STEAMVR™
Tracking Training

STEAM®VR
Tracking Training

Firmware

Firmware

Chris Pezzee

Senior Firmware Engineer - Synapse

chris.pezzee@synapse.com

Overview

- Firmware capabilities of the HDK

- Customization options

- Firmware logging

- Firmware update

Firmware Features

- Core functionality (tracking)

- Controller mode

- HMD mode

Controller and HMD modes modify the core Tracking function

"Controller" and "HMD" are not mandatory boxes; guiding concepts

Firmware - Core

Core Functions:

- Tracked object: up to 32 sensors (USB) / 28 (Wireless)

- USB or 2.4 GHz radio link to PC

- Battery management: charger, fuel gauge

- Firmware update: MCU, FPGA, radio

Firmware - Controller

Controller mode:

- 250 Hz IMU (wireless limit)

- Trackpad: Cirque GlidePoint

- Analog trigger: Hall Effect sensor and magnet

- Haptic motor: force feedback / rumble

- 5 clickable buttons: system, trigger, trackpad, A (menu), B (aux)

Firmware - HMD

HMD mode:

- 1000 Hz IMU

- Serial flash (display calibration data)

- One or more buttons; trackpad and trigger are disabled

HMD mode does not support any particular display, headphones, microphone

Firmware

Source code for MCU, FPGA, radio not licensed

- Hard real-time: easy to break tracking

- Custom wireless: on-the-fly packet compression

- Valve wants to avoid Android-style fragmentation

- Valve is still innovating - the interface is not fixed

  - New features and bug fixes are being released regularly

Firmware changes must be contracted through Synapse

Firmware

How to build your custom tracked object?

- Customize firmware?

- Add more hardware?

It depends...

Customization Scenarios

- Simple tracked object: no firmware changes

- Controller: new buttons, additional controls, communicates to SteamVR

- HMD: display, backlight, headphones, microphone

Might need firmware customization

Might solve with more hardware

Up front development cost (NREs) vs. ongoing BOM cost / board space

Synapse can advise

Customization

Hardware scenario:

- Add dedicated application MCU

- USB hub in the device

    - Tracking MCU, application MCU, USB audio, USB camera

- BYO display or other functionality

Little or no interaction with the tracking subsystem

Additional BOM costs / space

Customization

Firmware scenario:

- Add tasks and device drivers to tracking MCU

- Additional triggers, buttons, lights, controls

- Display control

Single MCU saves cost / space

Tracking MCU: Cortex-M4, floating point, 120 MHz, 160 KB RAM, 512 KB flash

Firmware Tips

- Status LED

- Debug UART

- Mode switch

- Radio pairing

- Firmware update

Firmware - Status LED

- Solid RED: not connected to SteamVR

- Solid GREEN: connected (USB)

- Solid BLUE: connected (Wireless)

- Blinking BLUE (1 Hz): pairing mode (Wireless)

- Rapid blinking RED (7 Hz): bootloader

- Slow blinking RED (0.5 Hz): critical firmware error

Firmware - Debug UART

- 460800 baud, no parity, 8 data bits, 1 stop bit

- System info and errors

- Mostly to help Synapse debug your hardware

Firmware - Debug UART

```
Watchman v3 Reference Design Version: 1473363695 Date: 2016-09-08 12:41:35 Git: 716edd8 (bootloader)
Loading app at 0x430299


Watchman v3 Reference Design Version: 1473382930 Date: 2016-09-08 18:02:10 Git: 0f9eb47
Init SPI1, HMD flash
Init SPI1, Trackpad
Init SPI3, IMU
Init SPI3, Radio
Init SPI5, ICE40 config
Init SPI5, ICE40 data
Init TWI2
Devices:
[ flash_mcu ] 512 KB (1024 * 512 bytes, 0 pages reserved) @ 0x00400000

flash regions:
[   bootloader ]: 0x00000000 - 0x0000bfff ( 45124 of  49152 bytes used)
[  ice40_image ]: 0x0000c000 - 0x0002ffff (135180 of 147456 bytes used)
[  application ]: 0x00030000 - 0x0007bfff ( 89204 of 311296 bytes used)
[     trackpad ]: 0x0007a000 - 0x0007bfff (     0 of   8192 bytes used)
[  stored_conf ]: 0x0007c000 - 0x0007dfff (     0 of   8192 bytes used)
[  descriptors ]: 0x0007e000 - 0x0007ffff (   280 of   8192 bytes used)
[  hardware_id ]: 0xc0ffeeee - 0xc0fff0ed (     0 of    512 bytes used)

stored_config: 0 of 8192 bytes used
HWID revision: 0x90030000 lot: 0x811f0001
BQ2429x No Battery Detected
2429x charger in Default Mode already
Started BQ27520 fuel gauge update timer at 60s
Queue: IMU time: 100 elements of size  4 [2000086c - 200009fc]
Queue: IMU RX: 100 elements of size 14 [20000a00 - 20000f78]
Queue: IMU TX: 25 elements of size 20 [20000f7c - 20001170]
S/N: = [LHR-2FB6B063]
usb_vbus( 1 )
Sensor variant = 0x0
Queue: LEP_IN: 10 elements of size 12 [20003578 - 200035f0]
LEP: optical version: 1
LEP: sync detect: 0
Wireless version: 0x57cefaec
Mode: CONTROLLER
Trackpad version: 0x5a
# 
```

Firmware - Mode Switch

Toggles between Controller and HMD mode

- Trackpad, analog trigger disabled for HMD

- Buttons work in either mode

- IMU: 1000 Hz vs. 250 Hz

- IMU: more vs less dynamic range
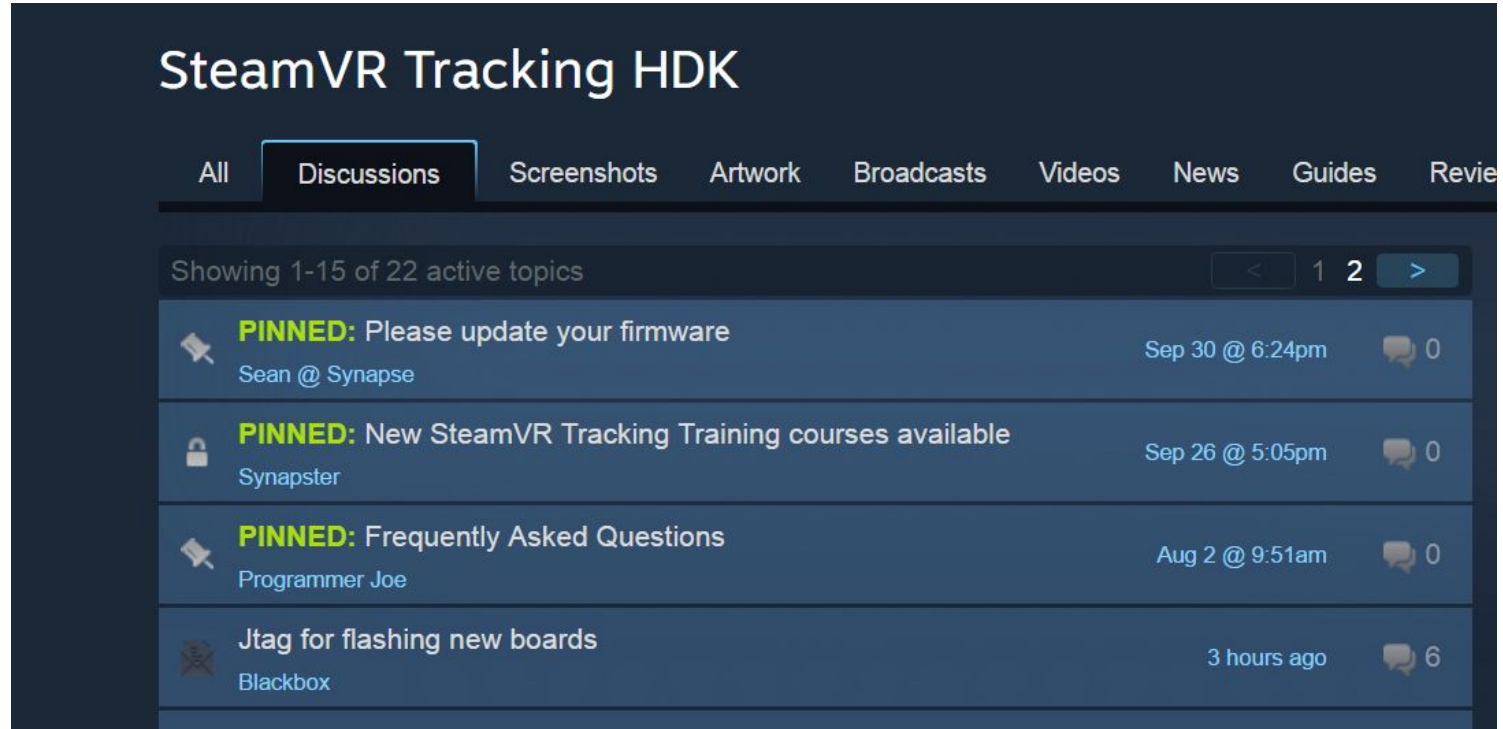
Mode switch resets the device

Firmware - Radio Pairing

1. Press System and Menu buttons for 3 seconds

2. LED blinks blue

3. In lighthouse_console, issue "unpair" + "pair" to USB dongle

4. LED solid blue if pairing succeeds

When using USB 3.0 port, plug dongle into extension cable

RFI - Radio Frequency Interference

- https://www-ssl.intel.com/content/www/us/en/io/universal-serial-bus/usb3-frequency-interference-paper.html

Firmware Updates

SteamVR Tracking HDK

All | Discussions | Screenshots | Artwork | Broadcasts | Videos | News | Guides | Revie

Showing 1-15 of 22 active topics   < | 1 **2** | >

PINNED: Please update your firmware
Sean @ Synapse   Sep 30 @ 6:24pm   💬 0

PINNED: New SteamVR Tracking Training courses available
Synapster   Sep 26 @ 5:05pm   💬 0

PINNED: Frequently Asked Questions
Programmer Joe   Aug 2 @ 9:51am   💬 0

Jtag for flashing new boards
Blackbox   3 hours ago   💬 6

Firmware Updates

- Firmware will be released via SteamVR, as needed

- Update firmware via USB

- JTAG binaries available for manufacturing

- JTAG: Segger J-Link Base is recommended

USB:

C:\Program Files (x86)\Steam\steamapps\common\SteamVR Tracking HDK\firmware\10.27.2016>hdk_firmware_update.bat

JTAG:

C:\Program Files (x86)\Steam\steamapps\common\SteamVR Tracking HDK\firmware\jtag>flash_mcu.bat <j-link S/N> watchman_v3_hdk_mcu_jtag.bin

Thanks!