An Autonomous Ship Based on Vision Detection for Maritime Navigation

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Abstract

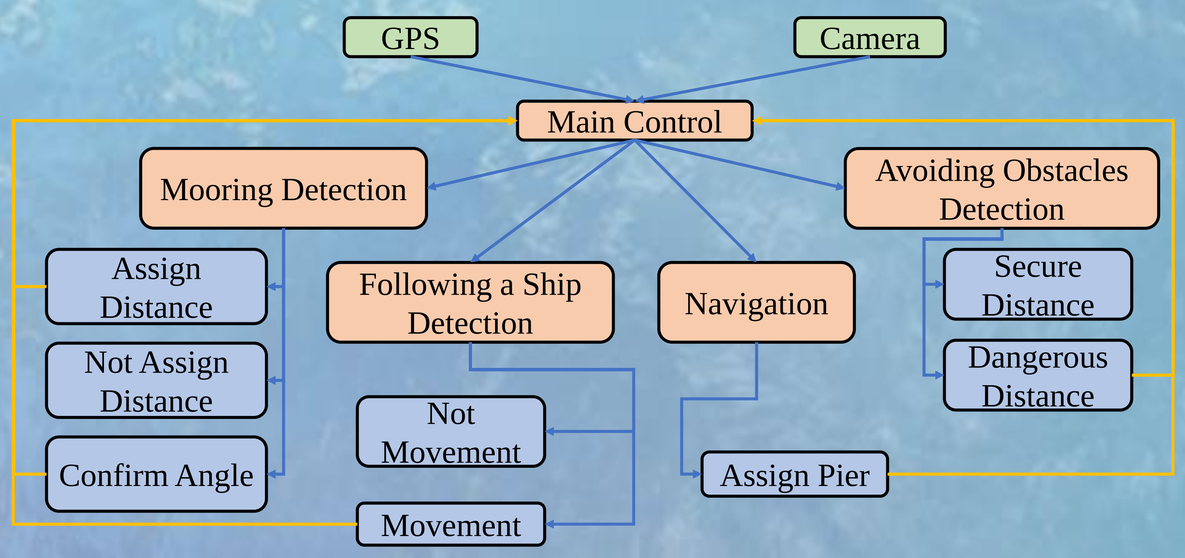
In this research, with combining image processing technology and human-machine interface which included sliding bars to adjust the value of HSV parameters. The autonomous ship can detect object with particular color, and calculate the distance of object to achieve avoiding obstacles, following a ship, mooring, and GPS tracking.

Motivation

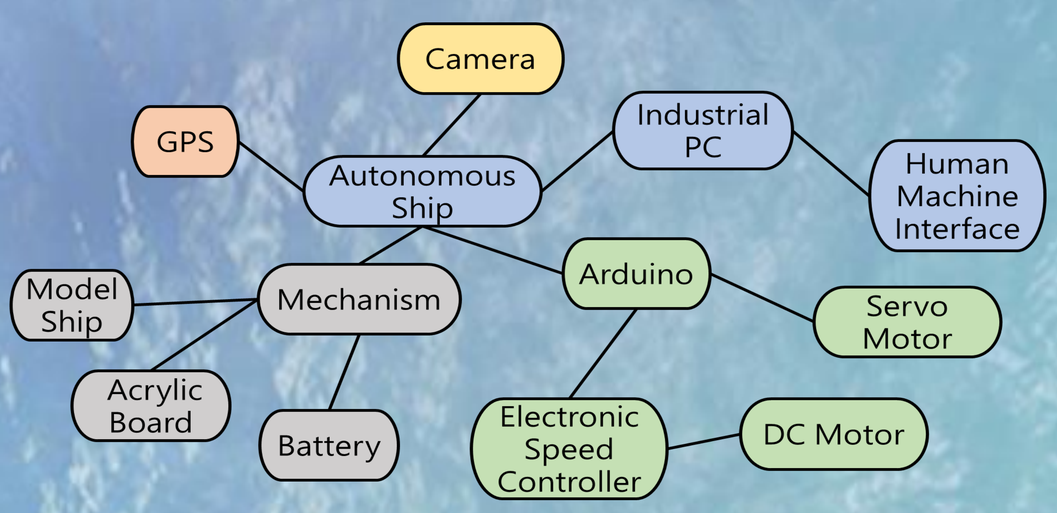
In cargo transportation, marine transportation have weighed in significant proportion, and also autonomous cars in recent technology appreciate. We designed an autonomous ship to alleviate the accident and costs in marine transportation, and handle problems that will occur on the ocean.

Experiment

In this research, the industrial PC receive the information from camera and GPS, and analyze and calculate command Arduino and motors. The system structure shown in figure(1), and the mechanism structure shown in figure(2).



Figure(1)



Figure(2)

A. Mechanism

The autonomous ship in figure(3) was refitted from a model ship, and separated into upper deck and lower deck. In the upper deck, there are cameras, GPS, Industrial PC, and Arduino Mega 2560. We put Industrial PC and Arduino in a plastic box to prevent water, and we also make a switch and add a fuse to prevent it from short circuit. In the lower deck, there are batteries, motors, and electronic speed controller.

Figure(3)

B. Human Machine Interface

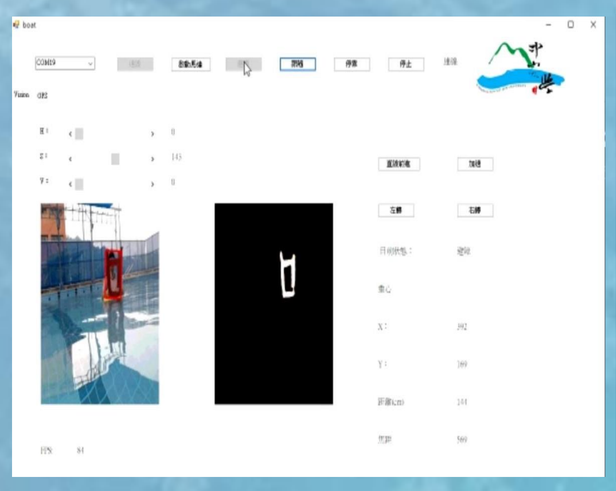
We utilize Visual C++ to programming the human machine interface, and all the information from the sensors will shown in the interface. Industrial PC receive the information from camera and GPS so that we can realize the distance and angle during the navigation. By utilizing algorithm to calculate the parameters, the industrial PC will command Arduino to control motors, and fulfill the purpose to control autonomous ship.

C. Avoiding Obstacles

Camera will load in real-time image, and utilize the data base of OpenCV. The industrial PC can transform the image by HSV and turn the image into binary image so that we can detect the obstacles. The PC will calculate the center of obstacles and decide to left or right turn. Shown in figure(4).

D. Following a Ship

The industrial PC will stick a green board at the following ship as a detect object. It will calculate the center of green board, and control the autonomous ship to follow it. This concept is similar to avoiding obstacles that transform the image by HSV and turn the image into binary image. Shown in figure(5).



Figure(4)

Figure(5)

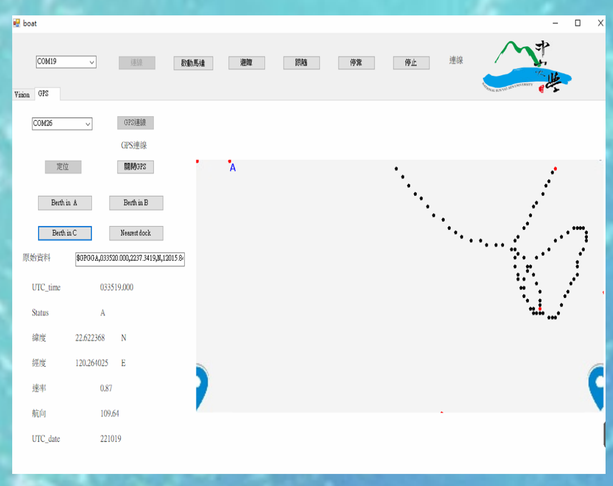
E. Mooring

The industrial PC will rotate the autonomous ship 360 degrees to find the object. It will calculate the center and distance of the object, and will read the data from GPS sensor which is the navigation angle. The autonomous ship will navigate approximately 45 degrees to the pier, and park parallel with the pier. Shown in figure(6).

F. GPS Tracking and Navigation

The industrial PC will read the data from the GPS sensor, and present the path on the human machine interface. We designed three piers that navigate the autonomous ship to assign pier, simulating the actually situation in the transportation. Shown in figure(7).

Figure(6)



Figure(7)

Discussion

In this research, we designed an autonomous ship that integral four functions, avoiding obstacles, following a ship, mooring, and GPS tracking. The industrial PC receive the signal from all the sensors, and command the Arduino to motors, and complete the mission in the navigation.

Conclusion

In this research, we provided the capability of autonomous ship that can navigate on the ocean. We hope to improve the efficiency of transport to reduce transport costs and risks. However, we can only be tested in swimming pool in NSYSU, not tested on the ocean. In the future, it is expected to add artificial intelligence and use big data training to construct a neural network to avoid image errors caused by light changes and weather factors in the experiment.