ROV mechanical structure

Introduction

In our design we are going to build a 40 centimeter long ROV which can operate at 40 meter depth. We will use a high power pump to move our ROV and we use a 10 meter long cable to connect the tail of the ROV and control board, which means it can work at around 10 meter depth.

Design

Design parameters

We build this ROV because we are interested in design the underwater vehicle. In our design we are going to build a 40 centimeter long ROV which can operate at 40 meter depth. In order to satisfy the requirement, we use 40 centimeter long plastic pipe for the body of the ROV. The pipe can hold 200kPa pressure. The cross section of top and bottom of the ROV should big enough to put the main control board in. We are going to use the control board to control the valves and use nozzles to operate our ROV under water.

implementation

Headhub

At the head of the ROV, we have a camera which is connected with main control center. The camera can send the image signal to the control board and we can see the underwater image by the camera. We also have a headlight and two led at the top of the ROV. The headlight will illuminate the front which can help camera have better image. Next, we need to seal the head of ROV. We use resin and glue to seal the top of ROV, because once we finish build the top of the ROV, we don’t need open it again.

Tailhub

For the tail sealing, we use a mechanical way to seal it. We use the same size plastic cap to seal the bottom of the ROV, because when we need to change something, we can open the ROV easily. we use a 10 meter long cable to connect the tail of the ROV and control board,

Body

We use a high power pump to move the whole ROV. The pump first connect to 10 different valves. The valves is also connect to the main control board. There are 8 nozzles in our design. 4 is on the top of the ROV and 4 is on the bottom of the ROV. The nozzles must exactly stay on the 90, 180,270,360 degrees, because ROV will use these nozzles to do all the operating. For example, if the nozzle has some offset, the ROV will move to the wrong direction. To connect the nozzles and valves, We use straps connect all the valves and the body of the ROV, and then we use hose to connect the valves and nozzles. When the ROV moving, the pump will push the pressure form valves to the nozzles. Then the nozzles will push the ROV in to right direction.

Connect main control board

After we fix the valves and the nozzles, the last thing we need to do is using wires to connect valves to the main control board. We first measuring the distance between each valves to each control pin and then cut the wires with extra 5 inch long. The extra length is to help us change the circuit once we have better idea in the design.

Trim

After we connect all the parts, there is one more things we need to do is to measure the center of buoyancy and the center of the gravity. In our design the center of gravity should be a little lower than the center of the buoyancy and both of them should around the center of our ROV. We have to satisfy the relationship between the buoyancy and the gravity, because when we put our ROV in to test. All the electric part is not working. The ROV have to not only immerse in the water, but also stay in a proper depth in the water. Once the power turn on, we can use the top of the nozzle push pressure and the ROV will dive. If the ROV has some part which is not immersion in the water. The top nozzle will push pressure in to the air and the ROV cannot dive even it have power. Therefore it is necessary to adjust the center of buoyancy and gravity. In our design we can move the position of the valves and pump to adjust the center of gravity to the right position.

Experiment

Electric part

We test our electric part by using the output LED lights. For example, if we want to turn right, the right LED should be up when we push the button on the control board. If the right LED is not up, it means our control system still has some problems.

Sealing and pump

After we finish our design, the first thing we need to do is to test the sealing of our ROV. We put our main control board outside, and put our ROV in the bathtub which has 20 centimeter depth. We can open the pump with a 12 V battery and see whether the ROV move like we thinking or not.

Then we takeout our ROV and check the inside. We find that all the sealing is good. There isn’t any water in the ROV inside.

Test Result

After testing all the things, we finish our design and use the bathtub for the final test. In the final test, our ROV works pretty well in the bathtub. It can dive 20 centimeter depth and all the functions work well. The auto-pilot mode also works well in the bathtub.

water tank result

Then we test our ROV in the water tank. The water tank is 2 meters depth. The electric part is still working well. However, the difference between the water tank and the bathtub is that the connect cable is too heavy when we use the long cable. The heavy cable change the center of the gravity of our ROV and let it dive fast before we open our power. Then we use some foam to increase the buoyancy of our ROV. We try several times with different amounts of foam and finally the ROV can stay in the 1 meter depth. However, we open the power supply of the ROV and try to operate ROV. Unfortunately, the ROV cannot operate. Then we open our ROV and find that our ROV has leaking problem. Fortunately , the water is running water and the control board is not burn out.

Improvement

Regardless of what we accomplished, there are still several parts that can be improved in our project. Although our electric system part works well, we still have some problems in the mechanical system. When we tested our ROV in the bathtub, all the function was working. However, when we test in the water tank, our ROV have leaking issue due to the pressure. As a result, our sealing method is something can be improved, such as using wax to seal the cap. Additionally, we have a lot of surface mounted valves, which brings up the wiring issue. For improvement, we could use a quick-connect jacket to help us disconnect and reconnect the actuators easier when we need to modify the ROV. Furthermore, our pump is not powerful enough through the test. The pump worked well by itself; however, after we connect the pump with hose and valves, the resistance of the hose reduces the output pressure of our direction control nozzles.

Now, we established a basic auto pilot function. The ROV can maneuver automatically if the error between the auto pilot configuration and the actual status provided by the sensor is larger than the threshold level. In the future, we can use some better algorithm such as PID controller or State Space controller to improve the control performance. We could also use the video signal recorded by the camera to implement video processing functions, such as line following and object detection.