CCD tracking avoid

The tutorial mainly demonstrates the patrol function of the balance car combined with the linear CCD module and the ultrasonic module.

```
The tutorial only introduces the standard library project code
```

Hardware connection

Ultrasonic module	STM32F103RCT6
VCC	5V
TRIG	PA0
ECHO	PA1
GND	GND

Peripherals	Development board
CCD: VCC	3.3V
CCD: AO	PA4
CCD: SLK	PB4
CCD: SI	PB5
CCD: GND	GND

Control principle

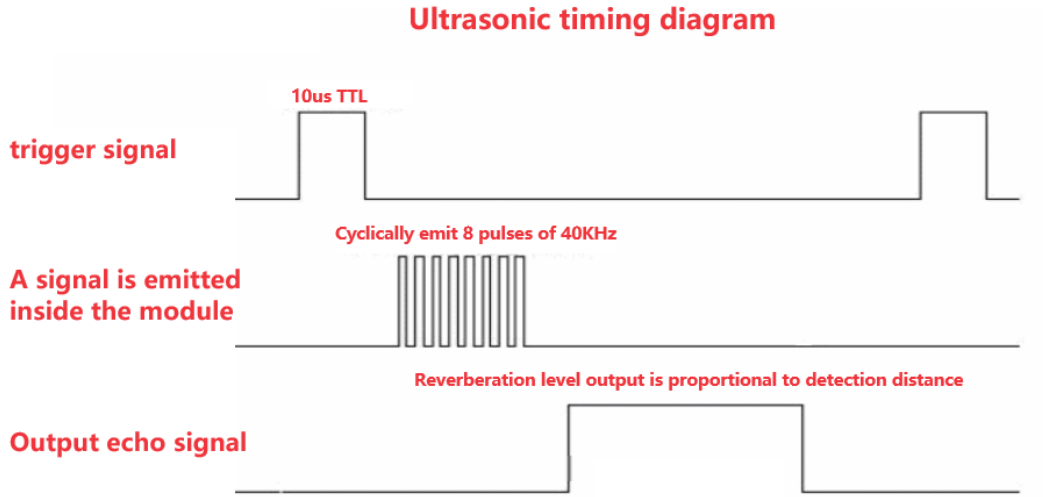
Obstacle avoidance function: Measure the distance of the obstacle in front through the ultrasonic module.

Line patrol function: The program determines the center pixel position of the black line detected by the CCD line patrol module, and compares the center pixel position with the preset CCD median value as the PID control error of the CCD line patrol.

```
Use the dynamic threshold algorithm to eliminate the influence of ambient light
on the CCD camera
```

Ultrasonic module

The ultrasonic module is mainly responsible for obtaining the distance between the obstacle and the car to achieve the obstacle avoidance function.



Trigger ranging signal

The TRIG pin sends a high level signal for more than 10us.

```
The ultrasonic module will automatically send 8 40KHz square waves and
automatically detect whether there is a signal return
```

Receive echo signal

If there is a signal return, the ECHO pin will output a high level. The duration of the high level is the time from the ultrasonic wave transmission to the return.

Distance conversion

$$D_{istance} = \frac{T_{high} * V_{speed}}{2}$$

```
T: Echo signal high level time
V: Sound speed (approximately equal to 340m/s)
```

CCD module

Peripherals	Description
CCD: VCC	Power supply pin: 3.3V-5V
CCD: AO	Gray value output pin: analog output
CCD: CLK	Clock pin, determines exposure time and controls the output of pixel gray value.
CCD: SI	Controls the acquisition and output of pixel gray value.
CCD: GND	Power supply pin: GND

> **Black line detected**

The corresponding grayscale value is low;

> **White line detected**

The corresponding grayscale value is high

Main code

The tutorial mainly explains the code for implementing the CCD line patrol and obstacle avoidance function. For detailed code, please refer to the corresponding project file.

> **Turn_CCD_PD**

CCD line patrol and obstacle avoidance adds ultrasonic distance judgment on the basis of CCD line patrol. The car stops when there is an obstacle in front.

If the line patrol effect of the balance car is not good, modify the PID parameters of the app_ccd_tracking.c file. It is not recommended to modify the PID parameters of the pid_control.c file (the PID parameters of the pid_control.c file are subject to the parameters finally confirmed in the balance car parameter adjustment tutorial).

```
int Turn_CCD_PD(float gyro)
{

    int CCDTurn = 0;
    float err = 0;

    if (g_distance < STOP_Dis && g_distance>0) //  There are obstacles ahead
    {
        return 0;
    }

    err=CCD_Zhongzhi-CCD_Minddle;

    CCDTurn=err*CCD_Trun_KP+gyro*CCD_Trun_KD;

    return CCDTurn;
}
```

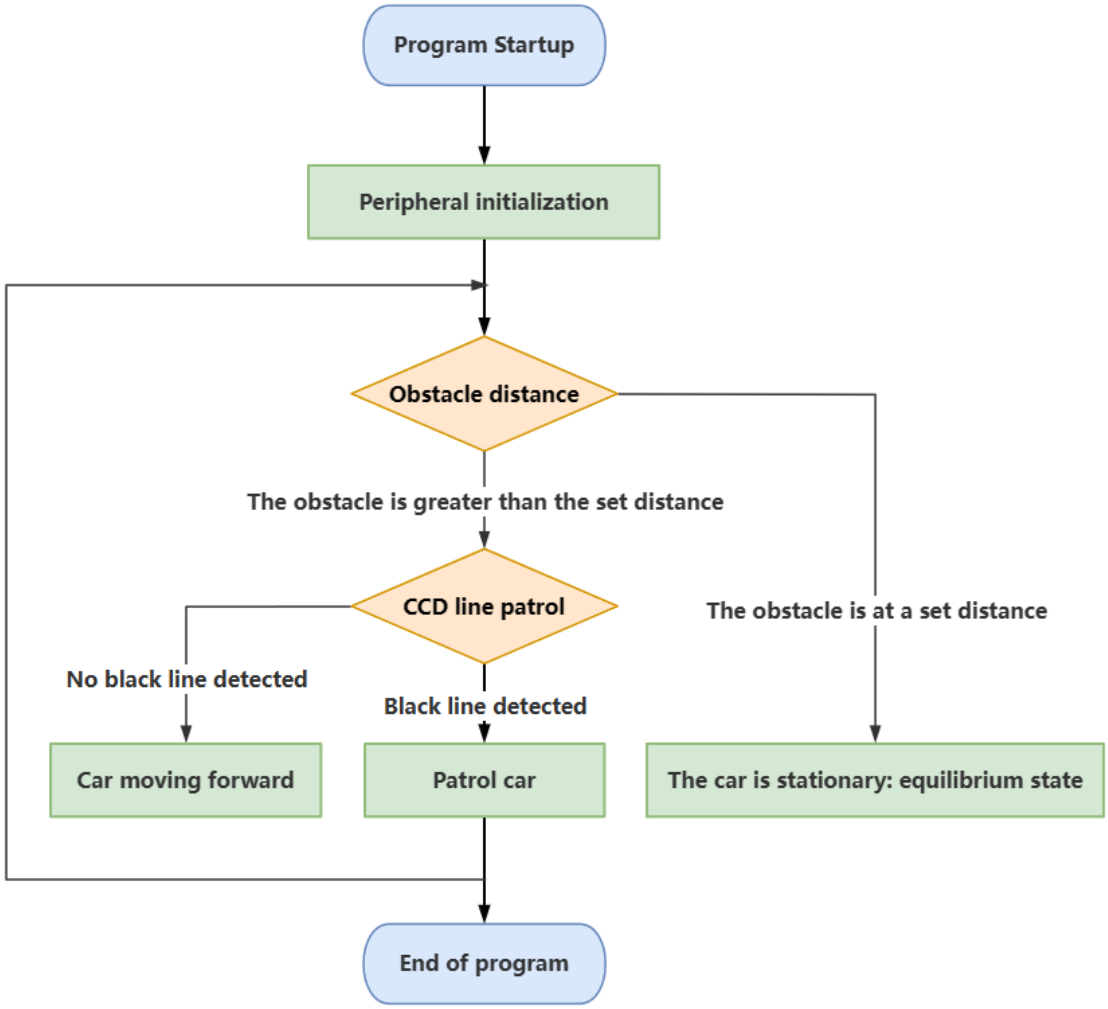
> **Set_track_speed**

```
void Set_track_speed(void)
{
    if (g_distance < STOP_Dis && g_distance>0)
    {
        Move_X = 0;// stop
        if(battery > 9.6)// Sufficient voltage
            BEEP_BEEP = 1;
        return;
    }

    if(battery > 9.6)// Sufficient voltage
            BEEP_BEEP = 0;
    Move_X = Track_Speed;
}
```

Program flow chart

Briefly introduce the process of function implementation:



Experimental phenomenon

> **Software code**

The CCD_Car_Line_stop.hex file generated by the project compilation is located in the OBJ folder of the CCD_Car_Line_stop project. Find the CCD_Car_Line_stop.hex file corresponding to the project and use the FlyMcu software to download the program.

```
Product supporting data source code path: Attachment → Source code summary →
5.Balanced_Car_Extended → 05.CCD_Car_Line_stop
```

> **Experimental phenomenon**

After the program is started, put the car on the patrol map, and press KEY1 according to the OLED prompt to start the CCD patrol obstacle avoidance function of the balance car: OLED displays CCD module data in real time in the form of a curve; when the ultrasonic wave detects an obstacle, it will sound a buzzer and stop moving to maintain balance.

```
The program has voltage detection. If the voltage is less than 9.6V, a low
voltage alarm is triggered and the buzzer will sound.
Common situations for triggering voltage alarms:
1. The power switch of the development board is not turned on, and only the Type-
C data cable is connected for power supply
2. The battery pack voltage is lower than 9.6V and needs to be charged in time
```