Unmanned Autonomous Navigation System : UANS

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Abstract

This journal describes design of the Unmanned Autonomous Navigation System of UOU, UANS. UANS is built to participate in the International RoboBoat Competition hosted by AUVSI and ONR. Technical approaches of various aspects of UANS are illustrated in this journal including hardware specification, environment sensing, experiment.

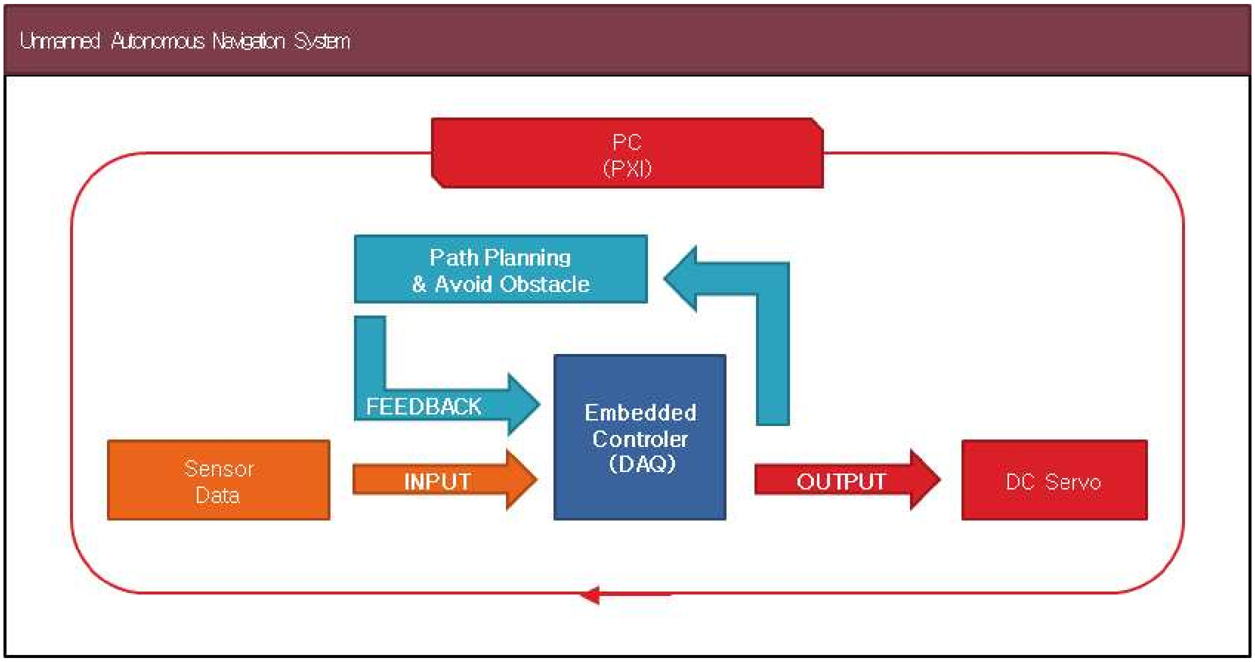
Introduction

UANS is an autonomous surface vehicle designed by ASV team CLEVIC at the University of Ulsan. Just like other participants in RoboBoat competition, UANS is built on rubber boat. Propulsion system, Sensor interface and a number of algorithms were designed by CLEVIC for successful operation of UANS in RoboBoat competition. Position and Attitude of MACS is measured by GPS and Lidar sensors.

By synthesizing informations from each sensors, UANS makes decisions about her future motion. Our goal is to make a suitable integration of informations from different sensors and structured environment, in order to make a safe and successful operation of UANS in the competition environment.

Composition of unmanned autonomous Surface Vehicle system

GPS collect information of current position and deliver information to computer. Sensor observes a forward obstacle , and calculate the distance and angle between the obstacle and the vehicle. After Arrangement of these information, Labview navigate the proper path. And then DAQ which connect motors and computer give voltage to motors. When we have to control directly , we control the vehicle by using remote controller



which is linked with laptop via TCP. Table 1 shows our vehicle's principal dimensions.

Beam	1.3m
Overall hull length	1.57m
Payload	68kg
Full load displacement	
Draft	0.

Table 1 principal dimensions of vehicle

Equipment of maritme unmanned autonomous system

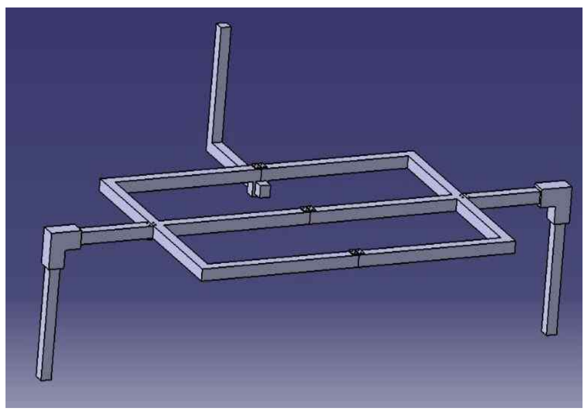


Figure 1 main flame

Figure 1 shows main flame. This frame is made 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.

Figure 2 Boat

Figure 2 shows the boat ATLANTIS. Thickness is 0.41mm and longitudinal and width length meters are 157 X 90. It's permitted payload is 68kg.

Figure 3 Motor

Figure 3 shows the motor A2208 KV1400. Its max efficiency is 80% and current capacity is 12A/60s. It's
dimensions are Φ27.8 x 23mm and shaft diameter is Φ3.17mm.

Figure 4 DAQ

Figure 4 shows DAQ from national instrument. DAQ play a role as a bridge between computer and motor. It give voltage to motor.

Figure 5 Vision camera

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.

Figure 6 Lidar

Figure 7 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.

Figure 7 Controller

Figure 8 shows the controller from Xbox. This device is used for manual control of USV and is of wireless type. We changed the wireless type into the USB type because the receiver of the wireless type couldnt get the signal from the controller at far distance

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). TCP part , GPS part , Sensor part , Task part and Main part.

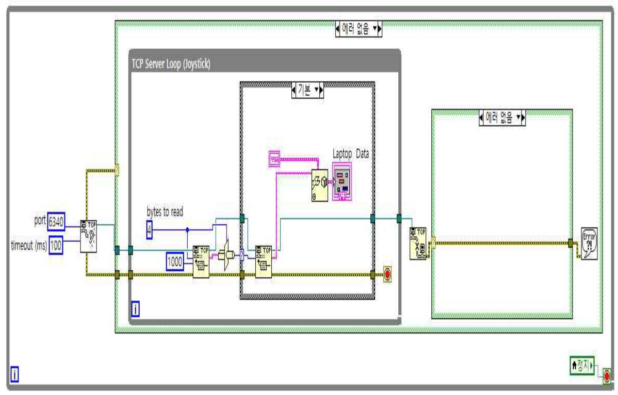


Figure 8 TCP part

Figure 8 shows TCP part. While we have USB type and wireless type but signal range is only 10m. So we use TCP connection by this program.
If Desktop and Laptop are use same Internet , we can control the vehicle by USB type controller that connedted with labtop.

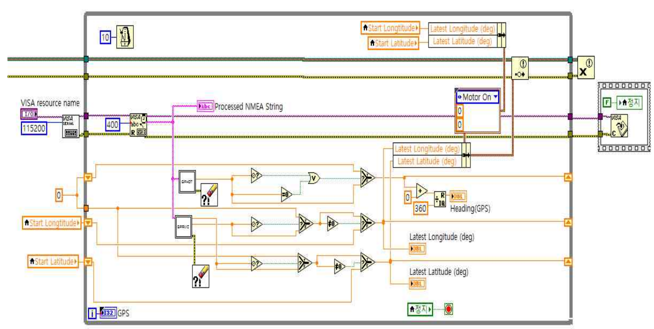


Figure 9 GPS part

Figure 9 shows GPS part. Location informations (longitude , latitude and heading) that GPS determine in real-time classify each data can use other. And It hand the information to main.

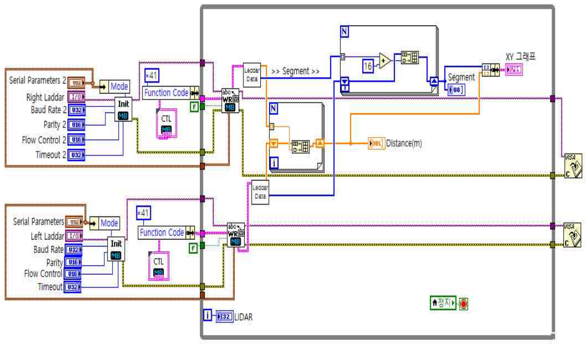


Figure 10 sensor part

Figure 10 shows sensor part VI. In this part sensor recognize forward obstacle and calculate the distance and angle between the obstacle and the vehicle. And it also hand the information to main.

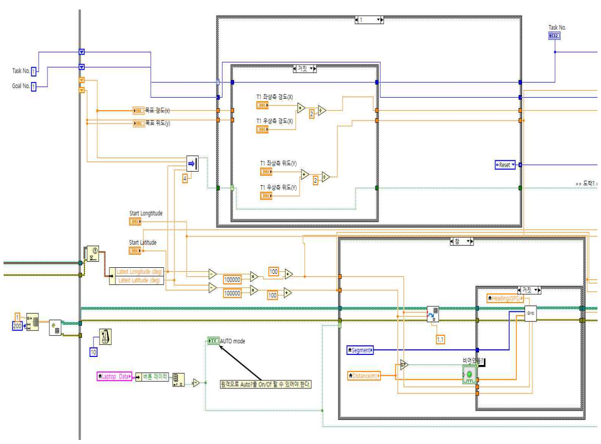


Figure 11 TASK part

Figure 11 shows TASK part. Each case has information of each task. So Each task control the motor suitably.

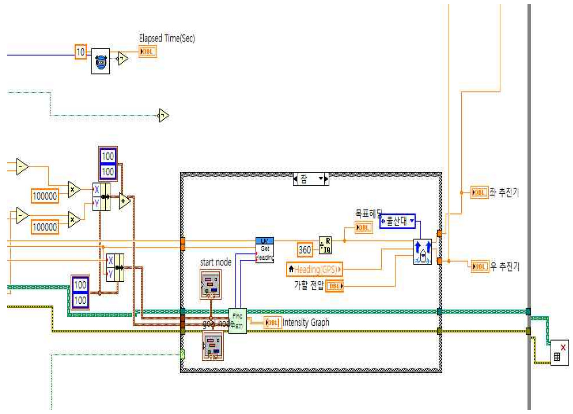


Figure 12 Main part

Figure 12 shows Main part VI. This VI collect all of data about location and obstacle in the path. And then find the proper path and avoid obstacle.

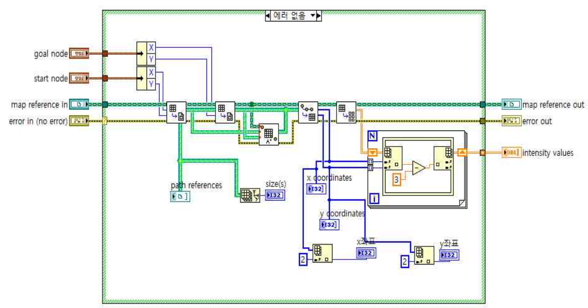


Figure 13 Astar Find Path

Figure 13 shows Astar Find Path in main part. This VI find the proper path. It shows the path in grid like

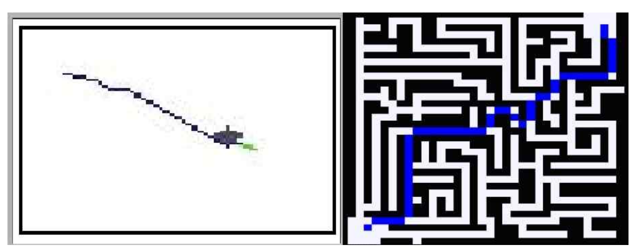


Figure 14 Result of Finding path.

Figure 14. 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 blue line between points. And when sensor recognize the obstacle, area of obstacle changes to black cell. And then VI correct and find the proper path again.

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.

Figure 16 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.

Figure 17 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 17) with wheel table. we install the equipment on a wheel table and push to the way that propeller lead. In this process, we can find some of problem in our program and after fixing we leave for reservoir.

Figure 18 Doohyun Water Reservoir near UOU

After ground test , our boat's voyage is started. At first , We set up a straight path and other shape of path like triangle or zigzag with buoy. After these test , we carry out recognize test about obstacle. But recognizing color or shape and docking test are something the matter because our program has problem about connecting with camera and our boat is affected to weather a lot.

Conclusions

After two months of time, team CLEVIC is prepared to present an ASV that is fully capable of operate in structured environment. Because operating environment is structured environment, UANS uses this information for decision making process in addition to sensor data in order to become more reliable and high performance vehicle.

Acknowledgements

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