Human body following

1. Opening Statement

The motor driver board used in this case is the four-way motor driver board of Yaboom. If you use this driver board, please read the "Motor Introduction and Usage" in the four-way motor driver board document first to understand the motor parameters, wiring method, and power supply voltage you are currently using. This will avoid burning out the motherboard or motor.

2. Experimental Preparation

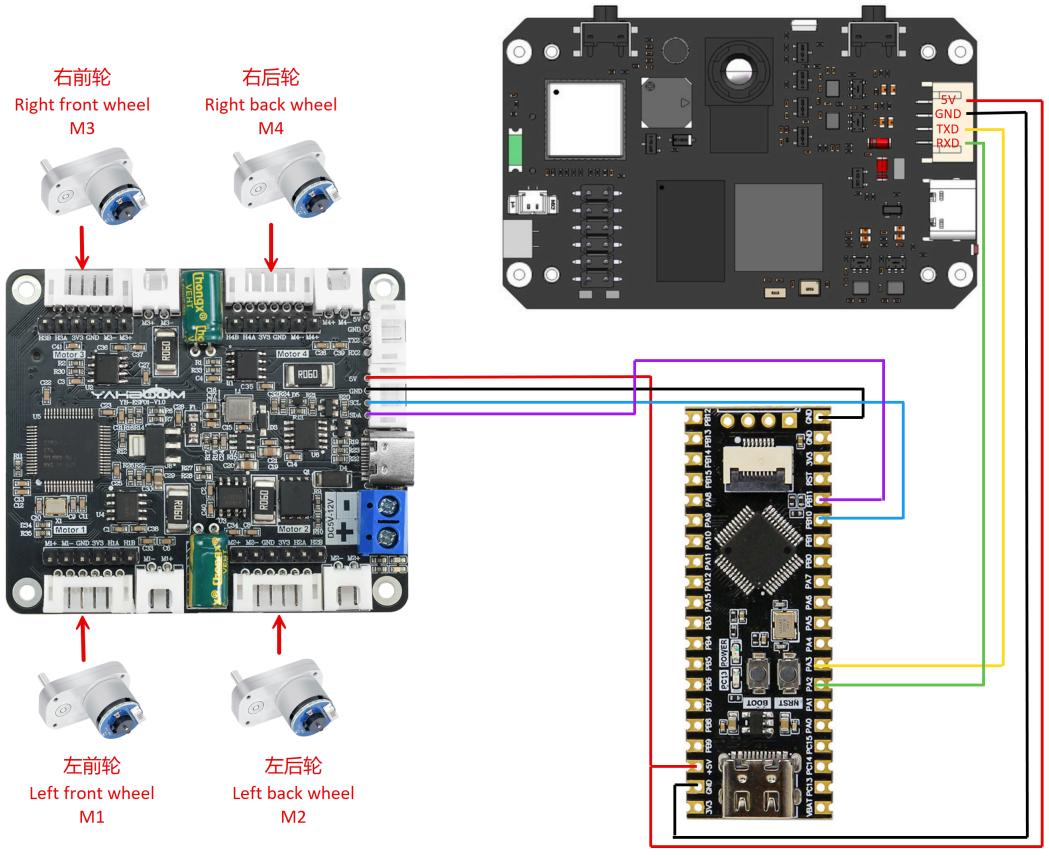
Wheeled car chassis, 4*L520 motors, 12V lithium battery, K230 vision module, Yaboom STM32F103C8T6 core board.

The relationship between the 4 motor interfaces and the car is as follows:

M1 -> Upper left motor (left front wheel of the car) M3 -> upper right motor (right front wheel of the car)

M2 -> Lower left motor (left rear wheel of the car) M4 -> Lower right motor (right rear wheel of the car)

Hardware Wiring



Wiring Pins

Four-way motor driver board	STM32F103C8T6
5V	5V
GND	GND
SCL	PB10
SDA	PB11

The following takes the M1 motor as an example, and other motors are similar:

Motor	Four-way motor driver board (Motor)
M2	M1-
VCC	3V3
A	H1A
B	H1B
GND	GND
M1	M1+

K230	STM32F103C8T6
5V	5V
GND	GND
TXD	PA3
RXD	PA2

3. Experimental Operation

1. Follow the hardware wiring instructions in the tutorial to connect.
2. Open the ProtocolHub project used by STM32, first check the beginning of the main.c file, the first thing to do is to change the number of MOTOR_TYPE to the motor you are using, after the modification is correct, compile and burn, and finally reset or power on.

3.Place Visual_line_tracking.py in the root directory of K230's sdcard and rename it to main.py, then reset or power on.

If you are not sure how to burn the program into K230, please read the K230 Quick Start tutorial first.

4. Place the car on the ground, move the K230 module bracket to a suitable angle, and connect the power supply.
5. After K230 is initialized successfully, it will start to recognize the human body. After waiting for one second, the robot will start to follow the human body.

Notice:

If you are not satisfied with the following effect, you can modify the PID value of the app_motor.c file in the ProtocolHub project.

```
#define KP (12)
#define KI (0)
#define KD (0.1)
```

4. Code analysis

- main.c

```
#define MOTOR_TYPE 5    //1:520电机 2:310电机 3:测速码盘TT电机 4:TT直流减速电机 5:L型520电机
                        //1:520 motor 2:310 motor 3:speed code disc TT motor 4:TT DC reduction motor 5:L type 520 motor


//修改当前要运行的颜色案例  Modify the color case currently being run
ColorMode color_mode = 1;  //1:巡线、2:跟踪  1: Patrol, 2: Tracking


//选择是否在初始化完成后，小车自主向前走，0为否，1为是(自主避让案例使用)
//Select whether the car moves forward autonomously after initialization is completed, 0 for no, 1 for yes (used in autonomous avoidance cases)
int Car_Auto_Drive = 0;


int main(void)
{
    //硬件初始化 Hardware Initialization
    BSP_init();
    Set_Motor(MOTOR_TYPE);


    if(Car_Auto_Drive)//K230上电初始化需要时间，等待初始化完成之后再开始前进。    It takes time for K230 to power on and initialize. Wait until the initialization is complete before moving forward.
    {

 delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);delay_ms(1000);
    }
    printf("Init Succeed\r\n");
    while(1)
    {
        Pto_Loop();
        delay_ms(10);
    }
}
```

MOTOR_TYPE: Used to set the motor type to be used. Modify the corresponding number according to the comments based on the motor you are currently using.

color_mode: Use 1 when running the visual line patrol case, and use 2 for the color tracking case

Car_Auto_Drive: Controls the car to move forward automatically after initialization. The default value is 0, which means the car does not move forward automatically. This function only needs to be enabled when using the autonomous avoidance case.

BSP_init: Hardware initialization

Set_Motor: Communicate with the four-way motor driver board and set motor related parameters

Pto_Loop: Continuously processes the received K230 messages.

- yb_protocol.c

```
/**
 * @Brief: 数据分析 Data analysis
 * @Note:
 * @Parm: 传入接受到的一个数据帧和长度    Pass in a received data frame and length
 * @Retval:
 */
void Pto_Data_Parse(uint8_t *data_buf, uint8_t num)
{
    uint8_t pto_head = data_buf[0];
    uint8_t pto_tail = data_buf[num-1];

    //校验头尾  Check head and tail
    if (!(pto_head == PTO_HEAD && pto_tail == PTO_TAIL))
    {
        //DEBUG_PRINT("pto error:pto_head=0x%02x , pto_tail=0x%02x\n", pto_head,
pto_tail);
        return;
    }

    uint8_t data_index = 1;
    uint8_t field_index[PTO_BUF_LEN_MAX] = {0};
    int i = 0;
    int values[PTO_BUF_LEN_MAX] = {0};
    char msgs[][PTO_BUF_LEN_MAX] = {0};

    //分割字段  Split Field
    for (i = 1; i < num-1; i++)
    {
        if (data_buf[i] == ',')
        {
            data_buf[i] = 0;
            field_index[data_index] = i;
            data_index++;
        }
    }

    //解析长度与功能ID  Parsing length and function ID
    for (i = 0; i < 2; i++)
```

```
    {
        values[i] = Pto_Char_To_Int((char*)data_buf+field_index[i]+1);
    }

    uint8_t pto_len = values[0];
    uint8_t pto_id = values[1];


 ParseCommonFields(pto_id,data_buf,pto_len,field_index,data_index,values,msgs);
}


//获取数据函数  Get data function
void ParseCommonFields(
    int func_index,       // 功能索引（对应func_table中的位置） Function index
(corresponding to the position in func_table)
    uint8_t *data_buf,    // 原始数据缓冲区 Raw data buffer
    uint8_t num,          // 数据总长度（含头尾）   Total length of data (including
head and tail)
    uint8_t *field_index, // 字段分隔符位置数组（逗号的位置）   Array of field
separator positions (positions of commas)
    uint8_t data_index,   // 总字段数（如数据有6个字段）    Total number of fields
(if the data has 6 fields)
    int* values,          // 存储整数字段的数组 Array to store integer fields
    char msgs[][PTO_BUF_LEN_MAX]        // 存储字符串的指针数组 Array of pointers to
store strings
){
    const FuncDesc* desc = &func_table[func_index-1];

    if(func_index != desc->id)
    {
        DEBUG_PRINT("Unsupported protocol ID: %d, Chosen ID:%d\n",
func_index,desc->id);
        return;
    }

    for (int i = 0; i < desc->field_count; i++)
    {
        const FieldMeta* meta = &desc->fields[i];
        uint8_t pos = meta->pos;

        if (meta->type == FIELD_STRING) {
            int start = field_index[pos] + 1;
            int end = (pos+1 < data_index) ? field_index[pos+1] : (num-1);
            int len = end - start;

            len = (len < PTO_BUF_LEN_MAX-1) ? len : PTO_BUF_LEN_MAX-1;
            memcpy(msgs[i], data_buf+start, len);
            msgs[i][len] = '\0';
        } else {
            values[pos] = Pto_Char_To_Int((char*)data_buf + field_index[pos] +1);
        }
    }
    desc->handler(values, msgs);
}
```

Parse the received data that conforms to the protocol, obtain the function ID number and the data information carried in the data, and execute the processing function of the corresponding function. This project uses the metadata parsing method. The core idea is to separate the description of the protocol format (field position, type, etc.) from the parsing logic, define the protocol format through data structures (such as structure arrays), and the parsing function automatically processes the data based on these descriptions.

The protocol contains different types of data that can also be parsed. If you want to know the implementation details, you can study it yourself. I won't give too many answers. This function has been adapted to all K230 communication protocols in our store, and you can use it normally without fully understanding it.

- bsp_motor_iic.c

```
//只能控制带编码器类型的电机 Can only control motors with encoders
//传入参数:4个电机的速度      Input parameters: speed of 4 motors
void control_speed(int16_t m1,int16_t m2 ,int16_t m3,int16_t m4)
{
    static uint8_t speed[8];

    speed[0] = (m1>>8)&0xff;
    speed[1] = (m1)&0xff;

    speed[2] = (m2>>8)&0xff;
    speed[3] = (m2)&0xff;

    speed[4] = (m3>>8)&0xff;
    speed[5] = (m3)&0xff;

    speed[6] = (m4>>8)&0xff;
    speed[7] = (m4)&0xff;

    i2cWrite(Motor_model_ADDR,SPEED_Control_REG,8,speed);


}


//控制带编码器类型的电机   Control the motor with encoder type
//传入参数:4个电机的pwm PWM of 4 motors
//此函数可以结合实时编码器的数据，来实现control_speed的功能   This function can combine
the data of real-time encoder to realize the function of control_speed
void control_pwm(int16_t m1,int16_t m2 ,int16_t m3,int16_t m4)
{
    static uint8_t pwm[8];

    pwm[0] = (m1>>8)&0xff;
    pwm[1] = (m1)&0xff;

    pwm[2] = (m2>>8)&0xff;
    pwm[3] = (m2)&0xff;
```

```
    pwm[4] = (m3>>8)&0xff;
    pwm[5] = (m3)&0xff;

    pwm[6] = (m4>>8)&0xff;
    pwm[7] = (m4)&0xff;

    i2cWrite(Motor_model_ADDR,PWM_Control_REG,8,pwm);


}
```

`control_speed` : Controls the speed of the motor. It splits the four motor speed values into high and low bytes, and then sends them to the motor controller via the I2C protocol to set the motor speed.

`control_pwm` : controls the PWM (pulse width modulation) value of the motor. It splits the incoming PWM values of the four motors into high and low bytes and sends them to the motor controller via the I2C protocol to control the speed and direction of the motor.

- app_engine.c

```
//控制小车运行，输入的参数分别为x、y、z三个轴上的速度值
//Control the movement of the car. The input parameters are the speed values on
the x, y, and z axes.
void Motion_Car_Control(int16_t V_x, int16_t V_y, int16_t V_z)
{
    float robot_APB = Motion_Get_APB();
    speed_lr = 0;
    speed_fb = V_x;
    speed_spin = (V_z / 1000.0f) * robot_APB;
    if (V_x == 0 && V_y == 0 && V_z == 0)
    {
        control_pwm(0,0,0,0);
        return;
    }


    speed_L1_setup = speed_fb - speed_spin;
    speed_L2_setup = speed_fb - speed_spin;
    speed_R1_setup = speed_fb  + speed_spin;
    speed_R2_setup = speed_fb  + speed_spin;

    if (speed_L1_setup > 1000) speed_L1_setup = 1000;
    if (speed_L1_setup < -1000) speed_L1_setup = -1000;
    if (speed_L2_setup > 1000) speed_L2_setup = 1000;
    if (speed_L2_setup < -1000) speed_L2_setup = -1000;
    if (speed_R1_setup > 1000) speed_R1_setup = 1000;
    if (speed_R1_setup < -1000) speed_R1_setup = -1000;
    if (speed_R2_setup > 1000) speed_R2_setup = 1000;
    if (speed_R2_setup < -1000) speed_R2_setup = -1000;
```

```
    //DEBUG_PRINT("L1:%d, L2:%d, L3:%d,
L4:%d\r\n",speed_L1_setup,speed_L2_setup,speed_R1_setup,speed_R2_setup);
    //DEBUG_PRINT("\r\n");
    if(PWM_Car_Flag)//如果小车是无编码器类型的，就直接控制pwm，否则控制速度 If the car is
encoderless, it controls PWM directly, otherwise it controls the speed
    {
        control_pwm(speed_L1_setup, speed_L2_setup, speed_R1_setup,
speed_R2_setup);
    }
    else
    {
        control_speed(speed_L1_setup, speed_L2_setup, speed_R1_setup,
speed_R2_setup);
    }
}


void HumanBody_Track(int x,int w,int h)
{
    if(!Wait_Flag)
    {
        delay_ms(1000);//delay 1s
        Wait_Flag = 1;
        return;
    }

    if(Wait_Flag && !SetTarget_Flag)
    {
        SetTarget_Flag = 1;
        target_area = w*h/100;
        DEBUG_PRINT("target_area:%d\r\n",target_area);
    }


    int now_area = w*h/100;

    int16_t err = 260 - x;
    DEBUG_PRINT("x:%d, CENTER:%d\r\n", x, 260);
    DEBUG_PRINT("err:%d\r\n", err);
    if(err<5 && err>-5)err=0;


    pid_output = PID_Calc(err);
    DEBUG_PRINT("pid_output:%d\r\n", pid_output);
    if(pid_output>400) pid_output=400;
    if(pid_output<-400) pid_output=-400;

    DEBUG_PRINT("\r\n");

    int16_t err_area = target_area - now_area;
    DEBUG_PRINT("now_area:%d, target_area:%d\r\n", now_area, target_area);
    DEBUG_PRINT("err_area:%d\r\n", err_area);

    if(err_area<60 && err_area>-60)err_area=0;
    pid_output1 = PID_Calc(err_area);
    DEBUG_PRINT("pid_output1:%d\r\n", pid_output1);
```

```
    if(pid_output1>750) pid_output1=750;
    if(pid_output1<-750) pid_output1=-750;

    DEBUG_PRINT("\r\n");

    Motion_Car_Control(pid_output1, 0, pid_output);
}
```

Motion_Car_Control: A function used to control the car. The input parameter value will be used to control the speed of the motor with encoder, and the motor without encoder will control the pwm value.

HumanBody_Track: One second after a human body is recognized, the area of the human body in the picture will be recorded. When the human body moves forward, backward, left, and right, the difference between the x-axis and the area will be calculated, and then the robot will be controlled to reduce these differences, thereby achieving the following function.

5. Experimental Phenomenon

Turn on the power switch and wait for the system to initialize. The screen will display the camera image. After recognizing a human body, the human body will be framed. After one second, it will start to follow the framed human body. In this case, when following a human body, it is recommended to try multiple times to find a suitable distance to start following. Being too close or too far will result in poor results.