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Float Technical Report

25 Mate-Ranger
RongZhen KaiWu / Suzhou Street

Summary:

Rongzhen Kaiwu is an eco-conscious and minimalist-oriented startup specializing in remotely operated vehicles (ROVs). It has developed **OctaXplore**, an innovative and highly scalable underwater robot framework. Committed to continuous growth and global expansion, the company strives to strengthen its presence on the world stage and contribute to global marine conservation efforts.

Second row (l-r): Zibin Lin, Kangning Shi, Siyuan Yu, Yutong Wu, Nuo Cheng, Junming Zhang, Moyang Liu

Front row (l-r): Yuanjie Li, Jiaqi Zhang, Jinwen Li, Liyan Huang, (Mentor) Yueming Fu

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1.1 DESIGN SPECIFICATIONS

1.1.1 POWER SUPPLY SYSTEM

The buoyancy device is powered by AA-type dry batteries (1.5 V nominal voltage, $12\,000$ mA h typical capacity, and a maximum continuous discharge current of 2 A). The system employs a 3-parallel 4-series (3P4S) configuration of 12 batteries to achieve a 6 V supply, with an integrated fuse for circuit protection. To meet the motor system's voltage requirements, a DC-DC boost converter steps up the voltage from 6 V to 12 V, ensuring a stable output current of ≥ 2 A for reliable operation.

1.1.2 CONTROL SYSTEM

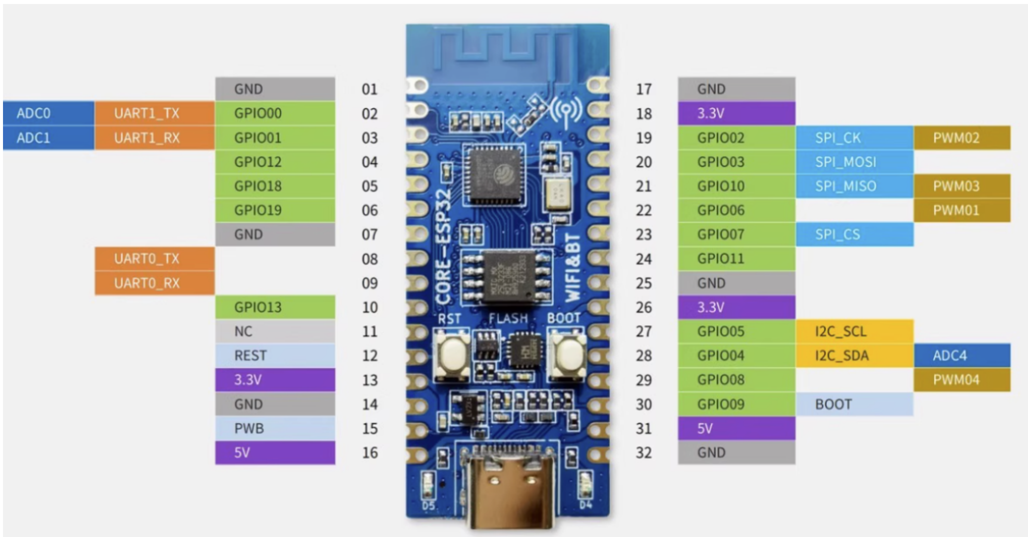


FIGURE 1: ESP32 MICROCONTROLLER

The ESP32 microcontroller serves as the core control unit, leveraging its low-power Wi-Fi/Bluetooth capabilities and versatile I/O resources for wireless communication and motor control. For motor actuation, the design currently utilizes the RZ7899 H-bridge driver IC, which supports 4.8 V to 28 V input and delivers up to 5 A continuous current. Direction, speed, and enable/disable functions are controlled via DIR, PWM, and ENABLE pins, respectively. Alternatively, the DRV8870 driver (with broader voltage/current tolerance) is under consideration for enhanced performance.

FIGURE 2: RZ7889 H-BRIDGE

1.1.3 BUOYANCY ADJUSTMENT SYSTEM

Buoyancy is dynamically regulated by a miniature brushed DC gearmotor that drives a syringe mechanism. By injecting or expelling water, the system adjusts internal ballast volume to enable controlled ascent and descent.

FIGURE 3: BUOYANCY CONTROL DEVICE

This is the gear motor used this time. It operates at 3 V and 200 rpm. We designed a lead screw for the motor. Anaerobic adhesive is used to prevent relative sliding between the shaft and lead screw. We also designed a stepped motor bracket to fix the motor and gear box. Also, a motor and syringe barrel fixing bracket is designed. M3 screws are used for fixation from both ends. After assembly, the lead screw and syringe are eccentric. This prevents the piston from rotating. The piston rod is removed to free up space, and a corresponding internally threaded piston is rod designed for the syringe.

1.1.4 STRUCTURAL DESIGN

FIGURE 4: FLOAT STRUCTURE

The housing incorporates a 25 mm pressure relief vent to prevent structural stress from internal pressure buildup. Batteries are secured at the base via 3D-printed mounts to optimize center-of-gravity stability. A depth sensor provides real-time feedback for closed-loop control, ensuring precise depth management.

1.2 OPERATING INSTRUCTIONS

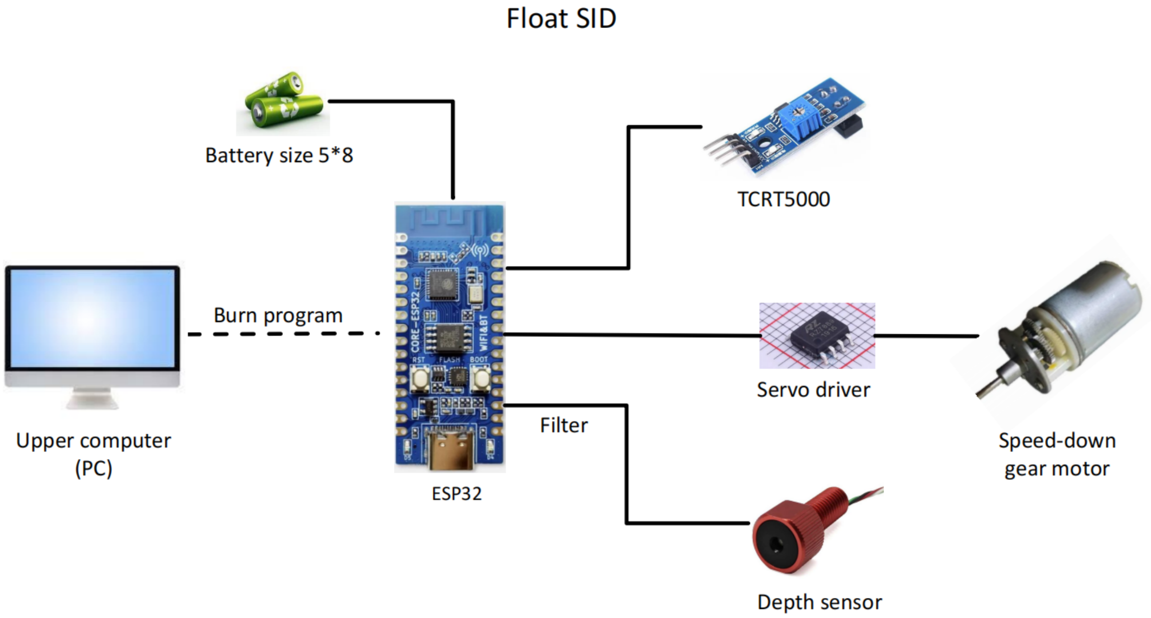
1.2.1 PROCEDURES

Before deployment, please install 8 AA batteries in a 2P4S configuration and check the integrity of the fuses. After power-on, the system starts a 30-second depth sensor calibration sequence, with the default being that the initial depth of A is 10 centimeters. During the operation process, the depth data is recorded once every 200 milliseconds. When the equipment reaches 2.5m, it stabilizes for 10 seconds, and then reverses the motor to surface again. After floating on the water surface, the buoy transmits the time-depth profile to the shore through program-set control sensors and waits for confirmation to repeat this cycle.

1.2.2 SAFETY & MAINTENANCE

- **Environment**: Testing should be conducted in freshwater; saltwater may compromise sensor accuracy.
- **Power**: Monitor battery voltage to prevent under-voltage disruptions.
- **Mechanical Checks**: Regularly inspect the pressure vent for blockages and ensure the syringe mechanism remains unobstructed for consistent buoyancy control.

2 SID



On the shore, we set up an ESP32 control panel and connected it to a computer when it floated on the shore to visualize the information. Underwater, the ESP32 control board is combined with the TCRT5000 photoelectric sensor, and a depth sensor is fixed at the bottom of the float to transmit depth information in real time, achieving the reading of information and the automatic control of the gear motor. Automatic control is achieved by transcribing the programs written on the shore into the control board. The power supply of the float adopts 8 No. 5 dry batteries, which are first connected in series and then in parallel to achieve power supply, fully realizing pollution-free power supply.

3 PHYSICAL DISPLAY AND DESCRIPTION

Our floats have an overall 3D printed structure, with internal pressure adjustment via two syringes, and push and pull operation of the syringes controlled by a motor. It is waterproof and has a counterweight to stabilize the float in the water. A depth sensor is mounted on the bottom of the float to accomplish the task, and a pressure relief valve is installed for safety. The top of the float is raised to allow for the placement of the communication device, and by aligning the buoyancy, we ultimately achieve a float that is just above the water to reveal the signal transmission section.

FIGURE 5: FLOAT OUTSIDE

Our float features an overall 3D-printed structure. The raised top part of the shell is designed for installing communication devices, while the bottom is equipped with a depth sensor to ensure precise underwater positioning and data collection. The external design of the buoy is minimalist, adhering to the minimalist concept, and at the same time, it guarantees the stability and functionally of the equipment in water.

FIGURE 6: FLOAT INSIDE

FIGURE 7: PHOTOELECTRIC SENSOR

The figure illustrates the overall layout inside the float and reflects the principles of modular and automated design. Our team integrated the power system with the control unit and buoyancy adjustment components, installed batteries on the side for power supply, and installed other sensors or expansion modules on the top for automatic control and signal transmission, so as to adapt to the needs of different application scenarios and facilitate the signal transmission after floating on the surface. Placed on top of the board and the sensing interface, the board houses multiple sensors. The upper part is welded with a filter sensor to avoid interference from the sensor, the middle part is equipped with a TCRT5000-type photoelectric sensor to determine whether the float has reached the lowest point, a depth sensor is equipped at the bottom to accurately determine the depth of the float, and finally a 3D printed bracket is equipped on the upper part to ensure the stability of the center of gravity of the equipment.

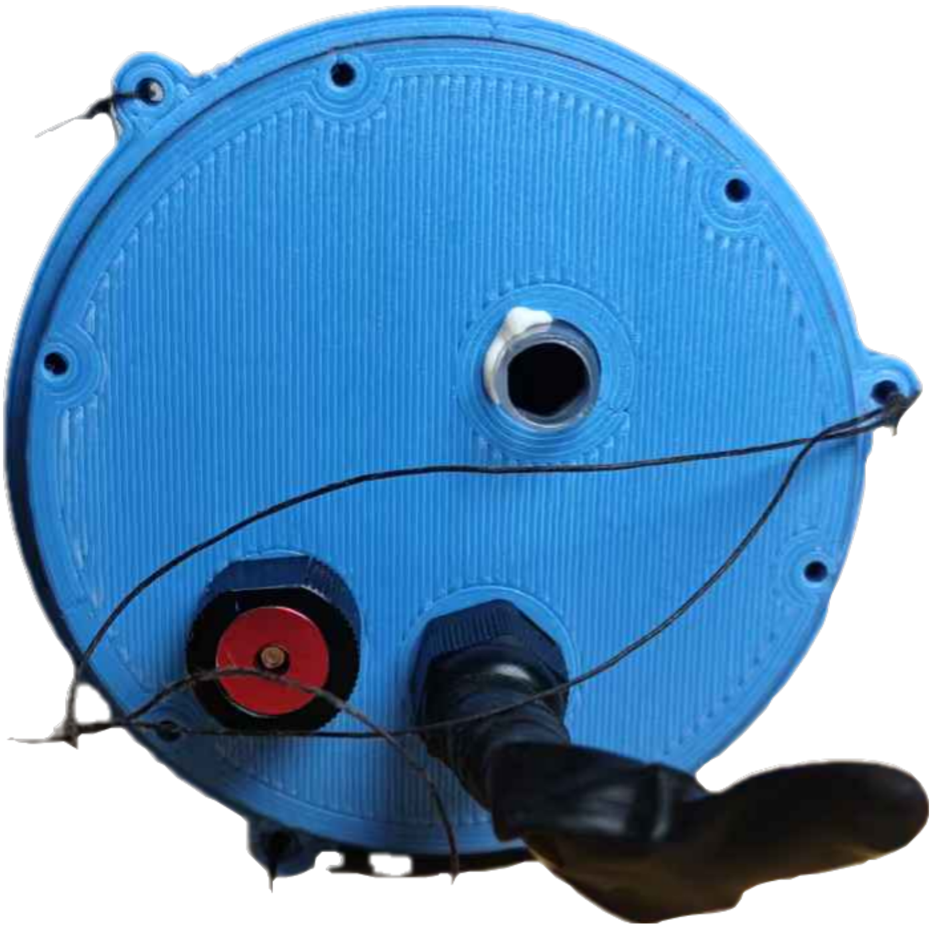


FIGURE 8: FLOAT BELOW

The design of the bottom of the float focuses on safety and functionality. At the center is a depth sensor, which can monitor the underwater depth in real-relief valves and ballast blocks, which ensure the structural safety and stability of the equipment in deep-water environments. The bottom structure also feature a waterproof design, protecting the internal electronic components from the effect of water pressure.

4 INSTRUCTIONS FOR USE OF THE FLOAT

4.1 REGULAR INSPECTION

Periodically disassemble the float to inspect its electrical circuitry and seal integrity. When not in use for an extended period, disconnect the power supply.

4.2 BATTERY PREPARATION

Before use, replace the battery or recharge it to ensure the float has sufficient power. Upon powering up, the float will automatically initiate a program to expel water from the internal syringe used for buoyancy adjustment. It will then adjust its weight within the reserved space inside the float based on local atmospheric and water pressure, ensuring that the top part of the float remains above the water surface when submerged, but not excessively protruding.

4.3 BUOYANCY CHECK

During use, recheck the seal integrity and carefully place the float into the water, ensuring that the buoyant force slightly exceeds its own weight after submersion.

4.4 OPERATION AND MONITORING

Set the predetermined routes and corresponding depth values for the mission via the computer program. Once the program is activated, the float will automatically perform a series of operations, including diving, hovering, data collection, and surfacing. Please monitor the entire operation process closely. In case of any abnormal situation, stop using it immediately and conduct maintenance.

4.5 POST-USE CARE

After use, retrieve the float, dry its surface, and disconnect the power supply. Store the float in a dry place, avoiding direct sunlight.

5 BUDGET AND COST ACCOUNTING

Float material list				
item	**description**	**Unit price (Yuan)**	**quantity**	**Total price (Yuan)**
Dry battery number five	1.5V dry battery	3	8	24
ESP32 development board	Master controller with wireless communication	20	1	20
moter drive	Dc motor drive, H bridge	10	1	10
Dc speed reduction motor	Drive syringe push and pull piston	20	1	20
injection syringe	20ml specification	6	1	6
3D printing fixed bracket	For battery and syringe mounting	30	2	60
UPVC watertight compartment	Protect motor and electronic components	80	1	80
depth transducer	MS5837-30BA	309	1	309
Pressure relief hole assembly	diameter 25mmh	8	1	8
waterproof cable	connect individual electrical components	20	1	20
fuse	overcurrent protection	8	1	8
connector	electrical connection	2	10	20
Total				**585**

This float has many advantages. First, its cost is well-controlled. The total cost of 585 yuan is reasonable and can save money for the team. The cost of key components is properly allocated. By controlling the quantity, it ensures the function without over-investment. Secondly, it has high cost-performance. Its functions are comprehensive, including power supply, propulsion control, depth monitoring, and wireless data transmission. All components are versatile and economical, meeting the requirements and are easy to obtain. Finally, the quantity is properly configured. It meets the functional requirements and avoids redundancy, ensuring the overall cost-effectiveness.