# Appendix

## Appendix 1: Hardware Specifications of the Camera and Processor
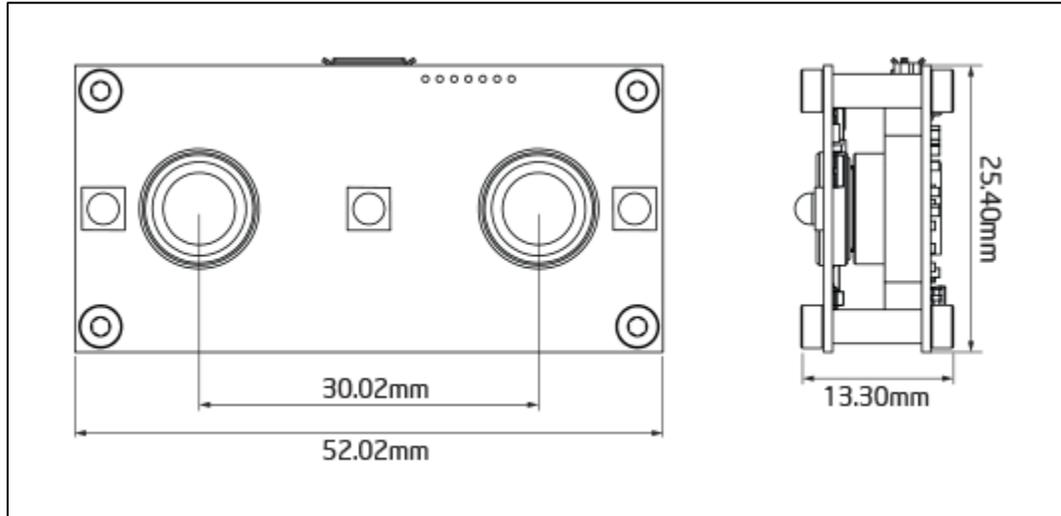
*Figure A1.1: Dimensions of the Stereo Camera*
*(source: https://duo3d.com/product/duo-minilx-lv1#tab=specs)*

*Table A1.1: Specifications of the Stereo Camera (based on details from the manufacture, Code Laboratory Inc.)*

| | |
|---|---|
| **Model** | DUO-MINILX-LV1  (DUO MLX R2) |
| **Baseline** | 30.0 mm |
| **Frame Rates** | 0.1 – 3000+  FPS |
| **Stereo Resolutions** | Configurable Binning / Windowing:<br> - 45 FPS @  752x480<br> - 49 FPS @  640x480<br> - 98 FPS @  640x240<br> - 192 FPS @ 640x120<br> - 86 FPS @  320x480<br> - 168 FPS @  320x240<br> - 320 FPS @  320x120 |
| **Pixel Size** | 6.0 x 6.0 µm |
| **Shutter Speed** | 0.3 µsec ~ 10 sec |
| **Lens Mount** | Standard M8 x P0.5 |
| **Field of View** | 170° Wide Angle Lens<br>Low Distortion < 3% |
| **Focal Length** | 2.0mm - 2.1mm |
| **Filters** | 850-870nm  Narrow  Band-Pass |
| **Illumination** | Fully Programmable LED Array<br>3 Independently controlled 3.4W 850nm IR LEDs 170° light cone |

| | |
|---|---|
| **Illumination Control** | Individual brightness sequence programmable in 256 linear steps |
| **Motion Sensing** | 100Hz Sampling Rate<br>Six Degree of Freedom (DoF)<br>Accelerometer/Gyroscope IMU/Temperature |
| **Colour Modes** | Monochrome (S/N Ratio > 54dB Linear) |
| **Control Functions** | Exposure/Shutter/Brightness |
| **Scanning Modes** | Progressive Scan/Global Shutter |
| **Power Consumption** | ~2.5 Watt @ +5V DC from USB |
| **Interface** | 480 Mbps - USB 2.0 Interface (Micro USB) |
| **Weight** | 12.5g |
| **Operating Systems** | DUO OS -Custom Linux Kernel, Linux, Mac OS or Windows |
| **Operating Temperature** | 0° to 40-50° C (32° to 104-122° F) |
| **Storage Temperature** | -20° to 45° C (-4° to 113° F) |
| **Relative Humidity** | 0% to 90% non-condensing |
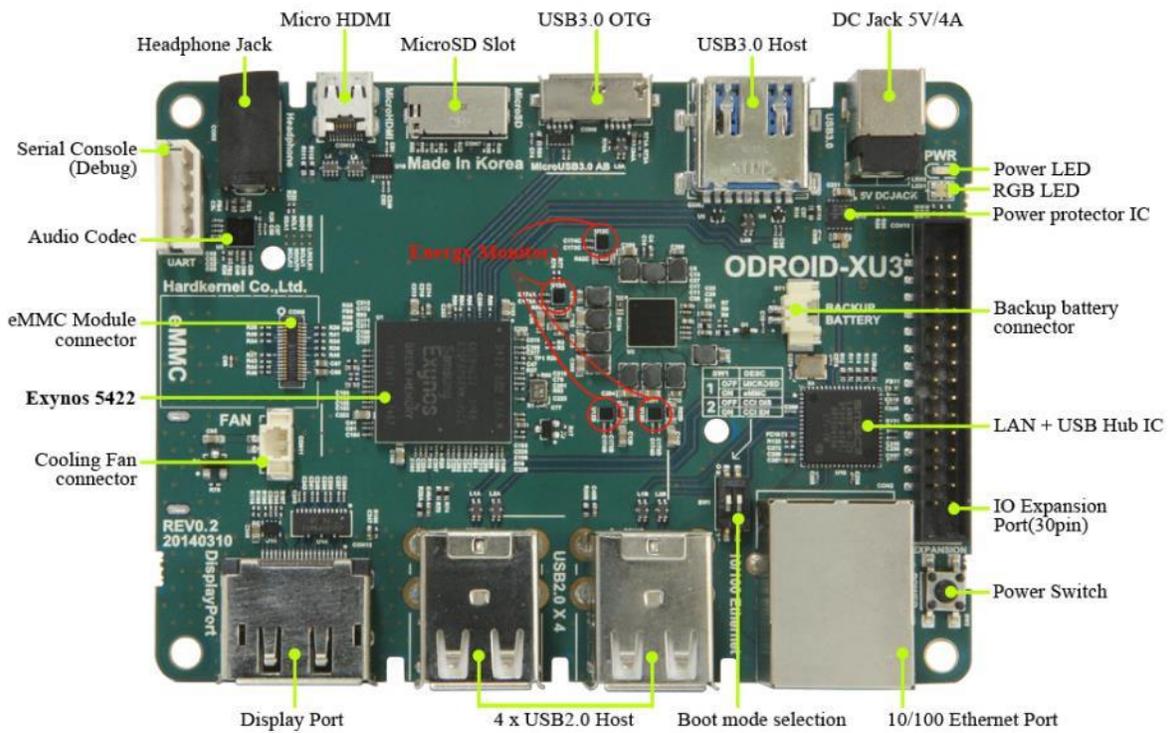
*Figure A1.2: Board detail of Odroid XU3 from the manufacture, Odroid HardKernel Co., Ltd.*

*Table A1.2: Specifications of Odroid XU3*

| | |
|---|---|
| **CPU** | Samsung Exynos-5422 : Cortex™-A15 2GHz and Cortex™-A7 big.LITTLE processor with 2GByte LPDDR3 RAM |
| **GPU** | Arm Mali-T628 (MP6) |
| **eMMC 5.0 module** | 16GB/32GB : Sandisk iNAND Extreme<br>64GB : Toshiba eMMC |
| **LAN/USB Hub** | LAN9514 4-port Hi-Speed USB 2.0 hub and 10/100 Ethernet controllers from SMSC/Microchip |
| **USB Load Switch** | NCP380 Protection IC for USB power supply from OnSemi. |
| **Audio Codec** | MAX98090 is a full-featured and high-performance audio CODEC from Maxim |
| **Power protector** | NCP372 Over-voltage, Over-current, Reverse-voltage protection IC from OnSemi. |
| **LED indicator** | Tri-color RGB LED to display the status of operating system |
| **HDMI connector** | Standard Micro-HDMI, supports up to 1920 x 1080 resolution |
| **DisplayPort connector** | Standard DisplayPort, supports up to 3840 x 2160 resolution |
| **IO Ports** | USB 3.0 Host x 1, USB 2.0 Host x 4, USB 3.0 OTG x 1, PWM for Cooler Ethernet RJ-45, Headphone Jack, 30 Pin : GPIO/IRQ/SPI/ADC |
| **Storage slot** | Micro-SD slot, eMMC 5.0 module connector |
| **DC Input** | 5V / 4A input, plug specification is inner diameter 2.1mm and outer diameter 5.5mm |
| **Energy Monitor** | 4 separated current sensors to measure the power consumption of Big CPU, Little CPU, GPU and DRAM in real time |

# Appendix 2: Design Details of the Data Collection Instrument
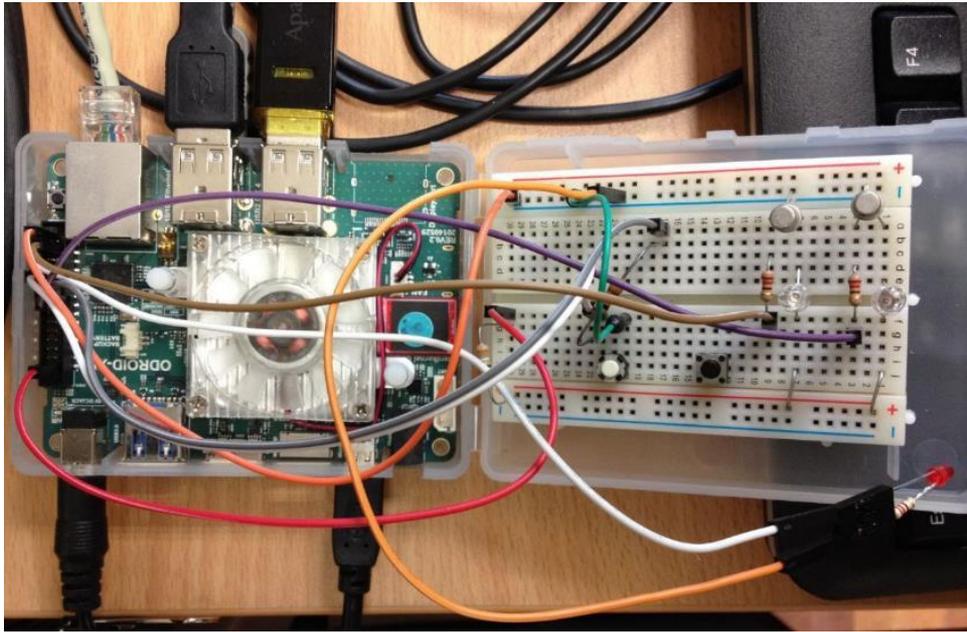
*Figure A2.1: ODROID XU3 board (left) and a breadboard (right) during the initial phase of designing the circuitry. The circuit was designed mainly to operate data capturing during this phase.*
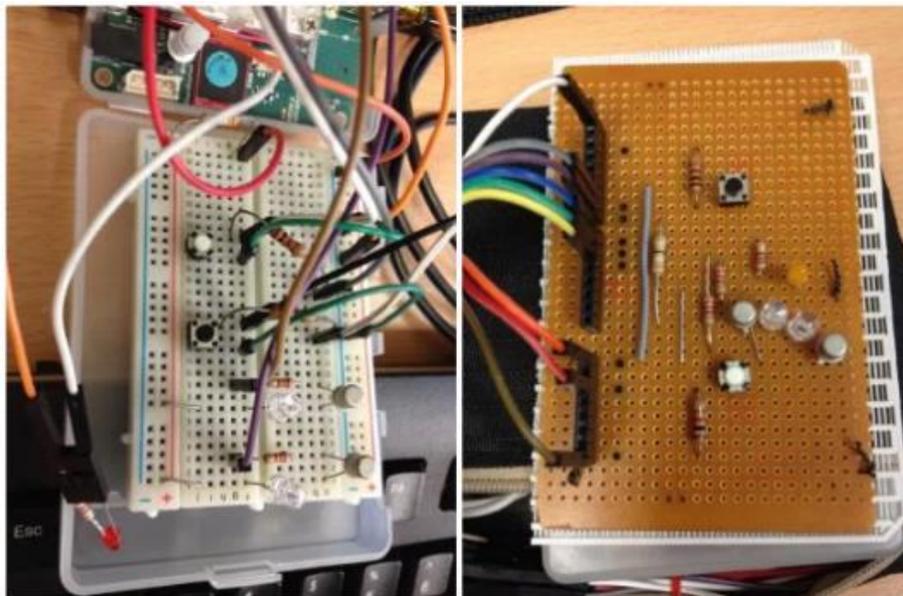
*Figure A2.2: Once finalized, the workable circuit on the left photo was moved to a Veroboard as shown on the right photo to make it handy for outdoor usage. 3 LEDs were added as indicators during data collection to indicate: (1) power status, (2) readiness of the system for data capturing, and (3) data storing status.*
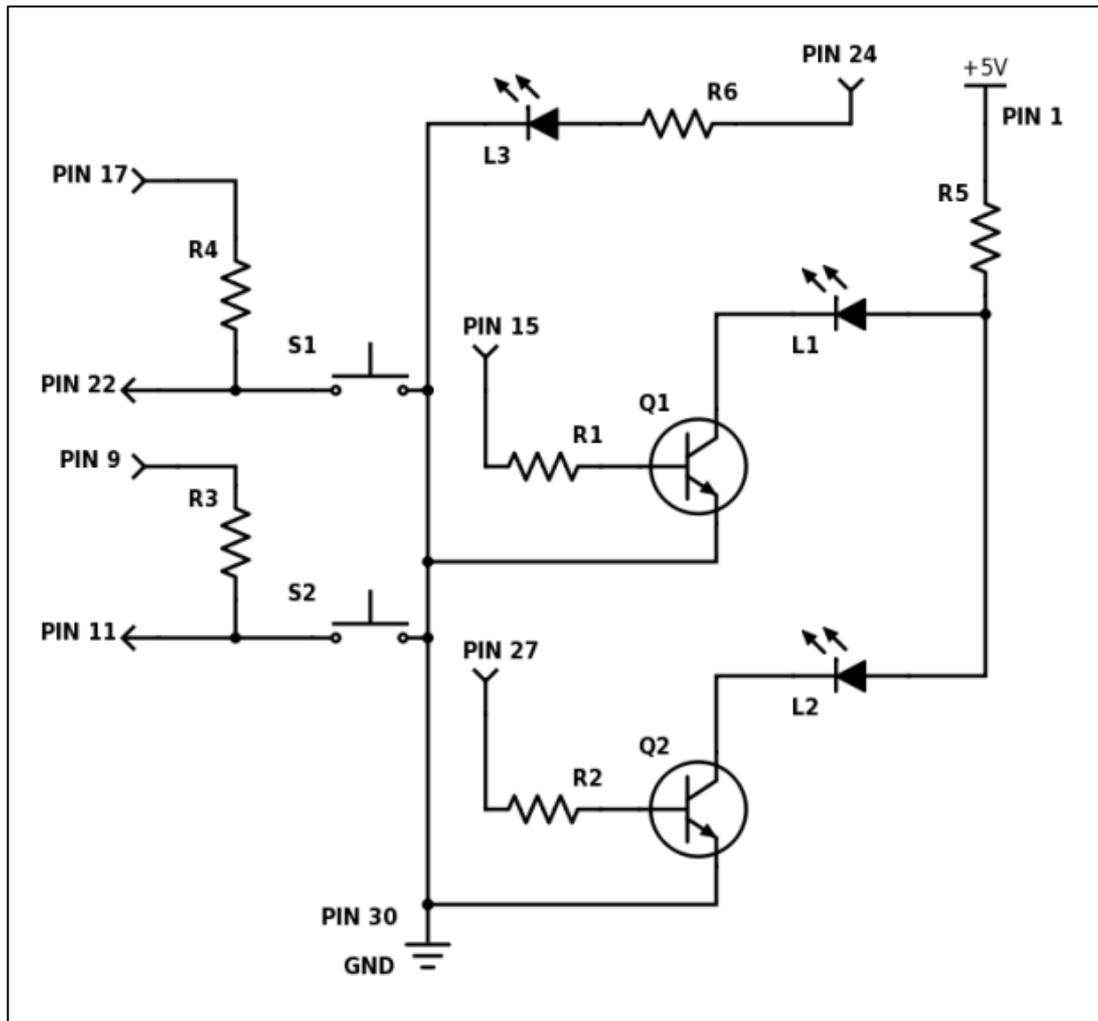
*Figure A2.3: The schematic diagram of the circuit to turn the camera program and data storing function ON/OFF by accessing the GPIO on ODROID XU3. LEDs were included as indicator. More details about the GPIO pins can be found in Appendix 1.*

List of electronic components used in the circuit as labelled in Figure A2.3:

- Q1, Q2: two N2222A transistors
- L1, L2: two LEDs (3 – 5 volts)
- L3: one LED (1.5 volts)
- S1, S2: two button switches (momentary press contact)
- R1, R2, R6: three 220 Ω resistors
- R3, R4: two 1 kilo Ω resistors
- R5: one 390 Ω resistor

*Figure A2.4: The lithium power source. Since ODROID XU3 is running on 5 volts, a voltage regulator (the green board) is added to convert the 11.1 volts from the lithium battery. Battery specifications: 11.1V, 2300 mAh, 30 C, Li-Polymer battery.*
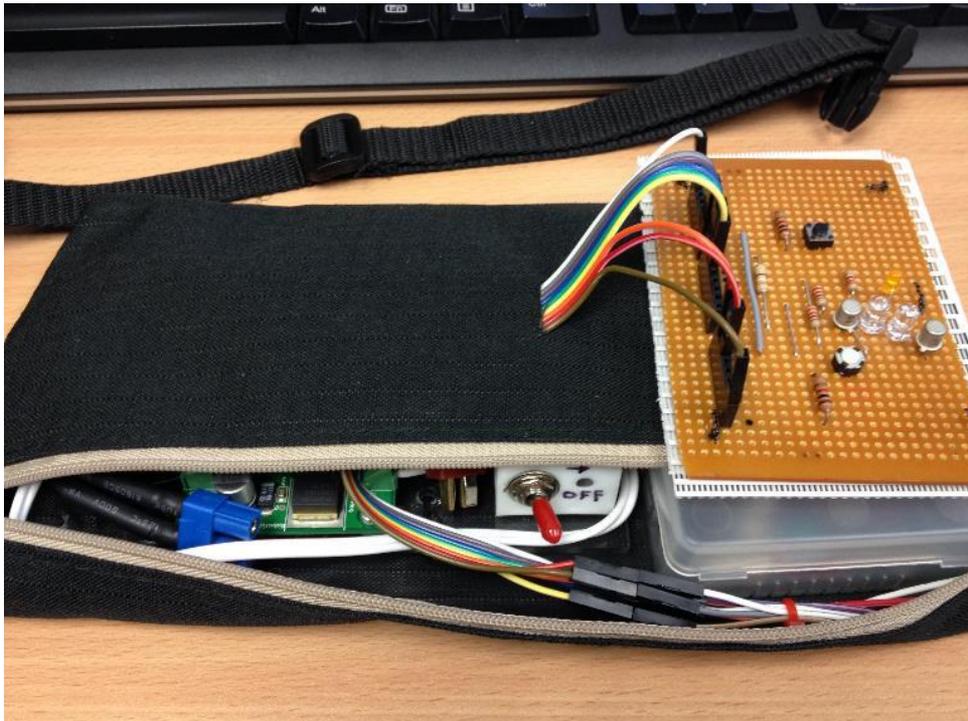
*Figure A2.5: All in a waist pouch – putting together the lithium power source, the ODROID board (can be seen hidden in a plastic box inside the pouch) and the circuit board ready for data collection.*

*Figure A2.6: Wearing the pouch at waist level of a user.*