9/15/98

Button Project for Monitor Control

KEYWORDS USB, HID, Win'98 WDM, H11A, Interrupt Pipe, OOC, Retrigger

Introduction: USB provides an untouched measure for PC peripheral vendors to design a wealthy amount of yet value-added PC peripheral devices. Furthermore, Win'98 WDM HID-class device supporting makes it possible to reduce the cost, shorten the time-to-market of products. In this application note, a few buttons are deployed together with our proprietary auto-brightness circuit to exploit some new interesting features for monitor control, hence add values for monitor. Additionally, the strength of H11A was further utilized to show its high performance in our design.

Button Board functionality:
In this project, a small board was made which can be directly mounted on our basic H11A demo board. This small board was designed for both Motolora and Philips MCU. Following figure shows the button board functions. In summary, they are

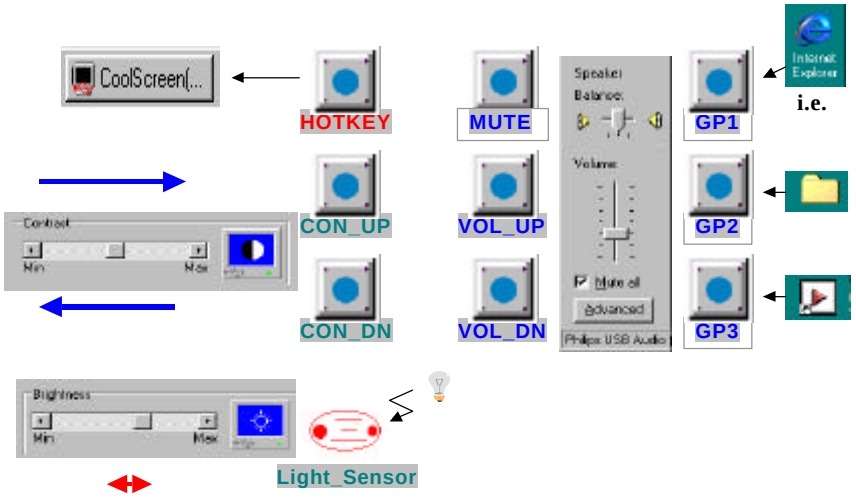

Figure 1 Button functionality illustration

- Automatic adjustment of monitor brightness (**Light_Sensor**)

Monitor brightness can be automatically adjusted following the ambient lighting condition. On button board, one commonly used light sensor together embedded MCU in monitor was made to acquire the ambient light, then, the monitor brightness can be automatically adjusted. (For more information about auto-brightness, refer to Aug. Newsletter of APIC). This is low-cost implementation because of no ADC was used.
Additionally, this capability can be enabled/disabled manually by CoolScreen.

- Audio playback control examples (**VOL_UP, VOL_DN, MUTE**)

Three most common audio control buttons: Volume Up, Volume Down and Mute were set shown as in Fig.1. In addition, the CoolScreen was made synchronized with audio control. This functionality has great performance because no additional else driver but Win'98 HID class driver is required to support USB audio speaker and non-USB audio speaker. But something has to be remembered during design the device-embedded firmware.
Audio control provided here is only some examples of all audio control. From here, it can be imaged that all of the

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audio playback controls can be made low-cost with USB HID-class driver of Win'98 WDM. In addition, this audio control isn't like that the USB audio class provides, it is HID-compliant

- User-defined Application buttons (**GP1,GP2,GP3**)

These three buttons provides user free selection of their favorite application. Once one button was pressed, then one of famous applications was launched.

- Synchronization between OSD buttons (**CON_UP** and **CON_DN**) and CoolScreen applet

Here only contrast up and contrast down of possible OSD controls are demonstrated. Pressing Contrast up/down will increase/reduce the contrast of the monitor and at the same time the CoolScreen scroll bar will move to right/left in synchronization to contrast variation.

- HotKey for CoolScreen Applet popping

Any OSD or Audio button pressed action will pop up CoolScreen applet.

Device interface definition and button Usage type for functionality:

In this design, H11A is utilized to implement Hub and USB composite device that consists of monitor control and audio control. So OS enumerates two independent devices: Philips Hub and one composite device.

Originally, we tried to use a single interface to encapsulate both monitor control and audio playback control. For monitor control implementation convenience, we use report ID to separate each feature item for monitor control, for example, brightness, contrast, etc., that will greatly reduce data transfer workload from firmware perspective and relieve the pain of writing the proprietary driver (DLL file) from software perspective. In this case, the audio control must be given a report ID before the true control. However, even the audio control can be successfully enumerated by OS (in this case, the audio control report descriptor is required to be defined as an independent top-collection), it doesn't work because HID driver doesn't bypass the report ID before the true control data, then application cannot be controlled. This flaw of HID driver requires us to use either two interfaces or one interface but two alternate settings. Two alternate settings require the Applet to switch between the two settings, so it is application-dependent, this is not the hope of device designer.

Two interfaces under one configuration should be the preference. It is especially true for H11A because it has so many free endpoints in normal use that we can add many interfaces as required. One interface is designed for Philips Monitor control---CoolScreen purpose, the other is for Audio playback control. So it is a composite device under USB device entry in the Device Manager List.

Device class is defined in device descriptor, configuration descriptor and interface descriptor by firmware at device-level. Win'98 will read those descriptors and load the correct class driver to parser and transfer the data returned from/to device. For HID device, after it is successfully enumerated, WDM HID-class drivers (hidclass.sys, hidusb.sys, hidparse.sys) will be loaded and parser HID report descriptor. WDM HID-class supporting architecture affects the device implementation at device-level, i.e., each descriptor content and report descriptor structure.

In the HID-class device, most of monitor control parameters are defined as FEATURE items of HID report, but the brightness and contrast were defined as INPUT as well. All those buttons are defined as INPUT. In addition, there is one item defined as OUTPUT to control auto-brightness enabled/disabled by Applet.

Normally, each button usage type should be defined following the way the defined functionality works. In this device, only two types of buttons are defined: OOC and Retrigger. OOC means ON/OFF Control, Retrigger means until button was released, the sound volume or monitor contrast will continuously change. So MUTE button of audio control, three general purpose buttons, GPx, and HOTKEY button for popping up CoolScreen must be defined as OOC-type, the volume Up/Down and Contrast Up/ Down must be defined as Retrigger-type.

OOC-type has three definitions according to HID usage Table. We choose one: A 0 to 1 transition toggles On/Off control, i.e., first 0-1 transition turn ON, next 0-1 transition turns OFF. For OOC-type button, the data returned to

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Host should be defined as Fig.2

Figure 2 OOC-type data definition

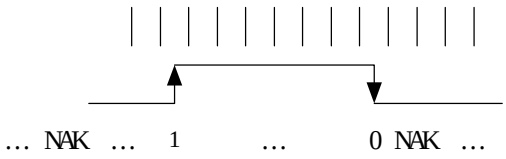

Figure 3 Retrigger type data definition

For other buttons, the data returned to Host is defined as in Fig.3. INPUT report is transferred to Host uni-directionally through interrupt pipe. Interrupt transfer means device doesn't respond until there is interrupt data pending, for buttons, that means, there is no data transfer until existing buttons are pressed at the time the Host polls this endpoint.

HID report descriptor:

Following report descriptor follows what is discussed above. These descriptors can help to understand HID-class origin.

```
;*****************************
;* STANDARD DEVICE DESCRIPTOR
;*****************************
EMB_STAND_DEV_DESC:
      DB    12H   ;0          BLENGTH
      DB    01H   ;1          BDESCRIPTORTYPE
      DB    00H   ;
      DB    01H   ;2-3        VERSION 1.00 USB SPEC WORD
      DB    00H   ;;04H   ;4       CLASS
      DB    00H   ;;01H   ;5       BDEVICESUBCLASS
      DB    00H   ;;0FFH         ;6 BDEVICEPROTOCOL
      DB    08H   ;7          BMAXPACKETSIZE0
      DB    71H,04H           ;8-9,IDVENDOR
      DB    00H,00H           ;00H,00H   ;A-B,IDPRODUCT
      DB    00H,00H           ;C-D,BCDDEVICE
      DB    00H   ;E          IMANUFACTURER
      DB    00H   ;F          IPRODUCT
      DB    00H   ;10         ISERIALNUMBER
      DB    01H   ;11         BNUMCONFIGURATIONS

EMB_CONFIG_DESC:
      DB    09H   ;0
      DB    02H   ;1
      DB    CONF_LENGTH ;configuration length
      DB    00h
;     DB    01H   ;only one interface
      DB    02H   ;TWO INTERFACES
      DB    01H   ;5
      DB    00H   ;6
      DB    0C0H  ;7
      DB    32H   ;8

EMB_INTERFACE_DESC:
      DB    09H   ;0
      DB    04H   ;1
      DB    00H   ;2, No.0 interface
      DB    00H   ;3
      DB    01H   ;4
      DB    03H   ;5
```

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```
      DB    01H   ;6
      DB    00H   ;7
      DB    00H   ;8

EMB_HID_DESC:
      DB    09H         ;DESCRIPTOR LENGTH
      DB    21H         ;DESCRIPTOR TYPE
      DB    00H         ;
      DB    01H
      DB    00H
      DB    01H
      DB    22H
      DB    REPORT_LENGTH           ;REPORT LENGTH
      DB    0H

EMB_ENDP1_INT_DESC:
      DB    07H   ;0
      DB    05H   ;1
      DB    81H   ;2
      DB    03H   ;3
      DB    8,0   ;4-5
      DB    0ffH  ;255 ms
;--------------------------
EMB_INTERFACE1_DESC:
      DB    09H   ;0
      DB    04H   ;1
      DB    01H   ;2    No.1 INTERFACE
      DB    00H   ;3
      DB    01H   ;4
      DB    03H   ;5
      DB    01H   ;6
      DB    00H   ;7
      DB    00H   ;8
;
EMB_HID1_DESC:
      DB    09H
      DB    21H
      DW    100H
      DB    00H
      DB    01H
      DB    22H
      DB    REPORT1_LENGTH          ;REPORT LENGTH
      DB    0H

EMB_ENDP1_INT_DESC1:
      DB    07H   ;0
      DB    05H   ;1
      DB    82H   ;2, ENDPOINT ADDRESS
      DB    03H   ;3, INTERRUPT
      DB    8,0   ;4-5
      DB    0ffh  ;255 ms
;=======================================
EMB_REPORT_DESC:
      DB    05H,080H          ;USAGE PAGE( MONITOR)
      DB    09H,01H           ;USAGE ( MONITOR CONTROL)
      DB    0A1H,01H          ;COLLECTION( APPLICATION)
      DB    15H,00H           ;LOGICAL MINIMUM(0)
```

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```
      DB    26H,0FFH,00       ;LOGICAL MAXIMUM(255)
;----
      DB    75H,08            ;REPORT SIZE( 8 BIT)
      DB    95H,07H           ;REPORT COUNTER ( 7)
      DB    85H,0FDH          ;REPORT ID ( FD)
      DB    09H,0FDH          ;USAGE ( FD)
      DB    0B2H,02H,01       ;FEATURE ( DATA,VAR,ABS, BUF)
;----
      DB    05H,082H          ;USAGE_PAGE ( VESA VIRTUAL CONTROL)
      DB    75H,10H           ;REPORT SIZE( 16 BIT)
      DB    95H,01H           ;REPORT COUNTER( 1 BYTES)
;----
      DB    85H,01H           ;REPORT ID( 1H)
      DB    09H,01H           ;USGAE ( DEGAUSS)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,10H           ;REPORT ID( 10H)
      DB    09H,10H           ;USGAE ( BRIGHTNESS)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;
      DB    09H,10H           ;USAGE ( BRIGHTNESS)
      DB    81H,02H           ;INPUT ( DATA, VAR,ABS)
;----
      DB    85H,12H           ;REPORT ID( 12H)
      DB    09H,12H           ;USGAE ( CONTRAST)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;
      DB    09H,12H           ;USAGE ( CONTRAST)
      DB    81H,02H           ;INPUT (DATA,VAR,ABS)   ;CONTRAST UP/DOWN
;----
      DB    85H,16H           ;REPORT ID( 16H)
      DB    09H,16H           ;USGAE ( R GAIN)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,18H           ;REPORT ID( 18H)
      DB    09H,18H           ;USAGE ( G GAIN)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,1AH           ;REPORT ID( 1AH)
      DB    09H,1AH           ;USAGE ( B GAIN)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,20H           ;REPORT ID( 20H)
      DB    09H,20H           ;USAGE ( HORIZONTAL POSITION)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,22H           ;REPORT ID( 22H)
      DB    09H,22H           ;USAGE ( HORIZONTAL SIZE)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,24H           ;REPORT ID( 24H)
      DB    09H,24H           ;USGAE ( HORIZONTAL PIN)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,30H           ;REPORT ID( 30H)
      DB    09H,30H           ;USAGE ( VERTICAL POSITION)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
```

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```
;----
      DB    85H,32H           ;REPORT ID( 32H)
      DB    09H,32H           ;USAGE ( VERTICAL SIZE)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,42H           ;REPORT ID( 42H)
      DB    09H,42H           ;USAGE ( TRAPEZOIDAL)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,44H           ;REPORT ID( 44H)
      DB    09H,44H           ;USAGE ( TILT)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,0ACH          ;REPORT ID( ACH)
      DB    09H,0ACH          ;USAGE ( HORI. FREQ)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;----
      DB    85H,0AEH          ;REPORT ID( AEH)
      DB    09H,0AEH          ;USAGE ( VERTI. FREQ)
      DB    0B1H,02H          ;FEATURE ( DATA,VAR,ABS)
;-------------
      DB    85H,0B0H          ;REPORT ID( B0H)
      DB    75H,02H           ;REPORT SIZE( 2 BIT)
      DB    95H,01H           ;REPORT COUNTER( 1 BYTES)
;-------------
      DB    15H,01H           ;LOGICAL MINIMUM(1)
      DB    25H,03H           ;LOGICAL MAXIMUM(3)
      DB    09H,0B0H          ;USAGE ( SETTING)
      DB    0A1H,02           ;COLLECTION ( LOGICAL)
      DB    05H,81H           ;USGAE_PAGE( MONITOR ENUM VALUES)
      DB    09H,01H           ;USAGE ENUM 1
      DB    09H,02H           ;USGAE ENUM 2
      DB    09H,03H           ;USGAE ENUM 3
      DB    0B1H,00H          ;FEATURE ( DATA,ARRAY,ABS)
      DB    75H,06H           ;REPORT SIZE (6 BITS)
      DB    0B1H,01H          ;FEATURE (CONSTANT)
      DB    0C0H              ;END COLLECTION
;---------------
      DB    05H,0CH           ;USAGE PAGE( CONSUMER DEVICE)
      DB    09H,01H           ;UASGE(CONSUMER CONTROL)
      DB    0A1H,01H                ;COLLECTION(APPLICATION)
      DB    15H,00H                 ;LOGICAL MINIMUM(0)
      DB    25H,01H                 ;LOGICAL MAXIMUM (1)
      DB    75H,01H                 ;REPORT SIZE( 1)  ;FROM HERE ON, REPORT
SIZE IS ALWAYS 1
;
      DB    85H,041H                ;REPORT ID( 41H)
      DB    95H,01H                 ;REPORT COUNT( 1) ;APPLET Menu hotkey
      DB    09H,40H                 ;USAGE ( MENU)
      DB    81H,02H                 ;INPUT (DATA,VAR,ABS)
      DB    95H,07H                 ;REPORT COUNT( 7)
      DB    81H,01H                 ;INPUT(CONSTANT)
;
      DB    85H,37H                 ;REPORT ID( 37H)
      DB    95H,03H                 ;REPORT COUNT( 3)
      DB    09h,36h                 ;usage (Function Buttons)
      DB    0a1h,01h                ;Collection(Application)
```

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```
      DB    05H,09H                         ;USAGE PAGE(BUTTONS)
      DB    09H,01H                         ;USAGE(BUTTON_1)  ;GP1
      DB    09H,02H                         ;USAGE(BUTTON_2)  ;GP2
      DB    09H,03H                         ;USAGE(BUTTON_3)  ;GP3
      DB    81H,02H                         ;INPUT (DATA,VAR,ABS)
      DB    0c0h                      ;end_collection
      DB    95H,0DH                   ;REPORT COUNT( 13)
      DB    81H,01H                   ;INPUT(CONSTANT)
;
      DB    85H,08H                   ;REPORT_ID(8)
      DB    05H,08H                   ;USAGE_PAGE(LEDS)
      DB    09H,09H                         ;USAGE(MUTE)
      DB    95H,01H                         ;REPORT_COUNT(1)
      DB    91H,02H                         ;OUTPUT(DATA,VAR,ABS)
      DB    95H,07H                         ;REPORT_COUNT(7)
      DB    91H,01H                         ;OUTPUT(CONST)
;
      DB    0C0H                      ;END_COLLECTION
      DB    0C0H                ;END_COLLECTION
EMB_REPORT_DESC_END:
;
EMB_REPORT1_DESC:
      DB    05H,0CH             ;USAGE PAGE (CONSUMER DEVICES)
      DB    09H,01H             ;USAGE (CONSUMER CONTROL)
      DB    0A1H,01H            ;COLLECTION(APPLICATION)
;     DB    85H,0E2H            ;REPORT ID( E2H)
      DB    15H,00H             ;LOGICAL_MINIMUM(0)
      DB    25H,01H             ;LOGICAL_MAXIMUM(1)
      DB    09H,0E9H            ;USAGE(VOLUME UP)
      DB    09H,0EAH            ;USAGE(VOLUME DOWN)
      DB    75H,01H             ;REPORT_SIZE(1)
      DB    95H,02H             ;REPORT_COUNT(2)
      DB    81H,02H             ;INPUT(DATA,VAR,ABS)
      DB    09H,0E2H            ;USAGE(MUTE)
      DB    95H,01H             ;REPORT_COUNT(1)
      DB    81H,02H             ;INPUT(DATA,VAR,ABS)
      DB    95H,05H             ;REPORT_COUNT(5)
      DB    81H,01H             ;INPUT(CONST)
      DB    0C0H                ;END_COLLECTION
;-------
EMB_REPORT1_DESC_END:
;
;---------------------------------------------
; descriptor length
;---------------------------------------------
CONF_LENGTH       EQU   EMB_REPORT_DESC-EMB_CONFIG_DESC
REPORT_LENGTH     EQU   EMB_REPORT_DESC_END-EMB_REPORT_DESC
REPORT1_LENGTH    EQU   EMB_REPORT1_DESC_END-EMB_REPORT1_DESC
;
      END
```

Conclusion:

Following figure is the result OS enumerate this device, the HID-compliant consumer device is the HID-based audio control, the other HID-compliant device services monitor control. Besides, in the Universal Serial Bus Controller entry, there exists a composite device. This is defined by the standard device descriptor. HID-compliant devices are defined by interface descriptor.

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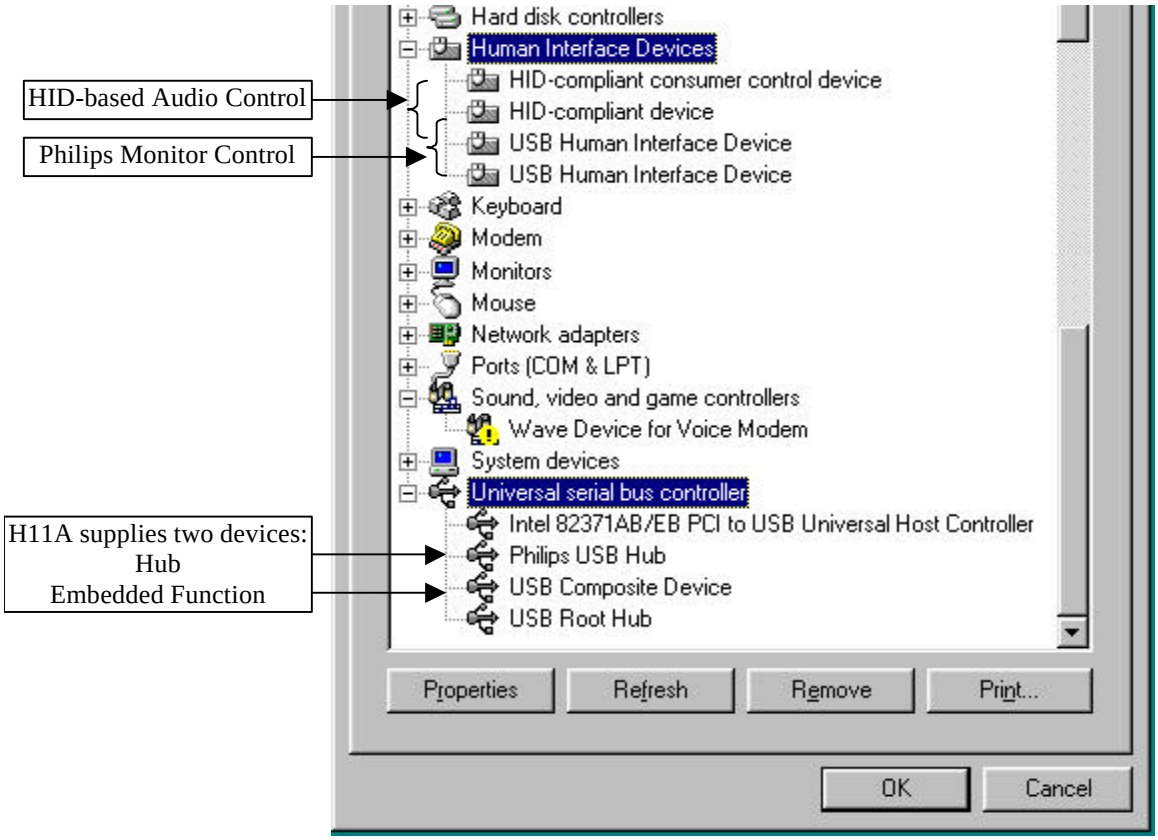

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