Wide Tank

Before carrying out outdoor test, we pretest about proper structure shape and TCP/IP control and propel in still water. But in place we can't use the GPS , so we determine to test outdoor.

2) Outdoor test (ground)

Figure 15 Playground in UOU

Before testing in reservoir , we have to check the labview with GPS system because our programs are not safe and exact. So we determine to test in wide playground (in figure 15) with wheel table. we install the equipment on a wheel table and push to the way that propeller lead. In this process, we found some of problem in our program and after fixing we leave for reservoir.

3) Outdoor test (reservoir)

Figure 16 Doohyun Water Reservoir near UOU

After ground test , We decided to test outdoors. At first, We just tested a straight path. At that time, we found some errors in our vehicle. And then we revised it. After this test , we tested other task such as docking and recognizing color or shapes. But, this place was not good for the test because there were lots of trash in the water so when we tested something, we couldn't use our propeller's thrust efficiently.

7. Collaboration

When we programmed the system coding, application engineers of National Instruments Corporation supported us. Also we didn’t have our specific roles in coding and studied together while developing the system.

8. Conclusions

From test results we get few problems. At first , our boat has excellent loading capacity but that are seriously affected by water wave and weather. So we make a decision that focus on the shape of ships next time. Secondly , we recognize that we are inexperienced handling skill of programing. For example, we use Astar find path VI, a cell has huge area in reality , so program realized that a small obstacle is big. But we spend a lot of time to solve this problem. So we think that we will learn and share with other teams and the persons in this competition for future of Unmanned Autonomous Surface Vehicle Systems.

9. Acknowledgements

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