CAD Design

*Our instructions are intended to be used with our **YouTube videos** that illustrate the different steps. For the CAD Design watch: **"How to build the SensorBox – 3D Print"**.*

We used FreeCAD for the design of our SensorBox. We saved our CAD designs in the folder **Design** in FreeCAD's native **.FCStd** file format. Designs for re-use were exported and imported as .step files. We exported our designs as **.stl** files into the folder **STL-files** for 3D printing.

FreeCAD

Take a look at the software setup section for how to set up your host computer.

Download FreeCAD
Firefox: https://www.freecadweb.org/
> Click Download now
> Click Linux 64-Bit AppImage
~/Download/FreeCAD_0.18-16146-rev1-Linux-Conda_Py3Qt5_glibc2.12-x86_64.AppImage
Ubuntu: Right-Click on FreeCAD_0.18-16146-rev1-Linux-Conda_Py3Qt5_glibc2.12-x86_64.AppImage and select Properties
> Select Permissions
> Check Allow executing file as program
An already downloaded copy can be found here:
sw/**FreeCAD_0.18-16146-rev1-Linux-Conda_Py3Qt5_glibc2.12-x86_64.AppImage**

Run FreeCAD
Ubuntu: Double-Click on sw/FreeCAD_0.18-16146-rev1-Linux-Conda_Py3Qt5_glibc2.12-x86_64.AppImage

Design

The design consists of two (2) major components: a) **sensors & processing board** with (almost) all the electronics and b) the **cover** that includes an integrated display, a power button and connectors. The cover slides over the sensors & processing board and is fixed with two screws in the front (top of the vision board).

The design is very modular, and as we provide the CAD design files, it should be easy to make any design changes you desire, like using different cameras by just making small changes to the vision board.

We designed a system of grooves to join all the walls of the SensorBox. This way the walls pull themselves tightly together and the entire structure supports itself, allowing the walls to be permanently attached with just a little bit of super glue. Note that gluing pieces that have been 3D printed with

PETG filament can otherwise become more challenging. The grooves were also designed so that the walls could be separated easily by just over-bending the joints.

All screws are metric and threaded heat inserts are used. The screw stands for the sensors have been designed so that they can be used with boards of any thickness.

Sensors & Processing Board

The sensors & processing board includes: a) a **bottom plate**, b) a screw-on **battery stand** for a Poweradd Power Bank (which is also used as the central support structure for other boards) which is fixed to the bottom plate (as close as possible to the center to keep the SensorBox balanced), c) a screw-on **sensor board** for a SparkFun RedBoard Turbo Development Board and a suite of screw-on sensors: SparkFun NEO-M9N GPS, SparkFun ICM20948 9DoF IMU, SparkFun LPS25HB Pressure Sensor and SparkFun TMP102 Temperature Sensor, which is fixed to the top of the battery stand, d) a screw-on **power board** for a SparkFun USB-C Power Delivery Board and a SparkFun Current and Voltage Sensor which is fixed upside-down just under the sensor board, e) a screw-on **processor board** for a NVIDIA Jetson Xavier NX development kit which is fixed on the side of the battery stand, exposing the fan to the right side and f) a screw-on **vision board** with a suite of screw-on vision sensors: two (2) Arducam Sony IMX219 Camera Modules with two (2) SparkFun LSM9DS1 9DOF IMUs and two (2) SparkFun Quiic Adapters, an Intel Realsense D435i RGB-D camera with a **support** plate, a FLIR Lepton 3.5 thermal camera with a GroupGets PureTermal 2 FLIR Lepton Smart I/O Module and a SparkFun Ultrasonic Range Finder.

The battery stand is sized slightly larger to accommodate different power banks.

All plugs and cables are located in the back, where the inclined display provides some extra room. On the left side of the battery is a passage for cables to the vision board. The bottom plate allows to attach a support for the SensorBox. The bottom plate also has a small opening for a screwdriver to help with sliding the cover off the sensors & processing board (as they hold nicely together).

The power board, the processor board, the sensor board and the vision board (mounted on the bottom plate) can be used by themselves as breadboards in early development.

We used the CAD design of the Intel RealSense Depth Camera D435 to design the cutout for the Intel RealSense D435i RGB-D depth camera.

Cover

The cover includes: a) a **back wall**, d) a **display wall** for an UCTRONICS 5 inch touch display, c) **two (2) side walls** that provide air holes for ventilation, one for the NVIDIA Jetson NX fan (right side) and the other as exhaust (left side), **three (3) keystone inserts** (left side) that can be used with any keystone connector, and in our case with direct-through connectors for USB-C (power), HDMI (external monitor) and USB (connection to NVIDIA Jetson Xavier NX), and a **hole** for a power button (right), and d) a **top wall**. The cover can be assembled by just sliding all the walls into each other.