自行车码表II

实验目的

- 熟练掌握中断驱动程序编程方法。

实验器材

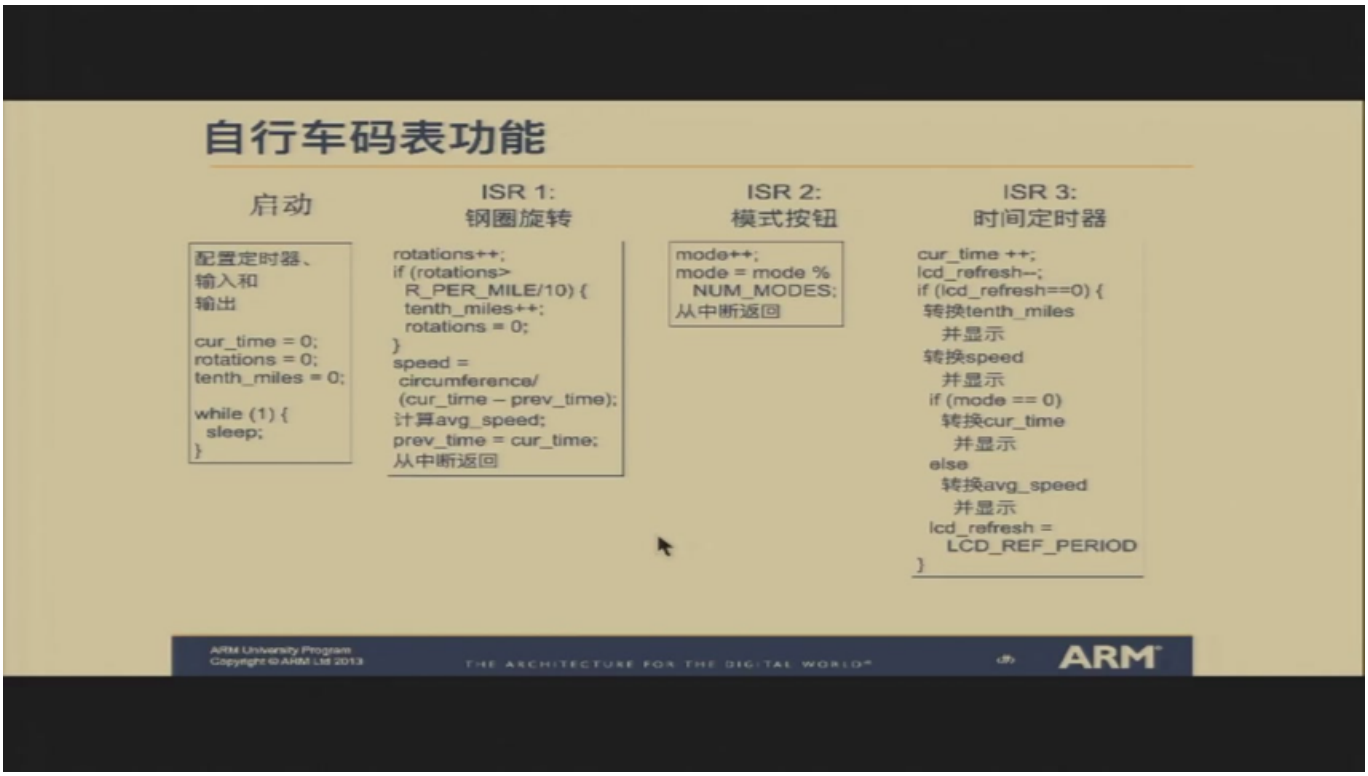
硬件

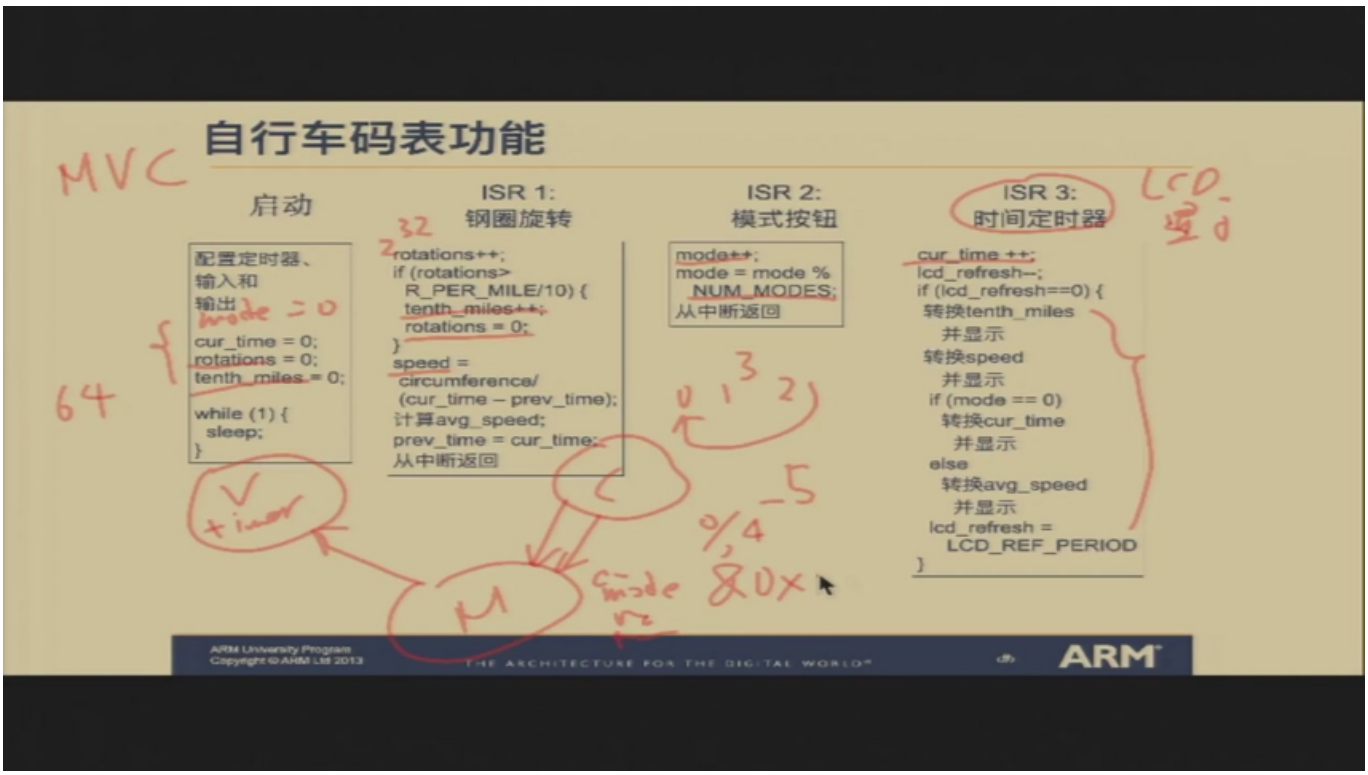
- STM32F103核心板1块；
- ST-Link 1个；
- 杜邦线(孔-孔）4根;
- 杜邦面包线（孔-针）3根;
- 面包线（针-针）若干;
- 按钮2个;
- 面包板1块。

软件

- STM32CubeIDE;
- Serial Port Utility(友善串口调试助手)

实验原理

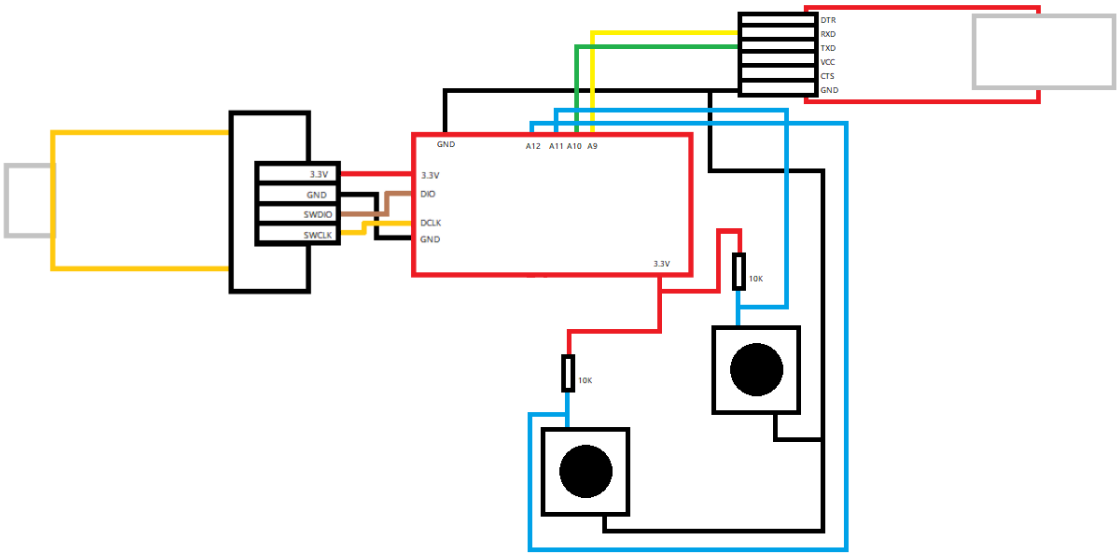




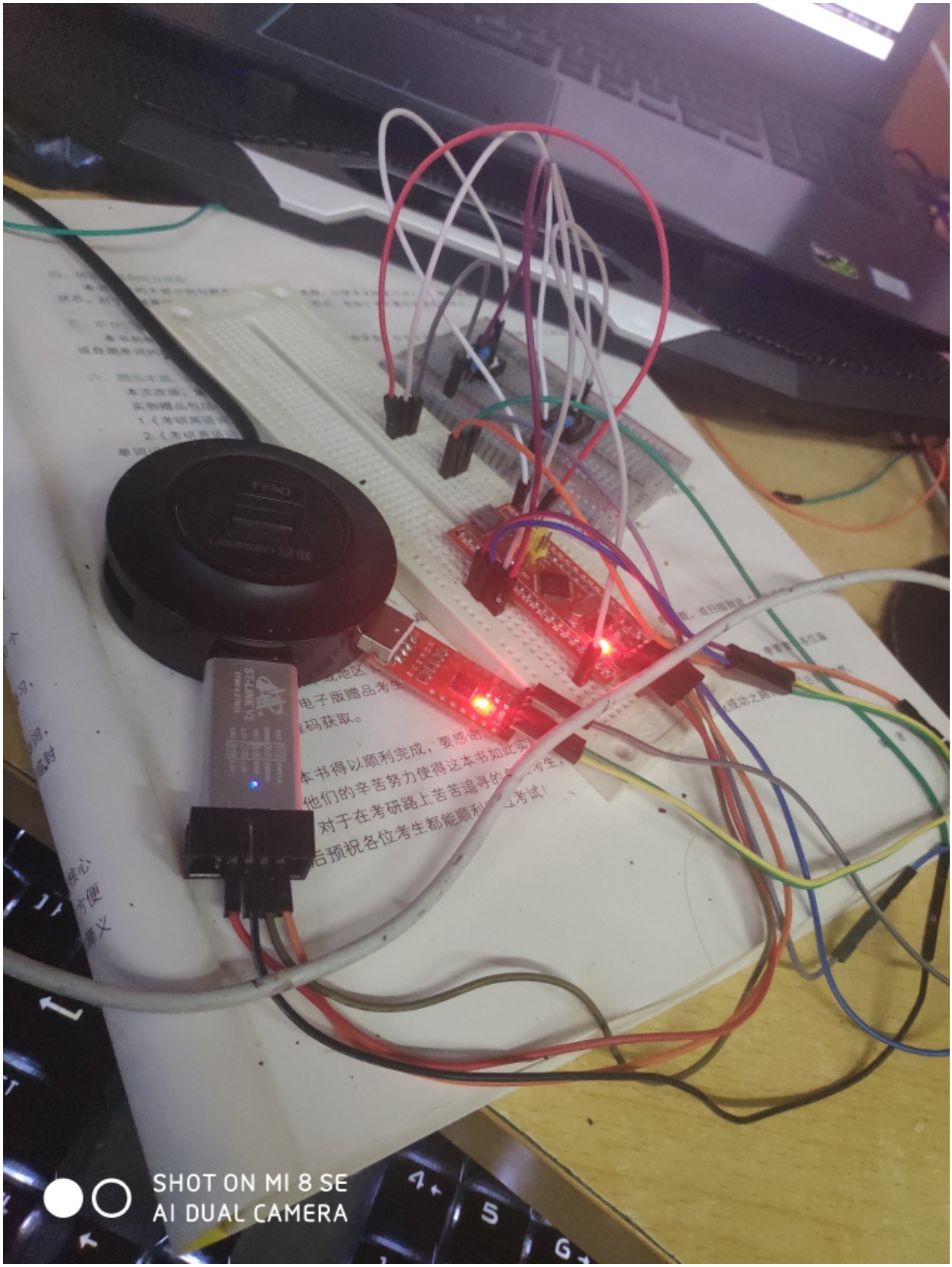
实验步骤

通过面包板在PA11和PA12各连接一个按钮开关到地；

- 连接原理图


DTR
RXD
TXD
VCC
CTS
GND
GND
A12 A11 A10 A9
3.3V
GND
SWDIO
SWCLK
3.3V
DIO
DCLK
GND
3.3V
10K
10K

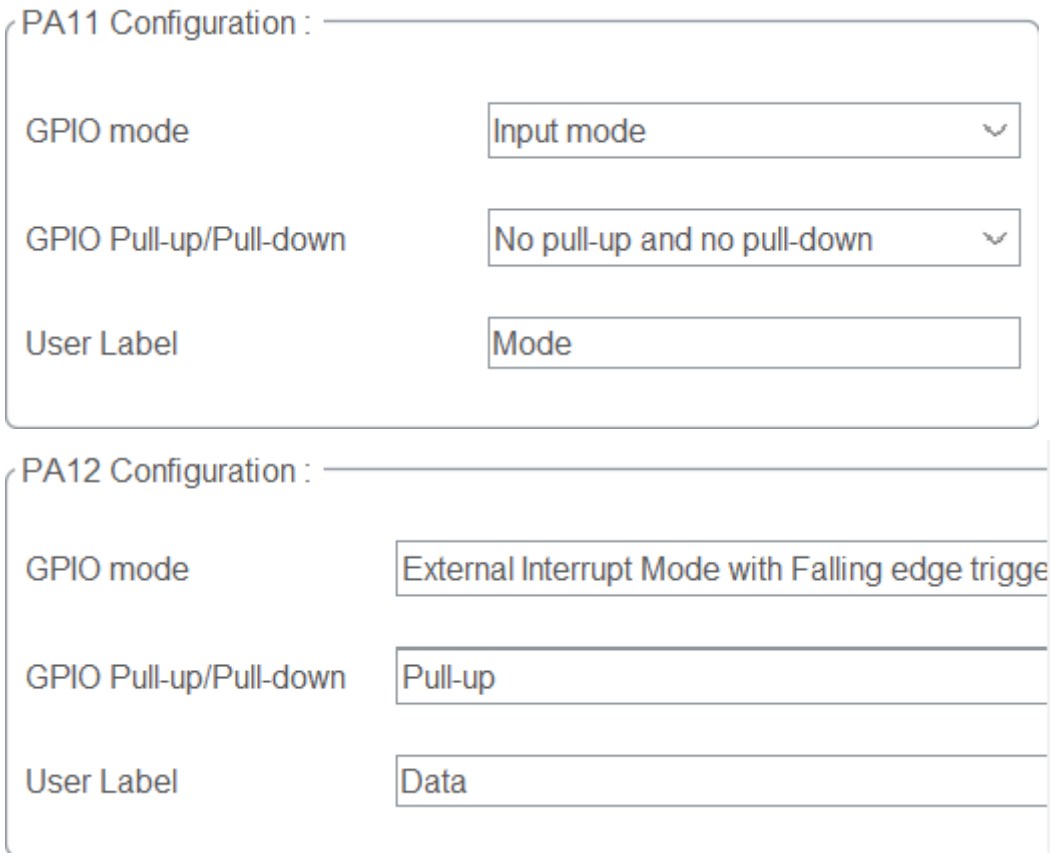
- 连接实物图



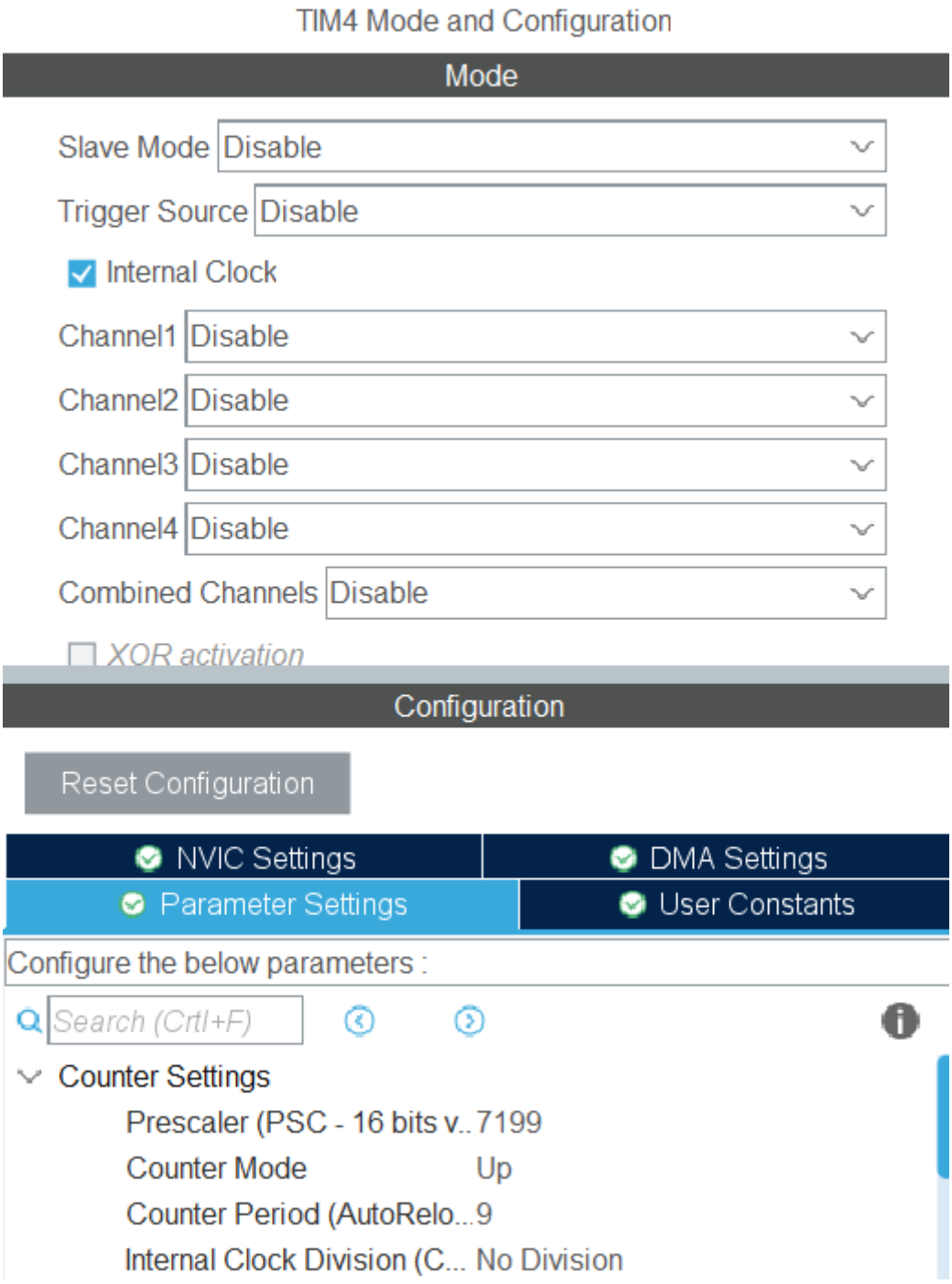
编写中断驱动模式程序，以中断处理时钟定时器和两个一个按钮（模拟钢圈计数），主程序循环中不做事情。

- 工程配置

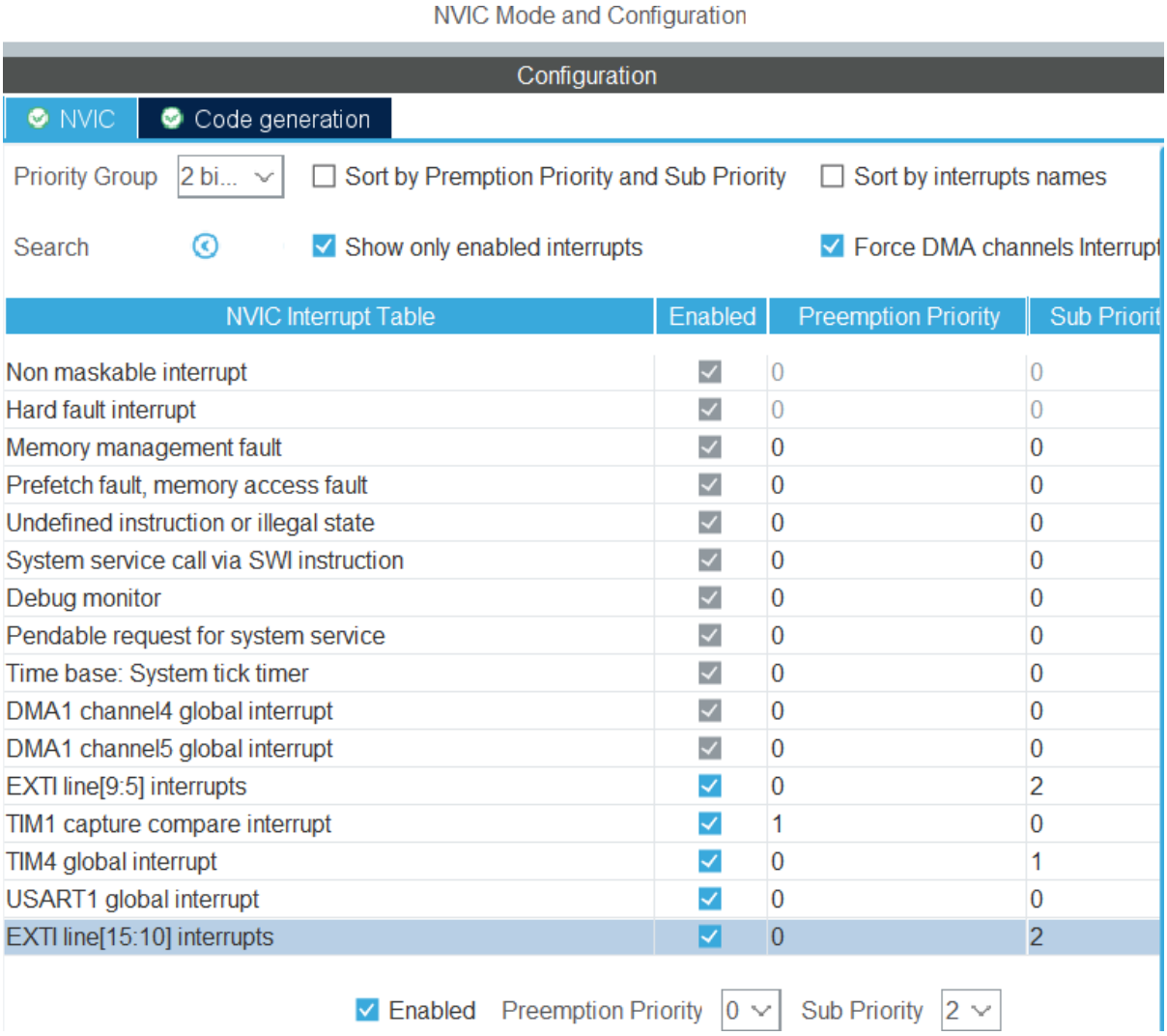
- 设置两个按钮对应引脚PA11和PA12;



- 定时器配置(1ms触发一次);



- 中断优先级设置(优先级比较是先比较组优先级，如果相同则比较子优先级，越小优先级越高);



  - 设置定时器中断优先级高于DMA中断高于外部中断

- 代码

```
/* stm32f1xx_it.c中利用Systick对PA11按钮去抖动 */
extern uint8_t BtnState;                // 按键当前状态
extern uint8_t BtnChangeFlag;           // 按键状态是否发生改变
extern uint8_t bike_watch_mode;         // 码表模式切换
void Key_Scan(void)
{
    if(HAL_GPIO_ReadPin(Mode_GPIO_Port,Mode_Pin) == GPIO_PIN_RESET)
//判断有没有按
    {
        char buf[64];
        if(btnCount == 0)
        {
            BtnState=1;                         //设置按键标志
            if(pushFlag == 0)
            {
                last = HAL_GetTick();
                pushFlag = 1;
            }
            btnCount = 0;
```

```
        }
    }
    else
    {
        btnCount = 0;
        if(BtnState == 1)
        {
            now = HAL_GetTick();
            BtnChangeFlag = 1;
            pushFlag = 0;
            HAL_GPIO_TogglePin(LED_GPIO_Port, LED_Pin);
            bike_watch_mode = (bike_watch_mode + 1) % 4;  // 4种模式
        }
        else
        {
            BtnChangeFlag = 0;
        }
        BtnState = 0;
    }

}
void SysTick_Handler(void)
{
  /* USER CODE BEGIN SysTick_IRQn 0 */
    Key_Scan();
  /* USER CODE END SysTick_IRQn 0 */
  HAL_IncTick();
  /* USER CODE BEGIN SysTick_IRQn 1 */
  HAL_SYSTICK_IRQHandler();
  /* USER CODE END SysTick_IRQn 1 */
}
/* main.c中定义全局变量 */
uint8_t BtnState = 0;                                                   // 按
键当前状态
uint8_t BtnChangeFlag = 0;                                              // 按
键是否改变状态
uint16_t bike_watch_counter = 0, bike_watch_last_counter = 0;           // 码
表计数器，加1表示转动1圈，假定转动1圈前进2.56m
uint8_t bike_watch_mode = 0, bike_time_flag = 0;                        // 码
表模式控制和码表刷新频率设置
uint16_t bike_watch_time = 0, bike_watch_time_last = 0;                 // 码
表计时器
double distance = 0, bike_speed = 0, bike_average_speed = 0;            // 路
程、速度、平均速度
/* main.c中定义引脚PA12对应按钮的外部中断回调函数 */
void HAL_GPIO_EXTI_Callback(uint16_t GPIO_Pin)
{
    if(GPIO_Pin == GPIO_PIN_12)
    {
        bike_watch_counter ++;                                          // 计
数器
        distance += 2.56 * (bike_watch_counter - bike_watch_last_counter);  // 计
算路程
        if(bike_watch_time != bike_watch_time_last)                     // 计
```

```
算速度，防止除0
            bike_speed = 2.56 * 1000 * (bike_watch_counter -
bike_watch_last_counter) / (bike_watch_time - bike_watch_time_last);
        else
            bike_speed = 0;
        bike_average_speed = 2.56 * 1000 * (bike_watch_counter) /
(bike_watch_time);    // 计算平均速度
        bike_watch_time_last = bike_watch_time;
        if(bike_watch_counter == 65536)
// 防止计数器溢出
        {
            bike_watch_counter = 0;
        }
    }
}
/* main.c中定义TIM4定时器中断回调函数 */
void HAL_TIM_PeriodElapsedCallback(TIM_HandleTypeDef *htim)
{
    if (htim->Instance == TIM4)
    {
        bike_watch_time ++;             // 计时器
        bike_time_flag ++;              // 刷新计数器
        if(bike_time_flag == 100)       // 大约100ms刷新一次
        {
            bike_time_flag = 0;
            char buf[100];
            uint16_t length;
            if(bike_watch_mode == 0)        // 模式1: 显示路程
            {
              length = sprintf(buf,"Distance: %.3fm \r\n", distance);
            }
            else if(bike_watch_mode == 1)   // 模式2: 显示时间
            {
                length = sprintf(buf, "Time: %.3fs\r\n", (float)(1.0 *
bike_watch_time / 1000));
            }
            else if(bike_watch_mode == 2)   // 模式3: 显示速度
            {
              if(bike_watch_time != bike_watch_time_last)
              {
                  length = sprintf(buf,"Speed: %.3f m/s\r\n",bike_speed);
              }
            }
            else if(bike_watch_mode == 3)   // 模式4: 显示平均速度
            {
                length = sprintf(buf, "Average Speed: %.3f m/s\r\n",
bike_average_speed);
            }
            HAL_UART_Transmit_DMA(&huart1, (uint8_t *)buf, length); // 串口输出
        }
        bike_watch_last_counter = bike_watch_counter;
    }
}
/* 扩展内容：main.c中main函数内while循环可以加入以下代码完成休眠操作，不过由于会关闭Sys
```

```
tick中断，所以需要将引脚PA11对应的按钮修改成引脚中断触发 */
HAL_SuspendTick();
__HAL_RCC_PWR_CLK_ENABLE();
HAL_PWR_EnterSLEEPMode(PWR_MAINREGULATOR_ON, PWR_SLEEPENTRY_WFI);
HAL_ResumeTick();
/* 注：最后实验没有采用实现休眠操作，因为在实验过程中发现以上代码编译下载到板子上后，后续烧录操作都会失败，需要根据实验1提供的实验指南对跳帽操作才能再次编译。 */
```

- 结果
  - 时间

```
[20:17:01.807] Time: 50.900s
[20:17:01.907] Time: 51.000s
[20:17:02.007] Time: 51.100s
[20:17:02.107] Time: 51.200s
[20:17:02.207] Time: 51.300s
[20:17:02.307] Time: 51.400s
[20:17:02.407] Time: 51.500s
[20:17:02.507] Time: 51.600s
[20:17:02.607] Time: 51.700s
[20:17:02.707] Time: 51.800s
[20:17:02.807] Time: 51.900s
[20:17:02.907] Time: 52.000s
[20:17:03.007] Time: 52.100s
[20:17:03.107] Time: 52.200s
[20:17:03.207] Time: 52.300s
[20:17:03.307] Time: 52.400s
[20:17:03.407] Time: 52.500s
```

  - 路程

```
[20:16:53.907] Speed: 0.629 m/s
[20:16:54.007] Speed: 0.000 m/s
[20:16:54.107] Speed: 0.000 m/s
[20:16:54.207] Speed: 0.000 m/s
[20:16:54.307] Speed: 9.734 m/s
[20:16:54.407] Speed: 17.902 m/s
[20:16:54.507] Speed: 17.902 m/s
[20:16:54.607] Speed: 17.902 m/s
[20:16:54.707] Speed: 10.079 m/s
[20:16:54.808] Speed: 10.079 m/s
[20:16:54.907] Speed: 10.079 m/s
[20:16:55.007] Speed: 9.922 m/s
[20:16:55.107] Speed: 9.922 m/s
[20:16:55.207] Speed: 10.894 m/s
[20:16:55.307] Speed: 10.894 m/s
[20:16:55.407] Speed: 10.079 m/s
[20:16:55.507] Speed: 0.000 m/s
[20:16:55.607] Speed: 21.880 m/s
[20:16:55.707] Speed: 21.880 m/s
[20:16:55.807] Speed: 13.264 m/s
[20:16:55.907] Speed: 13.264 m/s
[20:16:56.007] Speed: 14.545 m/s
[20:16:56.107] Speed: 14.545 m/s
[20:16:56.207] Speed: 15.610 m/s
[20:16:56.307] Speed: 0.000 m/s
[20:16:56.407] Speed: 18.824 m/s
[20:16:56.507] Speed: 18.824 m/s
[20:16:56.607] Speed: 12.995 m/s
[20:16:56.707] Speed: 29.767 m/s
[20:16:56.807] Speed: 18.824 m/s
[20:16:56.907] Speed: 43.390 m/s
[20:16:57.007] Speed: 43.390 m/s
```

- 速度

```
[20:16:57.607] Average Speed: 4.233 m/s
[20:16:57.707] Average Speed: 4.233 m/s
[20:16:57.807] Average Speed: 4.368 m/s
[20:16:57.907] Average Speed: 4.368 m/s
[20:16:58.007] Average Speed: 4.409 m/s
[20:16:58.108] Average Speed: 4.503 m/s
[20:16:58.207] Average Speed: 4.503 m/s
[20:16:58.307] Average Speed: 4.540 m/s
[20:16:58.406] Average Speed: 4.641 m/s
[20:16:58.507] Average Speed: 4.684 m/s
[20:16:58.607] Average Speed: 4.892 m/s
[20:16:58.707] Average Speed: 4.981 m/s
[20:16:58.807] Average Speed: 4.981 m/s
[20:16:58.907] Average Speed: 5.070 m/s
[20:16:59.007] Average Speed: 5.112 m/s
[20:16:59.107] Average Speed: 5.157 m/s
[20:16:59.207] Average Speed: 5.198 m/s
[20:16:59.308] Average Speed: 5.455 m/s
[20:16:59.407] Average Speed: 5.496 m/s
[20:16:59.507] Average Speed: 5.496 m/s
[20:16:59.607] Average Speed: 5.528 m/s
[20:16:59.707] Average Speed: 5.562 m/s
[20:16:59.807] Average Speed: 5.654 m/s
[20:16:59.907] Average Speed: 5.696 m/s
[20:17:00.007] Average Speed: 5.696 m/s
[20:17:00.107] Average Speed: 5.727 m/s
[20:17:00.207] Average Speed: 5.727 m/s
[20:17:00.307] Average Speed: 5.757 m/s
[20:17:00.407] Average Speed: 5.801 m/s
[20:17:00.507] Average Speed: 5.838 m/s
[20:17:00.607] Average Speed: 5.934 m/s
[20:17:00.707] Average Speed: 6.117 m/s
```

- 平均速度

```
[20:17:05.907] Distance: 670.720m
[20:17:06.007] Distance: 673.280m
[20:17:06.107] Distance: 675.840m
[20:17:06.207] Distance: 675.840m
[20:17:06.307] Distance: 678.400m
[20:17:06.407] Distance: 680.960m
[20:17:06.507] Distance: 683.520m
[20:17:06.607] Distance: 686.080m
[20:17:06.707] Distance: 686.080m
[20:17:06.807] Distance: 691.200m
[20:17:06.907] Distance: 693.760m
[20:17:07.007] Distance: 693.760m
[20:17:07.107] Distance: 711.680m
[20:17:07.207] Distance: 714.240m
[20:17:07.307] Distance: 714.240m
[20:17:07.407] Distance: 716.800m
[20:17:07.507] Distance: 721.920m
[20:17:07.607] Distance: 721.920m
[20:17:07.707] Distance: 724.480m
[20:17:07.808] Distance: 727.040m
[20:17:07.907] Distance: 734.720m
[20:17:08.007] Distance: 737.280m
[20:17:08.107] Distance: 742.400m
[20:17:08.207] Distance: 742.400m
[20:17:08.307] Distance: 742.400m
[20:17:08.407] Distance: 752.640m
[20:17:08.507] Distance: 755.200m
[20:17:08.607] Distance: 755.200m
[20:17:08.707] Distance: 765.440m
[20:17:08.807] Distance: 765.440m
[20:17:08.907] Distance: 765.440m
[20:17:09.007] Distance: 765.440m
```

- 综合

```
[20:17:03.007] Time: 52.100s
[20:17:03.107] Time: 52.200s
[20:17:03.207] Time: 52.300s
[20:17:03.307] Time: 52.400s
[20:17:03.407] Time: 52.500s
[20:17:03.508] Speed: 14.798 m/s
[20:17:03.607] Speed: 14.798 m/s
[20:17:03.707] Speed: 14.798 m/s
[20:17:03.807] Speed: 4.531 m/s
[20:17:03.907] Speed: 2560.000 m/s
[20:17:04.007] Speed: 25.098 m/s
[20:17:04.107] Speed: 25.098 m/s
[20:17:04.207] Speed: 16.732 m/s
[20:17:04.307] Speed: 16.732 m/s
[20:17:04.407] Speed: 16.732 m/s
[20:17:04.507] Average Speed: 7.646 m/s
[20:17:04.607] Average Speed: 7.646 m/s
[20:17:04.707] Average Speed: 7.621 m/s
[20:17:04.807] Average Speed: 7.621 m/s
[20:17:04.907] Average Speed: 7.640 m/s
[20:17:05.007] Average Speed: 7.726 m/s
[20:17:05.107] Average Speed: 7.750 m/s
[20:17:05.207] Average Speed: 7.750 m/s
[20:17:05.307] Average Speed: 7.768 m/s
[20:17:05.407] Average Speed: 7.768 m/s
[20:17:05.507] Average Speed: 7.768 m/s
[20:17:05.607] Distance: 665.600m
[20:17:05.707] Distance: 668.160m
[20:17:05.808] Distance: 668.160m
[20:17:05.907] Distance: 670.720m
[20:17:06.007] Distance: 673.280m
[20:17:06.107] Distance: 675.840m
```

实验心得

- 本次实验其实非常简单，一是只是将实验4的实现方式由前后台模式变为中断触发模式。算法、代码变动都不是很大。二是在课堂上老师都已经给我们详细讲解过了。
- 个人认为本次实验比较需要注意的点是：为不同的中断设置不同的优先级。实验中还遇到了一个小问题，就是传输输出字符串的字符数组开的太小了，导致PC查看到的串口输出存在乱码情况。所以如果没有特别情况需要非常节省内存空间的话，尽量还是把数组开的大一点。