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Design of Wireless Remote Control Boat Toy Based on Mcu

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Abstract: In this paper, a wireless remote control speedboat based on STM32 single chip microcomputer is designed and implemented. The STM32F103C8T6 is used as the main controller, the water sensor is used to detect whether the speedboat is put into the water, and the nRF24L01 wireless communication mode is adopted. the wireless remote control end navigates smoothly on the water through the straight sliding potentiometer and rocker, and the OLED displays the rocker direction, throttle control information, speedboat entry induction information and battery charge information. The experimental results show that the design has the advantages of stable operation, strong real-time performance, long communication distance, good interface interaction and simple operation.

1. Introduction

Mini water navigation technology is a high and new technology with broad prospects, and toys are an important part of our childhood memories. Now all kinds of toys walking on the ground and flying in the sky can be seen everywhere in the market, and they are no longer fresh. It can not satisfy people's curiosity, let alone bring enough happiness [1]. In this paper, a speedboat toy with multi-functions such as wireless remote control, human-computer interaction, low electricity and water entry detection is designed, which has strong entertainment, is suitable for people of all ages, and has low cost, simple operation, good real-time performance and innovation.

2. System Structure

The system mainly includes two parts: the wireless remote control end and the wireless receiving end. The wireless remote control end is mainly composed of rocker module, throttle control module, single chip microcomputer and OLED display module. The wireless receiver is mainly composed of water sensing module, single-chip microcomputer, voltage detection module, motor drive module and steering gear module. The system architecture is shown in figure 1. The main controller uses STM32F103C8T6 chip, combined with nRF24L01 wireless communication module[2], through embedded programming technology to realize the wireless communication between the speedboat wireless remote control end and the receiver. The remote control end collects rocker and throttle control data information, wirelessly controls speedboat motor steering, speed and steering direction, and displays steering and other related data information and wireless received speedboat battery

voltage and water sensing data information through the UI interface of OLED.

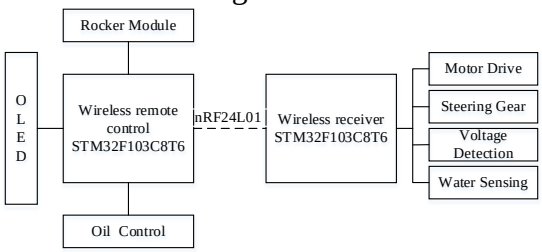

Fig.1 System Architecture

3. Design of System Hardware

3.1 Hardware Design of Wireless Remote Control Terminal

3.1.1 Main Control Module

The main control module of wireless remote control terminal mainly includes STM32 single chip microcomputer, rocker module, throttle control module, wireless module and OLED display module. The main controller adopts a 32-bit microcontroller based on ARM Cortex-M kernel STM32 series, which has a program memory capacity of 64KB, an operating voltage of 2VVO3.6V, and comes with two 12-bit 1 μ S analog-to-digital converters (up to 10 channels), 37 fast input and output ports, 2 SPI, 2 I2C, 3 USART, 3 general timers and 1 advanced control timer. The main frequency can reach 72MHz. The package has the advantages of small size, low price and high performance-to-price ratio, so it is suitable for speedboat toy design.

3.1.2 Design of Power Supply

The wireless remote control terminal of this design uses 3.7V lithium battery for power supply. Considering the relatively low supply voltage, a more suitable power regulator chip 662KGI 662K is a high ripple suppression rate, low power consumption, low dropout, CMOS step-down voltage regulator with over-current and short-circuit protection. It has a very low static bias current (8.0 μ A Typ), achieves the output current of 250mA with a very small difference between input and output voltages, and still maintains a good adjustment rate.The chip is often used in low power circuit design, stabilizing the voltage from 3.7V to 3.3V, and is small in size, so it is suitable for use in the remote control board. The power supply hardware design is shown in figure 2.

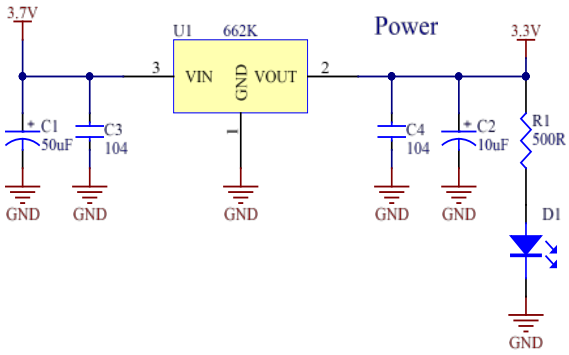

Fig.2 Schematic Diagram of Power Supply Design

3.1.3 Nrf24l01 Wireless Module

NRF24L01 is a monolithic wireless transceiver chip produced by NORDIC, which works in the 3.4GHz~2.5GHz world-wide ISM band [3]. The wireless transceiver includes a frequency generator, an enhanced “SchockBurst” mode controller, a power amplifier, a crystal oscillator, a modulator and a demodulator. The output power, channel selection and protocol settings can be set through the SPI interface. In this design, nRF24L01 is connected with the SPI1 port of STM32F103C8T6.

3.1.4 Oled Module

The wireless remote control end uses a 0.96-inch OLED LCD screen to display remote control operation mode, battery power information, steering gear steering and other information. The module has the characteristics of small size, highlight, with its own boost circuit, built-in SSD1306 driver chip, working voltage 3.3 V, but the compact size has a resolution as high as 128-64. The OLED module is connected with STM32F103C8T6 through a 4-wire SPI bus.

3.1.5 Throttle Control Module

The throttle control of speedboat is designed by direct sliding potentiometer. Through the sliding rod to change the resistance value of the direct sliding potentiometer, thus changing the corresponding voltage value to realize the control of the speedboat speed, through the straight sliding potentiometer to control the speedboat throttle can bring a strong sense of experience, can feel the whole process of the speed from low to high, compared with the remote control speedboat sold in the market has a better experience effect. In this design, the direct slip potentiometer is connected with the IN2 of the ADC1 of STM32F103C8T6.

3.2 Hardware Design of Wireless Receiver.

3.2.1 Main Control Module

The main controller adopts STM32F103C8T6, motor module and uses IRLR7843 MOS tube [4] and IR2104 to drive the motor, which is connected with the PB0 and PB1 ports of STM32F103C8T6. The data information of the remote control terminal is received wirelessly through nRF24L01, and the interface mode is the same as the wireless remote control terminal. The steering gear module adopts AS1015 [5] voltage regulator chip, which is connected with PB6 port. The water sensing module is connected with the PA0 port. The voltage monitoring module is connected with the PA1 port.

3.2.2 Power Supply Module

In order to supply power to the main control and steering gear, it is necessary to convert the battery voltage from 7.2V to 5V and 3.3V, so TPS7333 and TPS7350 power regulator chips are used. The 5V voltage regulator circuit is shown in figure 3 and the 3.3V voltage regulator circuit is shown in figure 4. TPS7333 and TPS7350 are ultra low dropout LDO, of TI company. TPS7350 stabilizes the battery voltage from 7.2V to 5V output to power the steering gear. TPS7333 stabilizes the battery voltage from 7.2V to 3.3V output to provide power for the single-chip microcomputer.

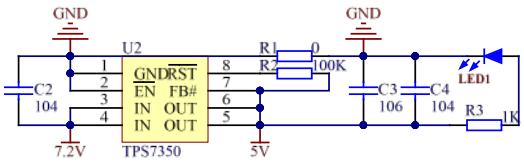

Fig.3 5v Voltage Stabilizing Circuit

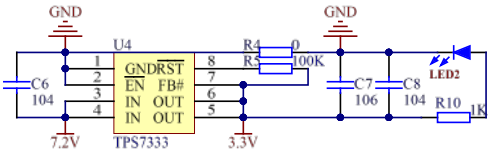

Fig.4 3.3v Voltage Stabilizing Circuit

3.2.3 Motor Module

The motor uses a carbon brush 540 high speed motor, which is used to drive the propeller to rotate. the faster the speed, the greater the thrust of the propeller and the faster the speed of the speedboat to achieve the drift effect. The motor is driven by the combination of N-channel MOS tube IRLR7843 and half-bridge drive chip IR2104. The motor drive circuit is shown in figure 5. The IRLR7843 MOS tube has strong driving ability, the maximum voltage can reach 30V, and the maximum current can reach about 160A, which ensures the driving ability of the speedboat, and the price is cheap, which reduces the design cost. In order to realize the forward and reverse rotation of the motor, two IR2104 are used to design the full-bridge drive circuit, which is connected with the PB0 and PB1 of STM32F103C8T6 respectively, and the timer T3 CH3 and CH4 output PWM [6] are used to control.

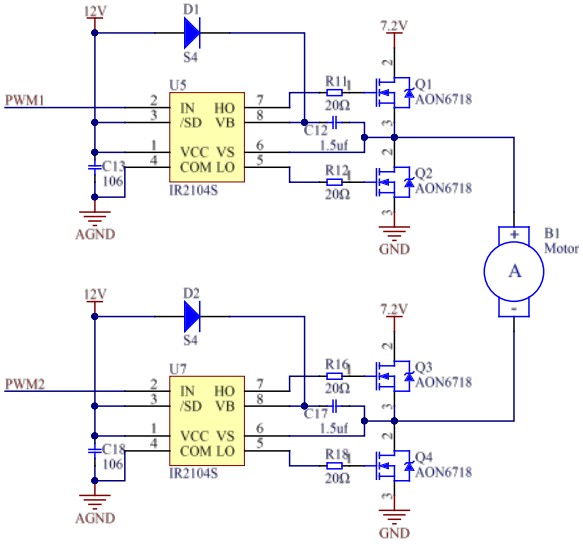

Fig.5 Motor Drive Circuit

3.2.4 Steering Gear Module

The steering gear module circuit is shown in figure 6, using AS1015 voltage regulator chip. AS1015 is a voltage-mode step-down DC-DC converter, including voltage reference source, error amplifier, oscillation circuit, p-channel MOSFET, etc., which meets the 5A output current, and uses the PWM control scheme to fix the switching 300KHz frequency. The input voltage range of AS1015 is from 3.6V to 23V, and the adjustable output voltage range from 0.8V to VIN is provided in the design. In this design, the AS1015 output voltage is 5V, which supplies power to the steering gear, connects with the PB6 port of the STM32F103C8T6, and uses the CH1 output PWM control of the timer T4.

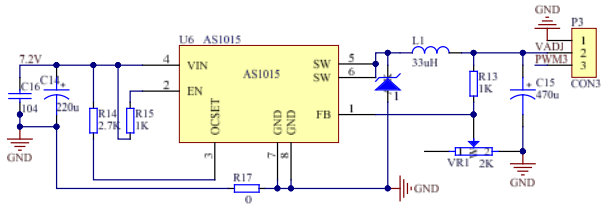

Fig.6 Steering Gear Drive Schematic Diagram

3.2.5 Water Sensor Module

In order to prevent the propeller from turning and scratching when the speedboat is not put into the water, a water sensing module is designed to detect whether the speedboat is placed in the water or not. The principle is to hit two screw holes and screw on the speedboat shell, and wire the two screws indirectly, one end is connected to GND, and the other end is connected to the PA0 port of STM32F103C8T6 (IN0 of ADC1), when the speedboat is not put into the water, the two screw points are not connected, when the speedboat is put into the water, because it is not pure water and has electrical conductivity, the two screw points will be connected, and you can know whether the speedboat is in the water by judging the state of the PA0 mouth.

3.2.6 Voltage Monitoring Module

In order to monitor the battery charge of the speedboat in real time and avoid overdischarge of the battery with too low voltage. The voltage divider circuit is designed. After dividing the voltage with 1m and 100K resistors, the PA1 port of STM32F103C8T6 (IN1 of ADC1) is connected. After internal AD conversion, the voltage value is obtained, and the voltage data information is sent to the remote control end and displayed in real time by OLED.

4. Design of System Software

4.1 Software Design of Wireless Remote Control Terminal

First, initialize the system, and then set the wireless module to the receiving mode to judge whether the data is received, and if it is not received, it is judged again. If received, the timer T2 is interrupted. Every 0.5 seconds, the OLED displays the received data, rocker direction value and other information.

4.2 Software Design of Wireless Receiver.

First initialize the system, enable timer T2, send and receive data every 0.5 seconds, and set the wireless module to send and receive data. The water sensing module detects whether the speedboat is currently in the water, and if the speedboat is in the water, the speedboat can be controlled, otherwise the wireless remote control end cannot control the speedboat. If water is detected, the speedboat receives the command information of the remote control end and sends the voltage monitoring data to the wireless remote control terminal.

5. System Test and Analysis.

The rocker rotation information is tested by OLED at the remote control end. When the rocker is rotated, its resistance value will change accordingly. The rocker voltage value will be collected through the ADC of STM32F103RBT6 to judge its direction. OLED shows the rocker direction test

as shown in figure 7.

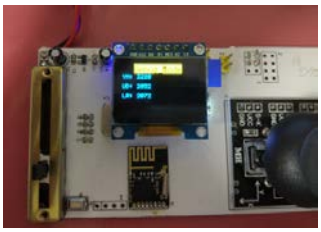

Fig.7 Rocker Direction Test

When the rocker test of the wireless remote control end is normal, the data communication test between the wireless remote control end and the wireless receiving end is carried out. After testing, the overall operation of the system is normal, the distance of the remote control is about 30 meters, the sailing time of the speedboat is about 30 minutes, and the continuous use time of the wireless remote control end can reach about 3 hours. The system operation diagram is shown in figure 8.

Fig.8 System Running Test Chart

6. Conclusion

This paper briefly introduces the hardware and software design of a wireless remote control speedboat toy. With STM32F103C8T6 as the main controller, it can wirelessly control the speedboat's forward, backward, turning and other functions, as well as adding the screen display function. The remote controller can clearly understand the power situation of the speedboat and the rotation in the rocker direction through OLED, and the whole process of the speedboat speed from slow to fast to slow can be controlled by the straight sliding potentiometer. There is a better drift experience.

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