Intelligent Lifebuoy Based on Machine Vision

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Abstract. This article mainly introduces the intelligent lifebuoy based on machine vision. The design uses the OpenMv camera to identify the drowning person. OpenMV sends the collected position information of the person to the MCU. If the drowning person is on the left or right side of the lifebuoy, the MCU controls the motor drive module. Control the differential rotation of the motor behind the lifebuoy so that the lifebuoy is facing the drowning person. If the drowning person is directly in front of the lifebuoy, the MCU controls the motor drive module to control the rotation of the motor behind the lifebuoy to make the lifebuoy gradually approach the drowning person, which can save life. Blue balloons was used instead of drowning people to conduct rescue experiments on the lake. The smart lifebuoy successfully recognized the blue balloon and swam near the blue balloon. Furthermore, a perfect solution is proposed for the shortcomings of the intelligent lifebuoy.

1. Introduction
Lifebuoys, life jackets, and life-saving throwing devices that already exist on the market cannot deliver the drowning person very accurately. The emergence of life-saving equipment is imminent. The intelligent lifebuoy introduced in this article can effectively identify and rescue the drowning person[2]. For every life buoy, the smart lifebuoy application can be used on the side, on the beach, on the beach or by the beach. If the lifeguard does not find the lifesaver in time, the smart lifebuoy will be able to play a role[3]. This intelligent lifesaving captures the drowning person according to the machine vision and sends the data to the master[4]. The master controls the driving of the trailing catcher through the output low voltage control. The predator will Find and save the drowning[5]. This article introduces the basic principles of this intelligent lifebuoy based on machine vision, and performs a water simulation test on the intelligent lifebuoy.

2. Peripheral circuit design
This article chooses Arduino as the MCU. The main reason is that Arduino is open source and it is easy to use. The MCU in the smart lifebuoy only needs to communicate with the OpenMV camera. Then it can control the motor by receiving the data collected by the camera OpenMV. The trajectory of the smart lifebuoy. Arduino fully meets the functional requirements of this design. The selected Arduino model is UNO R3. Figure 1 is the physical picture of Arduino UNO R3.
2.1. OpenMV3 camera module
The OpenMV camera module is a small machine vision system with image acquisition, image processing and motion control. And the OpenMV3 module is relatively small, it can be installed and moved freely outside the smart lifebuoy[6]. Its core board is STM32, and the camera is OV7725[7]. The front of the camera can be rotated to adjust the focus. It is convenient for the intelligent lifebuoy to simulate and recognize a drowning person in different scenarios. It is also a highlight of the smart lifebuoy. Most smart lifebuoys on the market use infrared and ultrasonic sensors. The OpenMV camera module used in the smart lifebuoy can identify more complex scenes than the ultrasonic module and infrared sensor module, and capture drowning faster Location. Figure 2 is the Pin diagram of OpenMV3.

2.2. L298N drive module
Arduino cannot directly control the high and low voltage to power the motor. It needs an indirect motor drive module between the Arduino and the motor. One L298N module can drive 2 motors, which can drive 2 motors in the water of the smart lifebuoy. It is required that the input voltage range of the driving DC motor is 3-16v, the power supply range is 6-12v, and the power supply range of the logic circuit in L298N is 5v-7v. Usually use a 12v power supply to power the logic circuit, and still use a 5v power supply to power the logic circuit, the purpose is to prevent the chip from heating up. The maximum output current of the left and right drive DC motor is 2A. Connect jumper caps to EA and EB respectively. OUT1 and OUT2 corresponding to IN1 and IN2 control the left motor, and OUT3 and OUT4 corresponding to IN3 and IN4 control the left motor. Using the single-chip microcomputer to control the output voltage can control the forward and reverse rotation of the motor. Realize a series of
operations such as forward, backward, left and right turn of the intelligent lifebuoy in the water. Figure 3 is the physical object of L298N drive module.

2.3. DC-DC DC adjustable boost voltage stabilized power supply module board
The input voltage of the L298N drive module inside the smart lifebuoy must reach 12v, and the 8v battery pack cannot supply power directly. The solution to this problem is to add a 2a booster board DC-DC adjustable booster regulated power supply module board. The power supply system requires a two-section 18650 battery pack to be boosted to 12v DC through a 2a booster board DC-DC adjustable booster regulated power supply module board to supply power to the L298N drive module. Select the adjustable power boost module and rotate the boost module clockwise to rotate the potentiometer to achieve the boost effect. Use a multimeter to measure it so that the boosted voltage is stable at 12v. If the voltage cannot be increased at the beginning, adjust the rotary potentiometer clockwise for more than 5 turns before adjusting. The booster module has an internal resistance of 100M ohm metal oxide semiconductor field effect transistor. The maximum output peak current of the boost module is 2A, the input voltage is between 2v-28v, and the input voltage of the battery pack is 8v, which conforms to the input voltage range. The maximum output voltage is limited to more than 28v, and only needs to be raised to 12v, which is in line with the output voltage range. The efficiency of the booster board is more than 93%. The size is 30mm in length, 17mm in width and 1.4mm in height. Figure 4 is the physical object of DC-DC adjustable boost voltage stabilized power supply module board. Figure 5 is the physical diagram of the smart lifebuoy circuit design.

Figure 3. Physical object of L298N drive module.

Figure 4. Physical object of DC-DC adjustable boost voltage stabilized power supply module board.
3. Overall design of intelligent lifebuoy

3.1. 2.5kg polyethylene plastic lifebuoy
The reason why the 2.5kg polyethylene plastic lifebuoy was chosen to make the smart lifebuoy is because the lifebuoy is heavier than ordinary lifebuoys. When carrying the internal circuit device, it has less impact on the balance of the smart lifebuoy, and can be relatively stable on the water surface with currents.

3.2. Waterproof motor
The experimental scene of this design is mainly in water, so a waterproof motor is needed. The waterproof motor has a shell length of 50mm, a diameter of 31mm, a total length of about 76mm, a propeller diameter of about 39mm, an input voltage range of 3-10v, and an input voltage of 7.4v. The no-load speed can reach 16,800 revolutions per minute, which is fully in line with the power design of the lifebuoy. If the speed is increased later, a larger propeller can be replaced to increase the speed and get closer to the drowning person. Table 1 is the required hardware type.

| name                  | model                          | Quantity |
|-----------------------|--------------------------------|----------|
| MCU                   | Arduino uno R3                 | 1        |
| webcam                | OpenMV3                        | 1        |
| Motor drive module    | L298N                          | 1        |
| Motor                 | Waterproof model motor         | 2        |
| Boost module          | DC adjustable boost module     | 1        |
| power supply          | 18650 battery                  | 2        |
| Lifebuoy              | 2.5kg polyethylene plastic lifebuoy | 1    |

3.3. Arduino and OpenMV communication
At first, Arduino needs to communicate with the OpenMV camera module, so that the OpenMV camera module can capture the location of the drowning person in time and send the data to the Arduino. In this way, the Arduino can further work according to the obtained data. Firstly, people need to connect the Rx port of Arduino to the P4 port of OpenMV, then connect the Tx port of Arduino to the P5 port of OpenMV. Subsequently, the ground between Arduino and OpenMV will be shared. OpenMV will first identify the object on the water. The camera will first capture the center horizontal coordinate of the
recognized object and compare it with the window horizontal coordinate of the camera itself. As shown in figure 6, if the difference is less than or equal to -15, it will determine that the object is on the left of the smart lifebuoy. The data of -1 will be sent to the master. As shown in figure 7, if the horizontal coordinate difference is between -15 and 11, it will be judged that the object is directly in front of the smart lifebuoy, and 0 will be sent to the master. As shown in figure 8, if the horizontal coordinate difference is greater than or equal to 11, it will be determined that the object is to the right of the intelligent lifebuoy, and 1 will be sent to the master.

Figure 6. \( x < -15 \) The blue balloon is on the left of the smart lifebuoy.

Figure 7. \(-15 \leq x \leq 11\) The blue balloon is directly in front of the smart lifebuoy.
3.4. Arduino operation motor debugging
Before testing the OpenMV camera module, researchers need to test whether the motor module can rotate normally. Testing Arduino requires to operate two motors, which are boosted by the battery pack to 12v and then connected to the L298N driver module. The 11, 10, 9, and 6 ports of the Arduino are connected to the IN1, IN2, IN3, and IN4 of the L298N. Arduino and the drive module share the same ground. The positive and negative poles of the left motor and the right motor are respectively connected to OUT1, OUT2, OUT3, and OUT4 of the L298N. Researchers use the code to test that the motor can rotate normally. When the left motor and the right motor input the same voltage, the rotation speed of the left motor will be slower than the rotation speed of the right motor.

3.5. Test experiment
Figure 9 presents the test in the lake on the campus of Tianjin University of Science and Technology. As the result of the test, the camera module can smoothly capture the position coordinates of the blue balloon of the substitute object, and successfully communicate with the Arduino. The position data of the blue balloon can be continuously transmitted to the Arduino. The smart lifebuoy keeps approaching the blue balloon, but the speed of the lifebuoy on the water surface is slow.
4. Conclusion
The smart lifebuoy is still in the simulation stage. Furthermore, the smart lifebuoy can automatically recognize the object and automatically control the continuous approach to the object to achieve the purpose of rescue. Moreover, there are still many parts need to be improved. Using blue balloons to replace the drowning person will make the recognition function of the smart lifebuoy imperfect. How to identify the drowning person in a complex environment needs to be further improved. Also, there are other problems, such as how to make the smart lifebuoy able to swim to the drowning person smoothly and quickly in a complicated water flow environment. When the driving motor voltage remains the same, researches can choose to increase the size of the propeller to increase the speed. When motors are on both sides, there is a slight difference in the rotational speed, and the output voltage needs to be controlled to adjust the speed when turning left and right. PID can be added to adjust the balance of the lifebuoy to deal with turbulent water conditions. In addition, the lack of camera recognition can also be made up by setting multiple modes, such as adding Bluetooth or handle control mode. In this way, in a harsh environment, when the camera cannot recognize the drowning person in time, this method can also be used to make the smart lifebuoy reach the drowning person quickly.

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