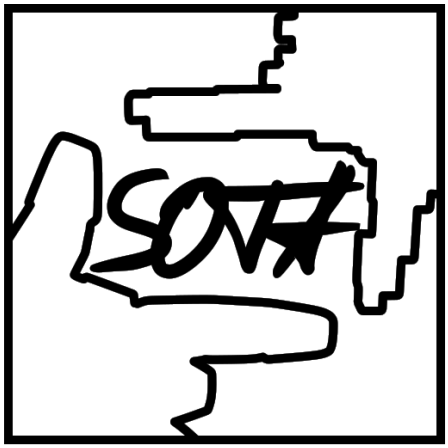


State Of The Art

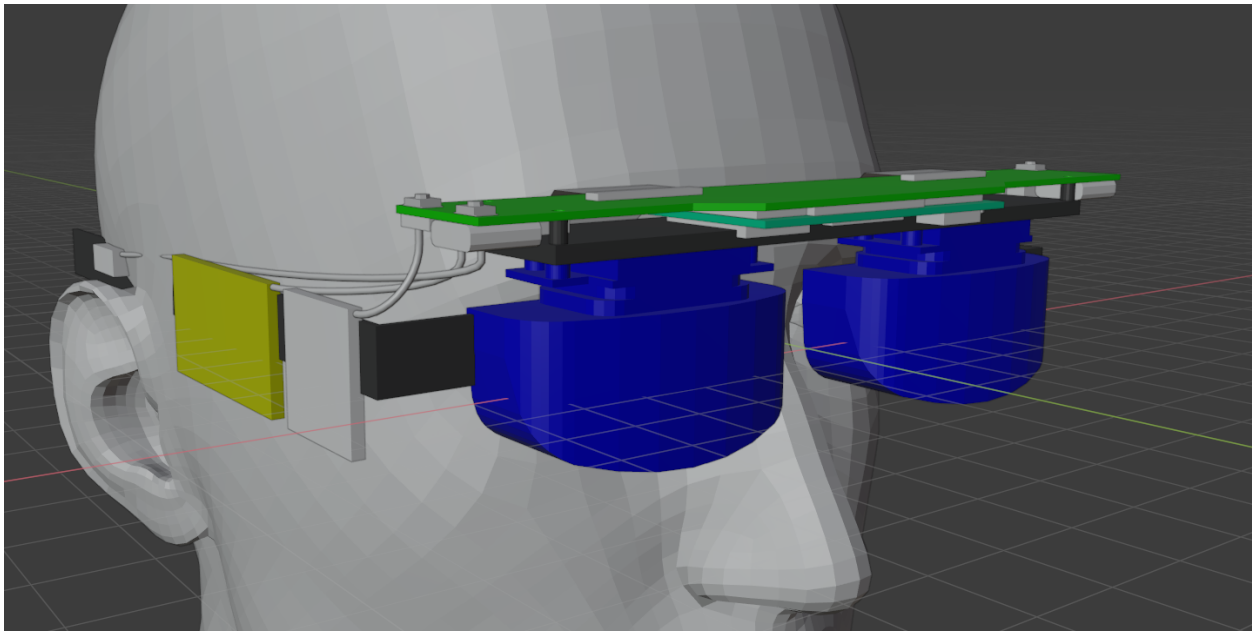
PDD: Binocular prototype

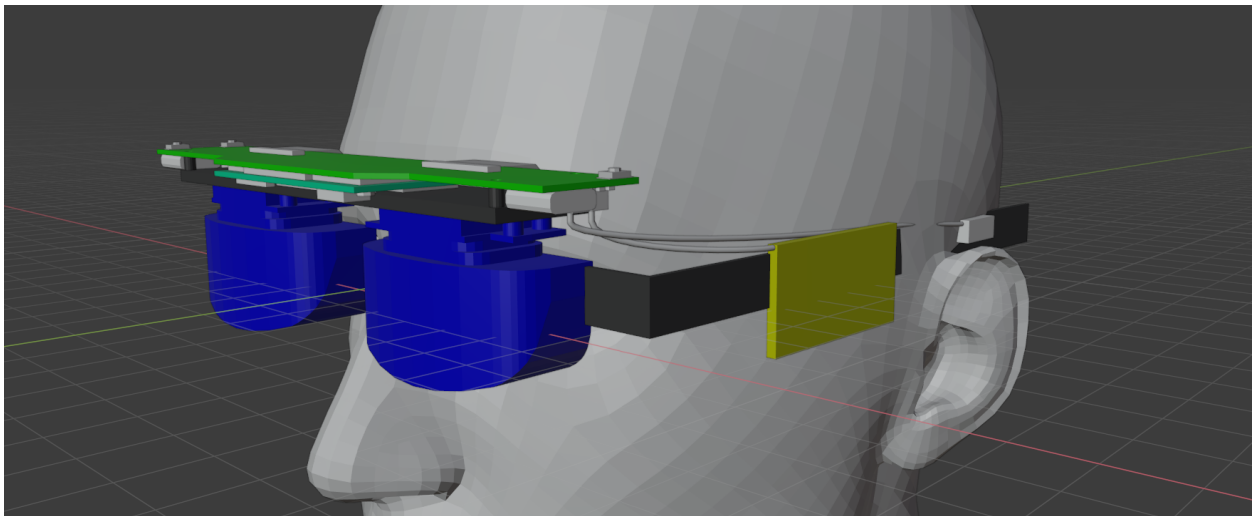
State Of The Art LLC

Revision: 0.99
Date: 2020-12-24

Project main ideas

1. Open Source and Open Hardware platform for light-weight wearable stereo displays as close as currently possible to the regular glasses
2. No AR-grade positioning detection - just good quality high resolution see-through displays (1920x1080)
3. Wireless (WiFi ac, h264/h265, battery power) and direct drive (USB-C DP alt-mode)



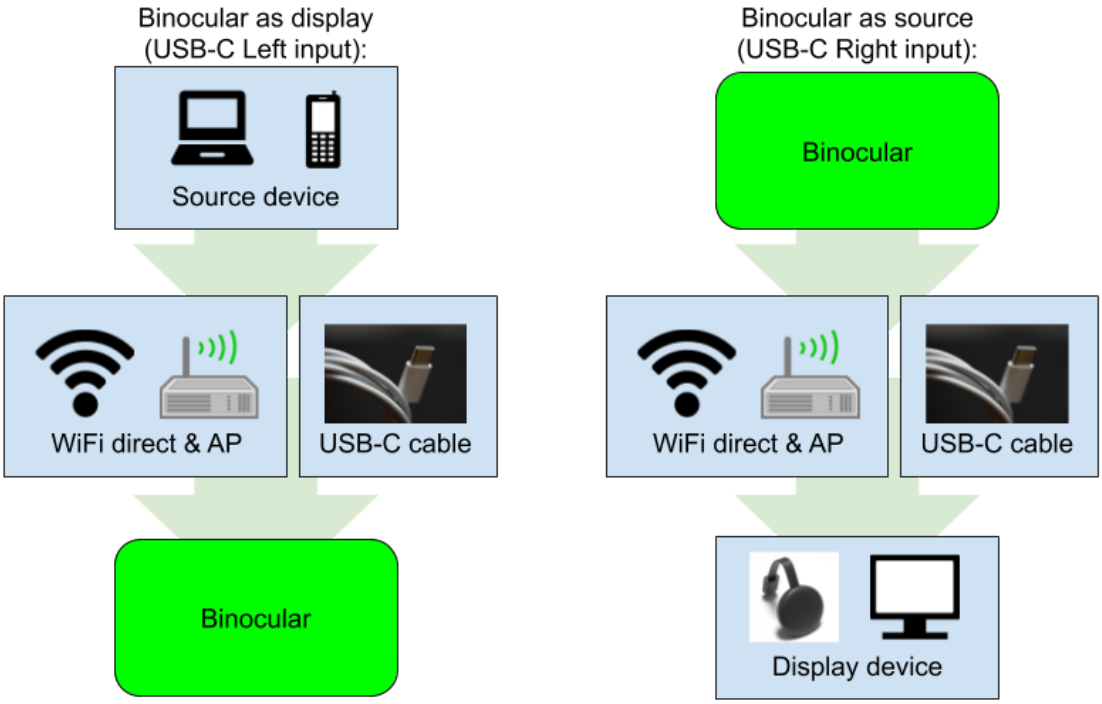


Features list

- Play media:
    - See-through modules with 1080p modules capable to show screen right in front of the eyes in mono and stereo mode
    - “USB-C Left” functionality:
        - Power Delivery 2.0 (charge)
        - DP1.2 HBR2 Alt-mode input, 4 lanes - 4x5.40Gbit/s:
            - 1920x1080@60Hz (3.20 Gbit/s) - fullhd mono default
            - 3840x1080@60Hz (2x3.20 Gbit/s) - fullhd stereo
            - 2560x1440@60Hz (5.63 Gbit/s) - 2k mono
            - 5120x1440@60Hz (2x5.63 Gbit/s) - 2k stereo
            - 3840x2160@60Hz (12.54 Gbit/s) - 4k mono
        - USB2 OTG (using USB-C D+/D- pins)
    - “USB-C Right” functionality:
        - Power Delivery 2.0 (charge)
        - Switch:
            - USB2/3 OTG (5GBit/s + 480MBit/s)
            - HDMI 2.0 Alt-mode output
    - Network video streaming (WiFi):
        - HTTP REST API for simple control of the device (playback/switches/profiles...)
        - RTSP/RTMP stream interfaces (send stream)
        - Miracast support
    - Play video from built-in flash (32GB) or connected usb flash device
    - HUD overlay mixed with video (SoC receives and sends video to displays)
    - Audio input:
        - From DP (LT7911B through I2S to SoC), stream or file
    - Audio output:
        - Bluetooth to connect audio devices
        - 2.5mm TRRS jack for headset (stereo+mic)
        - Built-in bone-conductive drivers (GD06)
        - HDMI Audio output
- Common Android device features:
    - Autonomous work of the most power-consuming use case for >= 2 hours
    - A couple of buttons to quickly access the important things:
        - volume +/- (android system master output volume)
        - power/sleep
        - home android button
        - back android button
    - Touchpad for precision control (similar to GearVR)
    - Run any applications available for Android ecosystem
    - Bluetooth input devices (mouse, keyboard, any HID)
    - USB-C modes:

        - Power Delivery - power & charge
        - OTG mode (usb-flash, input, cameras, ethernet...) with power 1-2A 5V of ext devices
        - ADB/Fastboot interfaces support
        - Drive external display via DP Alt-mode
    - Accel/Gyro/Mag - IMU for simple head control gestures

Common use cases



The binocular device could be used as display (receive DP and act as display) or as a source (if connected via USB-C to display). 2 USB-C connectors can be used simultaneously, but the right one can serve one mode at a time: USB2/3 OTG or HDMI.

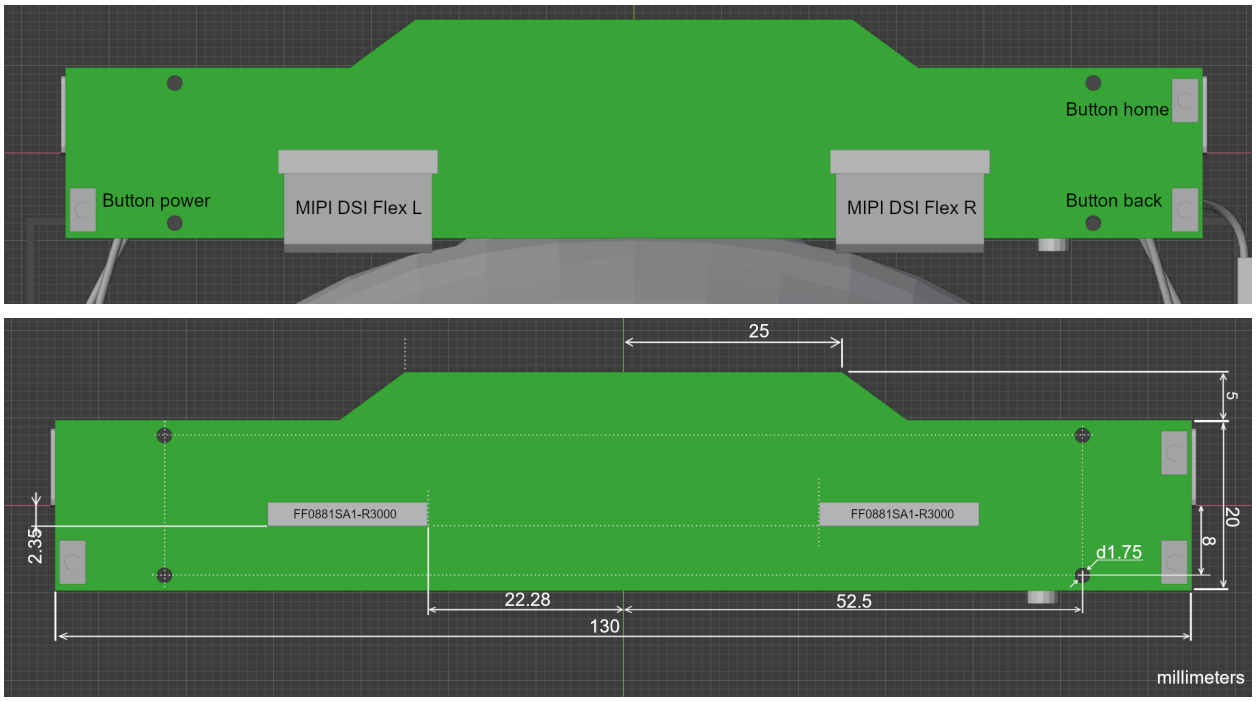
- User power-on the device
    - Android boots up
    - Monitoring daemons starting up (check the connected devices and chooses the action to execute)
    - Network daemons starting up (listens on TCP/UDP ports for incoming connections on HTTP/RTP/RTMP and other supported protocols)
    - ?WiFi AP mode enabled (default)
        - WiFi AP announces and wait for incoming connections
    - ?WiFi has saved connections
        - Scan around and connect to SSID if it's available
    - Bluetooth announces device and waits for incoming connections
        - ? Bluetooth paired devices available
            - Connect paired device
- User connects the device to notebook via "USB-C Left"
    - PD Power + Charge
    - ? Device in fastboot mode
        - Fastboot

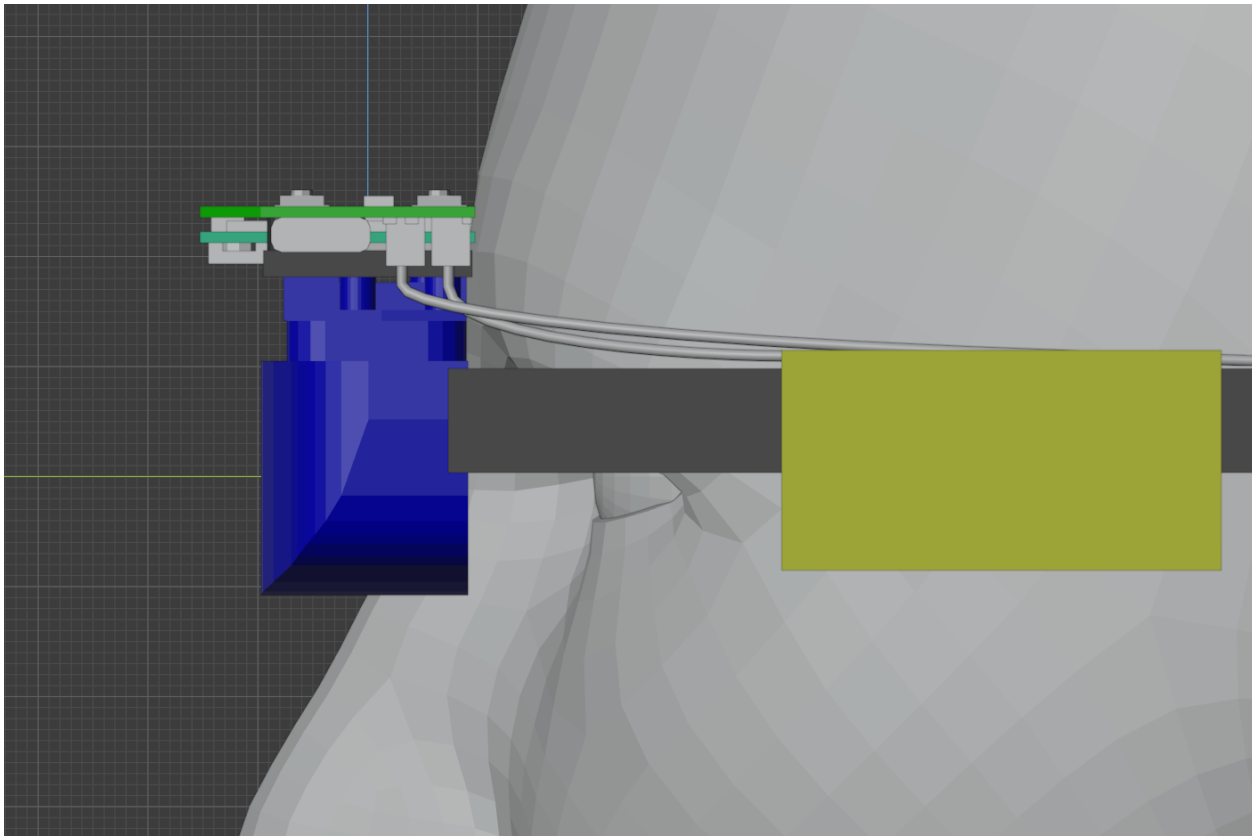
        - ? DP Alt-mode is enabled (default)
            - Daemon on android starts to show the display via built-in application
                - ? User choose mono
                    - 1920x1080@60
                - ? User choose stereo
                    - 3840x1080@60
                - ? App has HUD enabled
                    - shows video as HUD profile is configured
        - ? ADB enabled
            - Working as regular ADB android device (root enabled)
- Device connected to USB-C monitor via “USB-C Right”
    - PD Power + Charge
    - ? Mirror display mode enabled (default)
        - Mirroring the MIPI DSI output to external monitor
    - ? Additional display mode enabled
        - Connect ext monitor as another display
- Device connected to regular USB3 port
    - PD Power + Charge
    - Device acts as USB3 device
- Device connected to USB2/3 mass-storage device
    - Power supply for connected device
    - Mount device as additional storage

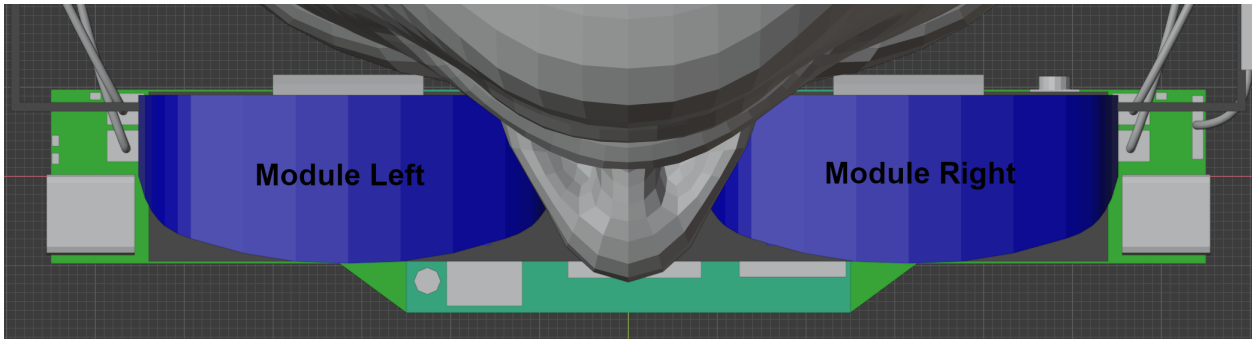
PCB board

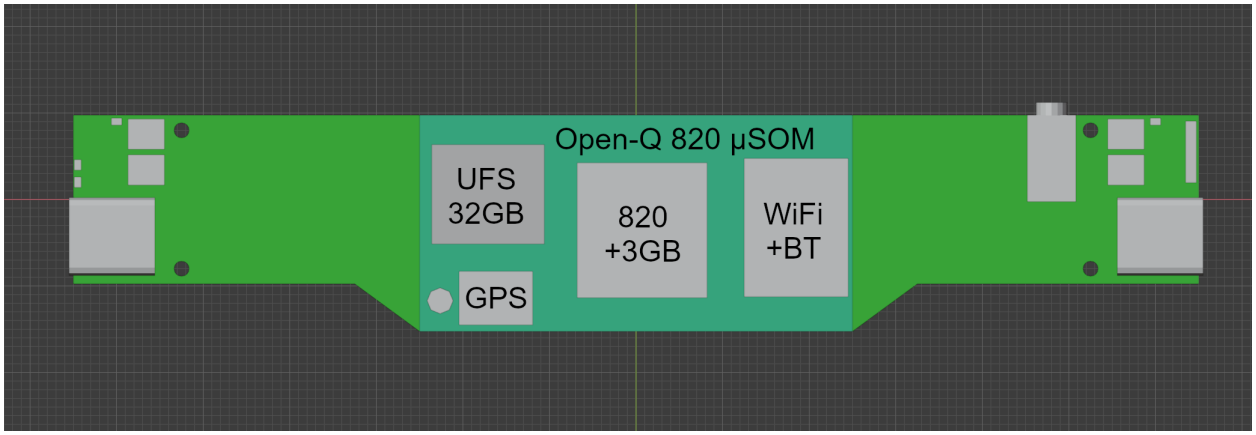
Will be placed on top of the modules, there is not much of space to place the components & connectors. So the dimensions should be 130x25x1mm.

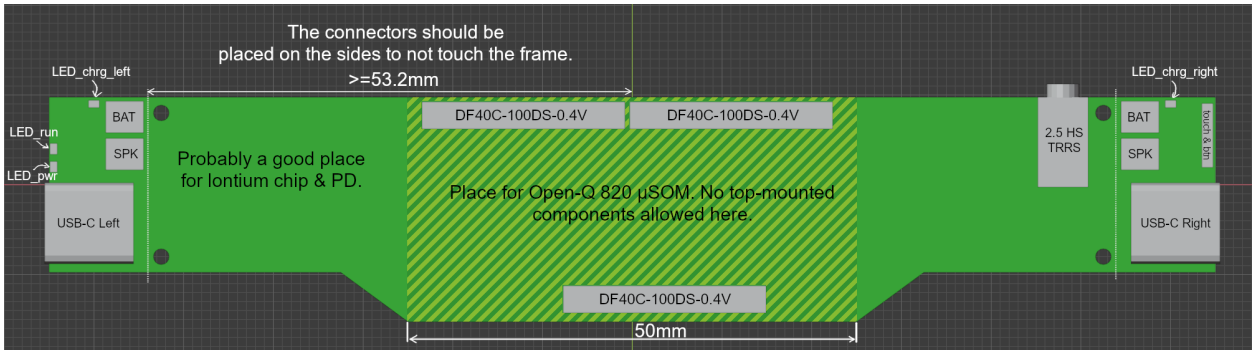
PCB design should be available in open source formats (KiCAD for example). They can be developed in any software and converted to those formats in order to generate output files for manufacturing. That means that the pipeline should prove the ability to regenerate the gerber files from open source tools (for example Eagle -> KiCAD -> Gerber files).



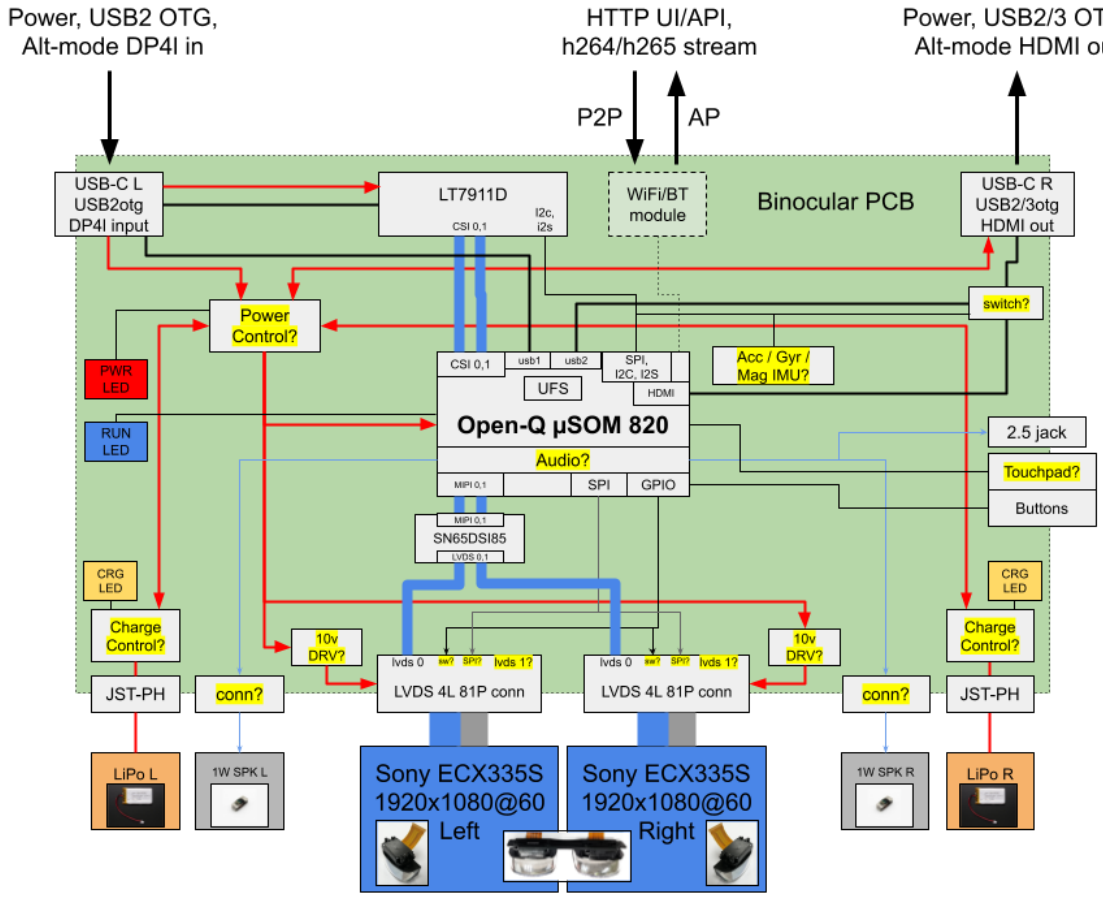



Module Left
Module Right


Open-Q 820 µSOM
UFS
32GB
820
+3GB
WiFi
+BT
GPS



Schema



Components

- **Displays**: 2x Sony ECX335S Enmesi modules (closest datasheet from displaymodule.com) connectors FF0881SA1-R3000
  - Custom LVDS to transfer the video data
  - SPI for setup and configure

    - IFSW probably can switch the LV inputs
- **Open-Q µSOM 820**: 50x25mm, HW spec
    - SoC: Snapdragon 820
    - RAM: 3GB
    - WiFi: AC
    - Bluetooth: 4.1
    - Flash: UFS 32GB
    - 2 MIPI DSI 4L
    - 3 MIPI CSI 4L
    - Decode: 4K@60 H264, VP8/9, HEVC 8/10bit
    - Encode: 4K@30 H264, VP8, HEVC
    - Design is available for open hardware Dragonboard 820c
- **USB-C Left**: PD for power/quick charging, Input DP alt-mode (4 lanes), USB2 OTG, ADB/Fastboot device
- **LT7911D**: converts DP to MIPI CSI/DSI, should be in sleep and not spend much power if USB-C Left is not connected. I2C/SPI interface to switch the modes (mono/stereo) and sleep/wake the chip.
- **USB-C Right**: PD for power/quick charging, powering the connected devices, switchable USB2/3 OTG or HDMI output
- **Headset jack**: TRRS 2.5
- **Battery**: 2x 1200mAh LiPo battery with JST 1.25 PH 2 Pin connector
- **IMU**: gyro/accel/mag for simple head motion control (not precise)
- **Buttons**: volume, power, home, back
- **Low power LEDs**: PWR - power, RUN - active, 2xCRG - battery charge indicator
- **Touchpad**: mouse control in the UI
- **2x1W audio speakers**: mini bone-conduction speakers

Goal parameters

- Weight of the product: <=80g (perfect value: 20g)
- Pressure on the nose: <=40g (perfect value: 15g)
- Input video display lag (HW from input to display pixel change): <= 14ms
- Product cost: <= $3000
- Autonomous work of the most power-consuming use case for >= 2 hours