HID 触控装置

NuMicro® 32 位系列微控制器范例代码介绍

文件信息

代码简述	HID 触控感应装置
BSP 版本	NUC123 Series BSP CMSIS V3.01.001
开发平台	NuTiny-EVB-NUC123-LQFP64 v1.0

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1 功能介绍

1.1 简介

本范例实作一个HID(Human Interface Device)触控装置。模拟两个输入轨迹。

1.2 原理

本装置内含控制管线(端点0)，用于控制传输。此控制管线由装置端硬件的端点0和端点1构成。从USB主机的角度看来，只会看到端点0；HID触控数据传输则是由唯一的接口完成，此接口有个中断的输入端点，此端点用于输入方向的中断传输(Interrupt Transfer)。接口和端点的关系列于表 1。

Endpoints in NUC123	Composite Device	Function
Endpoint 0 Control IN **Endpoint 1 Control OUT**	Control Pipe (Endpoint 0)	Control Transfer
Endpoint 2	Interface 0: Endpoint 1: Interrupt IN	HID Touch

表 1: HID 触控装置的接口和端点组态

接口0的触控数据，使用表 2的格式回传。此格式即是HID的报告描述元所定义的数据格式，定义了两组相同的数据结构，让此装置可同时回传两个不同的轨迹。关于触控装置报告描述元更详细的字段解说，可参考微软公司网站。

Byte	Bits	Description
0	0	Tip Switch
0	1	In Range
0	2	Touch Valid
0	3 ~ 7	Padding
1	0 ~ 7	Contact Identifier
2 ~ 3	0 ~ 7	X-axis
4 ~ 5	0 ~ 7	Y-axis
6	0	Tip Switch
6	1	In Range
6	2	Touch Valid
6	3 ~ 7	Padding
7	0 ~ 7	Contact Identifier
8 ~ 9	0 ~ 7	X-axis
10 ~ 11	0 ~ 7	Y-axis

表 2: HID 触控装置的 报告格式

1.3 执行结果

此范例需与连接个人计算机才能运行。此范例程序执行时，使用windows的设备管理器，可以

获得图 1的装置列表，HID-compliant touch screen就是此次展示的装置。

图 1:设备管理器的装置列表

图 2是使用USB封包分析仪纪录的传输封包，可看见每次交易(transaction)，有14 字节的数据以输入的方向传送。

Transaction	F	IN	ADDR	ENDP	T	Data	ACK	Time	Time Stamp
196	S	0x96	60	1	1	01 00 00 00 00 00 00 00 01 00 00 00 00 00	0x4B	1.000 ms	1 . 722 543 132
197	S	0x96	60	1	0	01 00 00 00 00 00 00 00 01 00 00 00 00 00	0x4B	999.982 us	1 . 723 543 150
198	S	0x96	60	1	1	01 00 00 00 00 00 00 00 01 00 00 00 00 00	0x4B	1.000 ms	1 . 724 543 132
199	S	0x96	60	1	0	01 00 00 00 00 00 00 00 01 00 00 00 00 00	0x4B	1.000 ms	1 . 725 543 132
200	S	0x96	60	1	1	01 00 00 00 00 00 00 00 01 00 00 00 00 00	0x4B	999.982 us	1 . 726 543 150
201	S	0x96	60	1	0	01 07 00 02 02 00 01 07 01 02 02 20 01 02	0x4B	1.000 ms	1 . 727 543 132
202	S	0x96	60	1	1	01 07 00 02 02 00 01 07 01 02 02 20 01 02	0x4B	1.000 ms	1 . 728 543 132
203	S	0x96	60	1	0	01 07 00 02 02 00 01 07 01 02 02 20 01 02	0x4B	1.000 ms	1 . 729 543 132
204	S	0x96	60	1	1	01 07 00 02 02 00 01 07 01 02 02 20 01 02	0x4B	1.000 ms	1 . 730 543 132
205	S	0x96	60	1	0	01 07 00 02 02 00 01 07 01 02 02 20 01 02	0x4B	1.000 ms	1 . 731 543 132

图 2:HID 触控装置的传输数据

在装置连加上计算机后，打开”小画家”软件，此装置会画出两条平行的轨迹，如图 3。

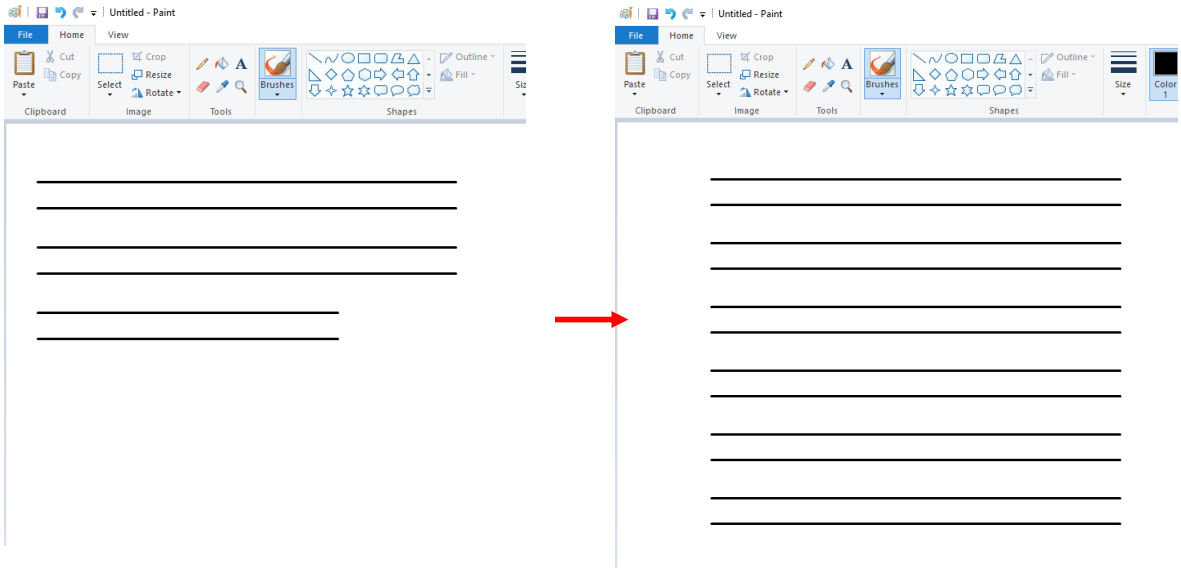


图 3: HID 触碰装置在小画家画并行线

2 代码介绍

此范例程序使用 HID 标准实现触控装置的仿真。当主机发出 IN TOKEN 时，IN 的中断传输端点使用定义于 HID 报告描述元的数据格式回传数据，如图 2。2.1~2.2 节将介绍程序处理的流程。

2.1 Main.c

While回圈内的HID_UpdateTouchData()用于数据的传输。里面实作的IN token中断产生时的处理逻辑。

```
    while(1)
    {
       HID_UpdateTouchData();
    }
```

2.2 hid_touch.c

USB主机会发出IN Token向端点2请求数据。当IN Token收到时，端点2的USBD中断处理程序会把g_u8EP2Ready设为真。当HID_UpdateTouchData ()检查到g_u8EP2Ready为真时，就会设定封包回传数据。 由于有两条轨迹同时上传，每条轨迹需要6字节的空间，每组数据前会再加上一个字节，存放Report ID。所以一次回传的数据长度总共14字节。

```
/* two lines demo in Paint */
uint32_t u32ReportCount = 0;
uint8_t u8IsX1Send04 = 0, u8IsX2Send04 = 0;
void HID_UpdateTouchData(void)
{
    uint8_t *pu8buf;
    static uint16_t u16X1 = 0x01f0, u16Y1 = 0x0100;

    if(g_u8EP2Ready)
    {

        pu8buf = (uint8_t *)(USBD_BUF_BASE + USBD_GET_EP_BUF_ADDR(EP2));

        /* Report ID 1 */
        pu8buf[0] = 1;
        pu8buf[2] = 0;
        pu8buf[8] = 1;
```

以下是画线的实作，把欲执行的触控资料填入对应的字段，使用者可以根据自己的需求更改程序，来仿真不同的轨迹效果。

```
        u32ReportCount++;

        if ((u16X1 >= 0x0200) && (u16X1 <= 0x0400)) /* touchDown */
        {
            u8IsX1Send04 = 1;

            pu8buf[1] = 0x07;
            pu8buf[3] = u16X1 & 0xff;
            pu8buf[4] = (u16X1 >> 8) & 0xff;
```

```
            pu8buf[5] = u16Y1 & 0xff;
            pu8buf[6] = (u16Y1 >> 8) & 0xff;
            pu8buf[7] = 0x07;
            pu8buf[9] = u16X1 & 0xff;
            pu8buf[10] = (u16X1 >> 8) & 0xff;
            pu8buf[11] = (u16Y1+0x20) & 0xff;
            pu8buf[12] = ((u16Y1+0x20) >> 8) & 0xff;
            pu8buf[13] = 2;
        }
        else if (u8IsX1Send04)     /* touchUp */
        {
            u8IsX1Send04 = 0;
            pu8buf[1] = 0x04;
            pu8buf[3] = 0x00;
            pu8buf[4] = 0x04;
            pu8buf[5] = u16Y1 & 0xff;
            pu8buf[6] = (u16Y1 >> 8) & 0xff;
            pu8buf[7] = 0x04;
            pu8buf[9] = 0x00;
            pu8buf[10] = 0x04;
            pu8buf[11] = (u16Y1+0x20) & 0xff;
            pu8buf[12] = ((u16Y1+0x20) >> 8) & 0xff;
            pu8buf[13] = 2;

            if (u16Y1 == 0x0100)
            {
                pu8buf[5] = 0xE0;
                pu8buf[6] = 0x02;
                pu8buf[11] = 0x00;
                pu8buf[12] = 0x03;
            }
            else
            {
                pu8buf[5] = (u16Y1-0x50) & 0xff;
                pu8buf[6] = ((u16Y1-0x50) >> 8) & 0xff;
                pu8buf[11] = ((u16Y1+0x20)-0x50) & 0xff;
                pu8buf[12] = (((u16Y1+0x20)-0x50) >> 8) & 0xff;
            }
        }
        else
        {
            pu8buf[1] = 0;
            pu8buf[3] = 0;
            pu8buf[4] = 0;
            pu8buf[5] = 0;
            pu8buf[6] = 0;
            pu8buf[7] = 0;
            pu8buf[9] = 0;
            pu8buf[10] = 0;
            pu8buf[11] = 0;
            pu8buf[12] = 0;
            pu8buf[13] = 0;
        }

        if ((u32ReportCount % 6) == 0)
            u16X1 += 0x3;

        if (u16X1 > 0x0400)
        {
            u16X1 = 0x01f0;
            u16Y1 += 0x50;
            if (u16Y1 > 0x0300)
                u16Y1 = 0x0100;
        }
```

最后设定端点2的数据长度来回传数据。

```
        g_u8EP2Ready = 0;
        USBD_SET_PAYLOAD_LEN(EP2, 14);
    }
}
```

2.3 Descriptor.c

2.3.1 HID Report Descriptor

HID_DigitizerReportDescriptor是此触控装置的HID报告描述元。此描述元定义了表 2中的数据格式。

字段的相关资料可以参考微软公司官方网站和USB开发者论坛(USB-IF)的HID Usage Table。

```
/*!<USB HID Report Descriptor */
const uint8_t HID_DigitizerReportDescriptor[] =
{
    0x05, 0x0D,         // USAGE_PAGE (Digitizers)
    0x09, 0x04,         // USAGE (Touch Screen)
    0xA1, 0x01,         // COLLECTION (Application)
    0x85, 0x01,         // REPORT_ID (1)
    0x09, 0x22,         // USAGE (Finger)

    0xA1, 0x02,         // COLLECTION (Logical)
    0x09, 0x42,         // USAGE (Tip Switch)
    0x15, 0x00,         // LOGICAL_MINIMUM (0)
    0x25, 0x01,         // LOGICAL_MAXIMUM (1)
    0x75, 0x01,         // REPORT_SIZE (1)
    0x95, 0x01,         // REPORT_COUNT (1)
    0x81, 0x02,         // INPUT (Data,Var,Abs)
    0x09, 0x32,         // USAGE (In Range)
    0x81, 0x02,         // INPUT (Data,Var,Abs)
    0x09, 0x47,         // USAGE (Touch Valid)
    0x81, 0x02,         // INPUT (Data,Var,Abs)
    0x95, 0x05,         // REPORT_COUNT (5)
    0x81, 0x03,         // INPUT (Cnst,Ary,Abs)
    0x75, 0x08,         // REPORT_SIZE (8)
    0x09, 0x51,         // USAGE (Contact Identifier)
    0x95, 0x01,         // REPORT_COUNT (1)
    0x81, 0x02,         // INPUT (Data,Var,Abs)
    0x05, 0x01,         // USAGE_PAGE (Generic Desktop)
    0x75, 0x10,         // REPORT_SIZE (16)
    0x55, 0x0E,         // UNIT_EXPONENT (-2)
    0x65, 0x11,         // UNIT (Centimeter)
    0x09, 0x30,         // USAGE (X)
    0x35, 0x00,         // PHYSICAL_MINIMUM (0)
    0x46, 0xE3, 0x13,   // PHYSICAL_MAXIMUM (0x13E3)
    0x26, 0x7F, 0x07,   // LOGICAL_MAXIMUM (0x77F)
    0x81, 0x02,         // INPUT (Data,Var,Abs)
    0x09, 0x31,         // USAGE (Y)
    0x46, 0x2F, 0x0B,   // PHYSICAL_MAXIMUM (0xB2F)
    0x26, 0x37, 0x04,   // LOGICAL_MAXIMUM (0x437)
    0x81, 0x02,         // INPUT (Data,Var,Abs)
    0xC0,               // END_COLLECTION

    0xA1, 0x02,         // COLLECTION (Logical)
    0x05, 0x0D,         // USAGE_PAGE (Digitizers)
    0x09, 0x42,         // USAGE (Tip Switch)
    0x15, 0x00,         // LOGICAL_MINIMUM (0)
    0x25, 0x01,         // LOGICAL_MAXIMUM (1)
    0x75, 0x01,         // REPORT_SIZE (1)
```

```
    0x95, 0x01,          // REPORT_COUNT (1)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0x09, 0x32,          // USAGE (In Range)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0x09, 0x47,          // USAGE (Touch Valid)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0x95, 0x05,          // REPORT_COUNT (5)
    0x81, 0x03,          // INPUT (Cnst,Ary,Abs)
    0x75, 0x08,          // REPORT_SIZE (8)
    0x09, 0x51,          // USAGE (Contact Identifier)
    0x95, 0x01,          // REPORT_COUNT (1)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0x05, 0x01,          // USAGE_PAGE (Generic Desktop)
    0x75, 0x10,          // REPORT_SIZE (16)
    0x55, 0x0E,          // UNIT_EXPONENT (-2)
    0x65, 0x11,          // UNIT (Centimeter)
    0x09, 0x30,          // USAGE (X)
    0x35, 0x00,          // PHYSICAL_MINIMUM (0)
    0x46, 0xE3, 0x13,    // PHYSICAL_MAXIMUM (0x13E3)
    0x26, 0x7F, 0x07,    // LOGICAL_MAXIMUM (0x77F)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0x46, 0x2F, 0x0B,    // PHYSICAL_MAXIMUM (0xB2F)
    0x26, 0x37, 0x04,    // LOGICAL_MAXIMUM (0x437)
    0x09, 0x31,          // USAGE (Y)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0xC0,                // END_COLLECTION

    0x05, 0x0D,          // USAGE_PAGE (Digitizers)
    0x09, 0x54,          // USAGE (Contact Count)
    0x15, 0x00,          // LOGICAL_MINIMUM (0)
    0x26, 0xFF, 0x00,        // LOGICAL_MAXIMUM (0x00FF)
    0x95, 0x01,          // REPORT_COUNT (1)
    0x75, 0x08,          // REPORT_SIZE (8)
    0x81, 0x02,          // INPUT (Data,Var,Abs)
    0x09, 0x55,          // USAGE (Contact Count Maximum)
    0x25, 0x02,          // LOGICAL_MAXIMUM (2)
    0x95, 0x01,          // REPORT_COUNT (1)
    0x85, 0x02,          // REPORT_ID (2)
    0xB1, 0x02,          // FEATURE (Data,Var,Abs)
    0xC0                 // END_COLLECTION
};
```

2.3.2 Configuration Descriptor

USB主机需要组态描述元(Configuration Descriptor)来辨识装置。gu8ConfigDescriptor是此范例使用的组态描述元，里面含有1组界面的描述。“bNumInterfaces”字段设定为1，让USB主机知道此装置有1组接口。界面描述元(Interface Descriptor)，HID描述元(HID descriptor)和端点描述元(Endpoint Descriptor)，依序列于组态描述元之后。

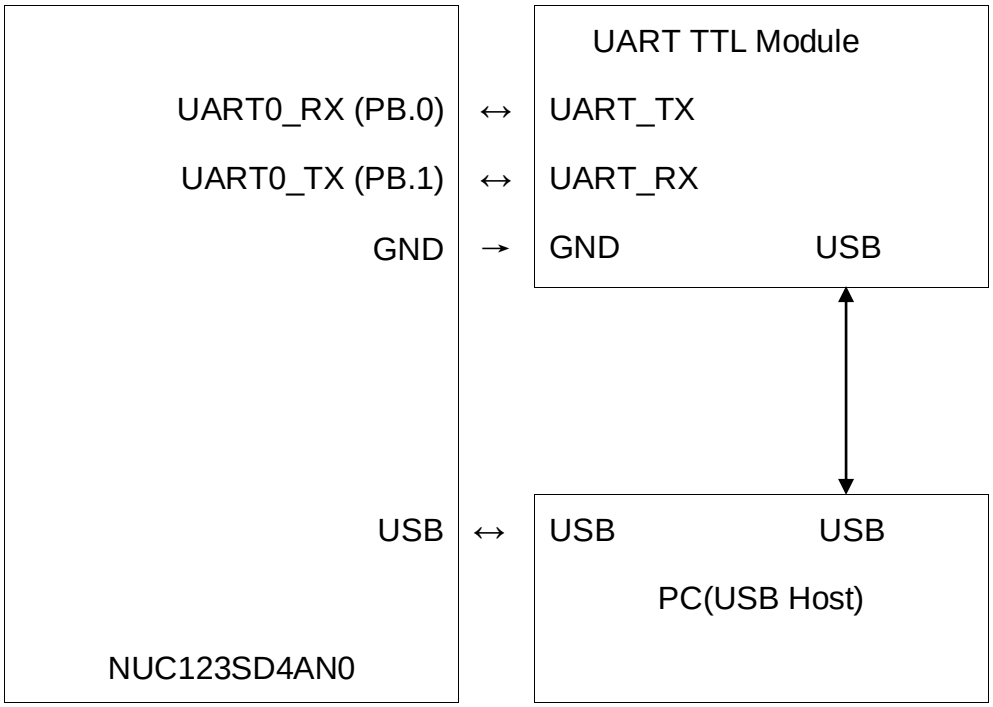
```
/*!<USB Configure Descriptor */
const uint8_t gu8ConfigDescriptor[] =
{
    LEN_CONFIG,     /* bLength */
    DESC_CONFIG,    /* bDescriptorType */
    /* wTotalLength */
    LEN_CONFIG_AND_SUBORDINATE & 0x00FF,
    ((LEN_CONFIG_AND_SUBORDINATE & 0xFF00) >> 8),
    0x01,           /* bNumInterfaces */
    0x01,           /* bConfigurationValue */
    0x00,           /* iConfiguration */
    0x80 | (USBD_SELF_POWERED << 6) | (USBD_REMOTE_WAKEUP << 5),/* bmAttributes */
    USBD_MAX_POWER, /* MaxPower */
```

```
    /* I/F descr: HID */
    LEN_INTERFACE,  /* bLength */
    DESC_INTERFACE, /* bDescriptorType */
    0x00,           /* bInterfaceNumber */
    0x00,           /* bAlternateSetting */
    0x01,           /* bNumEndpoints */
    0x03,           /* bInterfaceClass */
    0x00,           /* bInterfaceSubClass */
    HID_NONE,       /* bInterfaceProtocol */
    0x00,           /* iInterface */

    /* HID Descriptor */
    LEN_HID,        /* Size of this descriptor in UINT8s. */
    DESC_HID,       /* HID descriptor type. */
    0x10, 0x01,     /* HID Class Spec. release number. */
    0x00,           /* H/W target country. */
    0x01,           /* Number of HID class descriptors to follow. */
    DESC_HID_RPT,   /* Descriptor type. */
    /* Total length of report descriptor. */
    sizeof(HID_DigitizerReportDescriptor) & 0x00FF,
    ((sizeof(HID_DigitizerReportDescriptor) & 0xFF00) >> 8),

    /* EP Descriptor: interrupt in. */
    LEN_ENDPOINT,   /* bLength */
    DESC_ENDPOINT,  /* bDescriptorType */
    (INT_IN_EP_NUM | EP_INPUT), /* bEndpointAddress */
    EP_INT,         /* bmAttributes */
    /* wMaxPacketSize */
    EP2_MAX_PKT_SIZE & 0x00FF,
    ((EP2_MAX_PKT_SIZE & 0xFF00) >> 8),
    HID_DEFAULT_INT_IN_INTERVAL     /* bInterval */
};
```

3 软件与硬件环境

- 软件环境
  - BSP 版本
    - NUC123 Series BSP CMSIS V3.01.001
  - IDE 版本
    - Keil uVersion 5.26
  - USB 封包撷取工具
    - USBLyzer (http://www.usblyzer.com/)
- 硬件环境
  - 电路组件
    - NuTiny-EVB-NUC123-LQFP64 v1.0
    - USB mini USB cable
    - USB-UART TTL(Optional)
    - USB packet analyzer(Optional)

■ 示意图


UART TTL Module
UART0_RX (PB.0)
↔
UART_TX
UART0_TX (PB.1)
↔
UART_RX
GND
→
GND
USB
USB
↔
USB
USB
PC(USB Host)
NUC123SD4AN0

4 目录信息

- EC_NUC123_USBD_HID_Touch_V1.00
  - Library — Sample code header and source files
    - CMSIS — Cortex® Microcontroller Software Interface Standard (CMSIS) by Arm® Corp.
    - Device — CMSIS compliant device header file
    - StdDriver — All peripheral driver header and source files
  - SampleCode
    - ExampleCode — Source file of example code

5 如何执行范例程序

1. 根据目录信息章节进入 ExampleCode 路径中的 KEIL 文件夹，双击 NUC123_USBD_HID_Touch.uvproj。
2. 进入编译模式接口
   a. 编译
   b. 下载代码至内存
   c. 进入 / 离开除错模式
3. 进入除错模式接口
   a. 执行代码

6 修订纪录

Date	Revision	Description
Nov. 01, 2019	1.00	1. 初始发布.

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