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CHAPTER  
**FIVE**

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## PENSAR CAMERA

### 5.1 Pensar Manual

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**PENSAR™**

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### 5.1.1 Using this Manual

This manual is separated into three main sections. (1) Product Profile & Quick Set-up (2) Using the Software and (3) Gimbal & Pensar™ Version.

Legend

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Read Before the First Flight

*text*

Video Tutorials

*text*

Download the Drone Volt App

*text*

Download Drone Volt Assistant

*text*

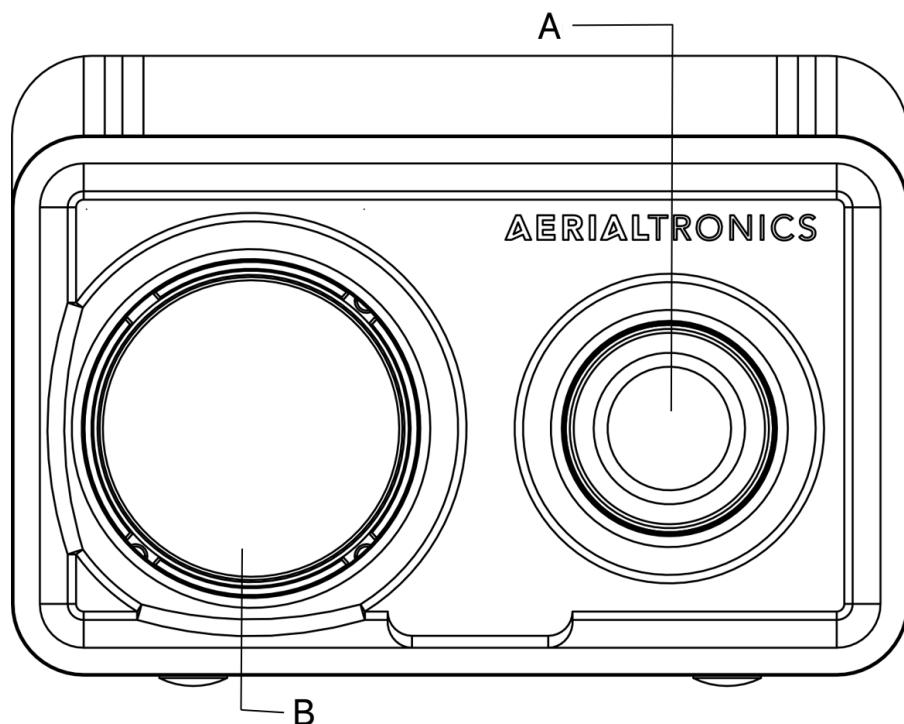
### 5.1.2 Product Profile

#### Presentation

The Pensar™ is a dual spectrum AI-powered camera designed around an extremely portable form factor with low power consumption profile, all-the-while being capable of complex real-time artificial intelligence and computer vision processing. It is equipped with a Sony 30x HD zoom camera, a FLIR Boson Infrared camera and an NVIDIA™ Jetson TX2 SoC (System on a Chip) that includes a 6-core ARM CPU and an NVIDIA Pascal GPU. The Pensar™ is a Linux-powered computer and comes with a number of pre-installed, ready-to-use applications: Dual Camera, Optical Tracking, AI-based Tracking, Facial Recognition and Object Detection. Custom applications can be developed, and custom neural networks can be implemented through the on-board Pensar™ SDK . The Pensar™ is the number one solution for all your on-field missions of surveillance, protection and monitoring.

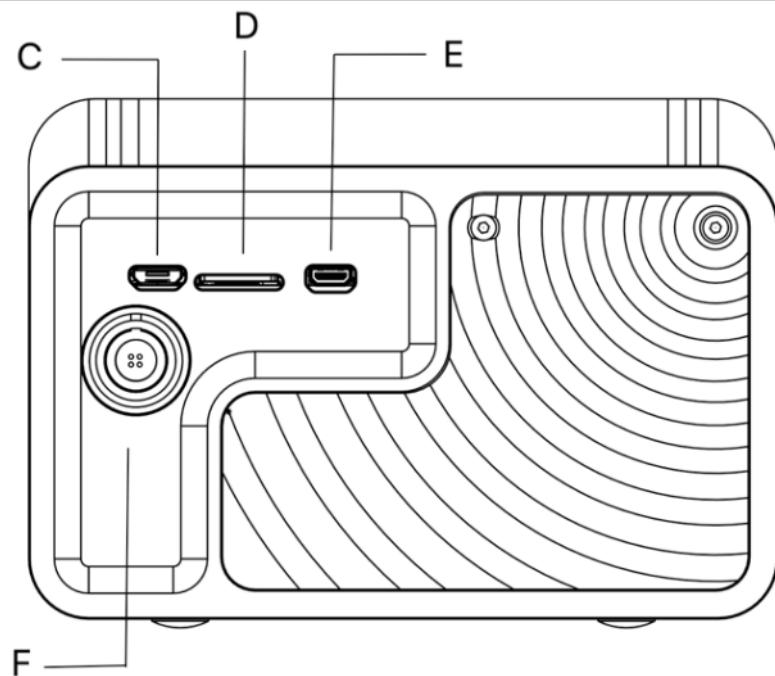
#### Specs (TO BE UPDATED, ON THE WEBSITE TOO)

#### Pensar™ Diagram



A). FLIR Infrared Camera

B). Sony 30X Zoom camera



C). Micro USB B

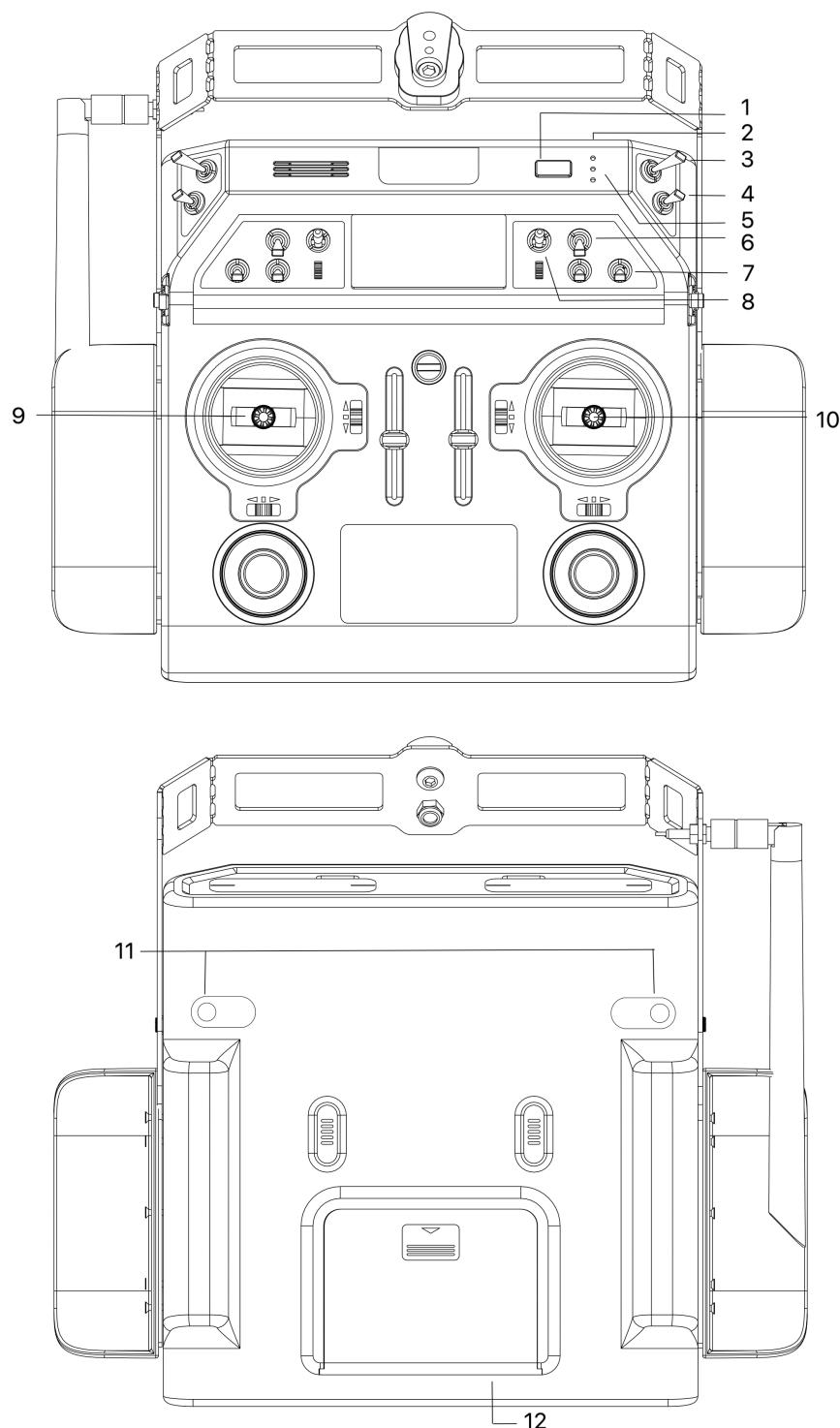
D). SD Card

E). Micro HDMI

F). Power Input (Lemo Connector)

### Remote Diagram

(For the Pensar, another remote is provided for the Altura-Zenith-Pensar Kit)



### 1. Remote Controller Power button

Hold for 1 sec to power the remote on Hold for 3 secs to power off (turns off on release)

### 2. Power Input (top side of remote)

Power cord input slot

### 3. Snapshot Switch

Press once to record a raw picture

### 4. Recording Switch

Flip the switch to start recording raw video of both the Visual and Infrared camera

### 5. LED Remote Status

- BATTERY: Turns on when there is enough current
- RF (Radio Frequency): Turns on when emitting High Frequencies
- WARNING: Blinks when there is too much lift, not enough signal, low battery.

### 6. Application action button

Interacts with the current GUI Application. More details in the application sections

### 7. Visual / Infrared Camera Swap

- Top position: Visual Camera Only
- Middle position: Dual Camera (last typeset – more details in dual camera section)
- Bottom position: Infrared Camera Only

### 8. Pensar Off Button

Pull the lever and place it at the bottom to turn off your Pensar.

To switch it on, replace the lever and unplug/plug the Pensar.

### 9. Gimbal Maneuvering Joystick

Directs the gimbal, and thus the camera

### 10. Zoom Joystick

Changes the primary camera zoom magnitude

### 11. Application Cycling Button

Cycles between the GUI applications

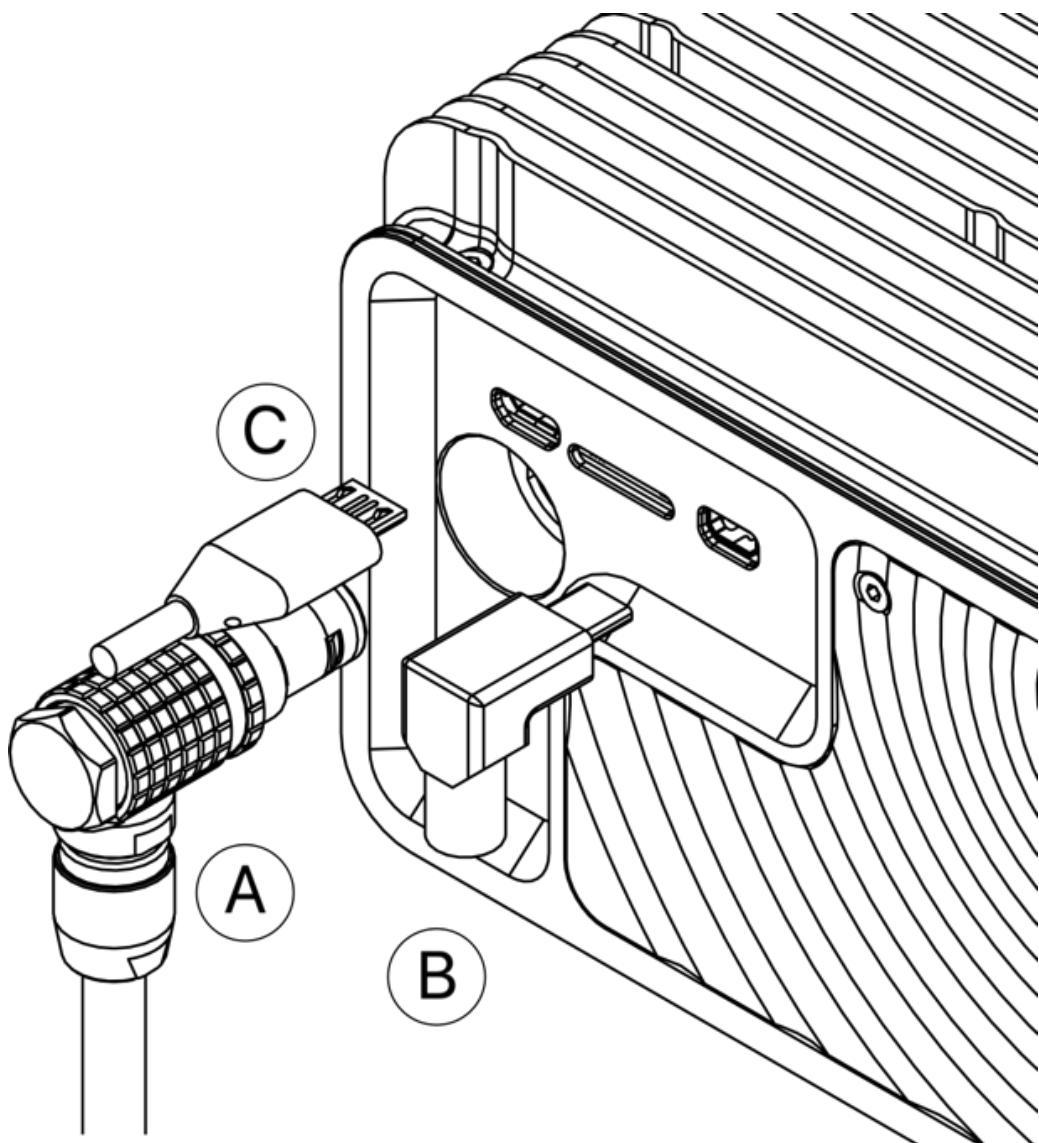
### 12. Battery Compartment

Stores the battery

## Quick Set-Up

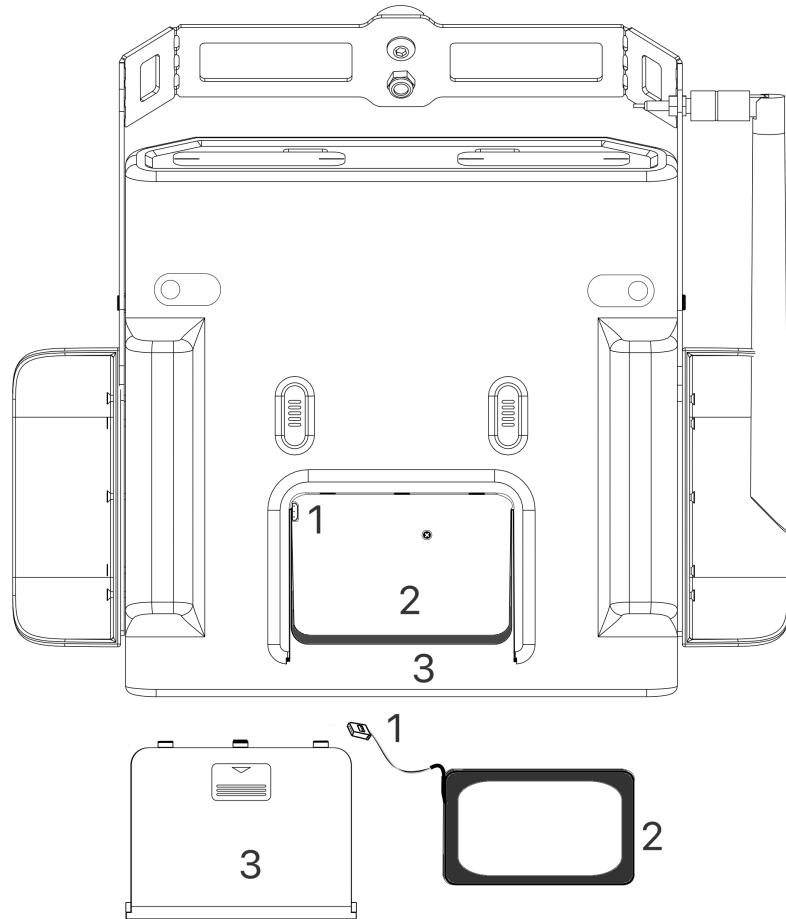
Carefully connect Pensar™ to all relevant modules provided in this package - this includes :

- A. Power connector (battery or wall power outlet)
- B. HDMI video output connection (either to the drone-integrated transmitter or directly onto a monitor)
- C. (OPTIONAL) Additional USB devices – mouse, keyboard, etc. The keyboard and mouse are used to setup Pensar™ and applications before take-off and can be operated short-range using an ordinary USB transmitter.



### Remote Controller

The remote is used to control Pensar™ during missions and can be operated long-range through the integrated drone transmitter. It is also used to transmit video signal to the pilot and to the Pensar™ operator. To connect the battery, use the following steps:

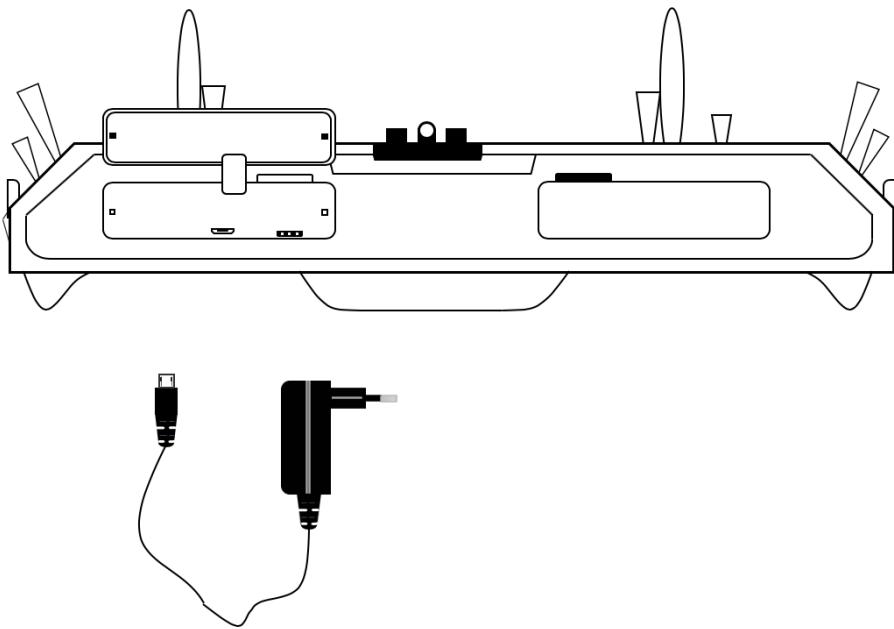


0. (remove the lid of the battery compartment)
1. Plug in the JR Male plug in the female slot located in the compartment
2. Insert the battery in its compartment
3. Close the lid

Once everything has been properly connected, the remote controller and camera can be switched on. Always turn on the emitter before the receiver to reduce any interference risks. Turn on the display on which you will monitor the Pensar™ and then plug the Pensar™ in to turn it on (this process can take a minute). Pensar™ will start in application mode by default, running Dual Camera application (see application details in section below). The remote controller allows to maneuver the gimbal, the camera and to control the most important application functions (refer to the remote diagrams for additional information). If a keyboard and mouse are connected it is possible to close the application launcher by pressing ESC and return to a Linux Desktop. From the desktop mode, double clicking on the Launcher icon will restart the launcher and bring Pensar™ in application mode, dedicated icons can be used to run specific applications (show desktop with icons).

## Charging Devices

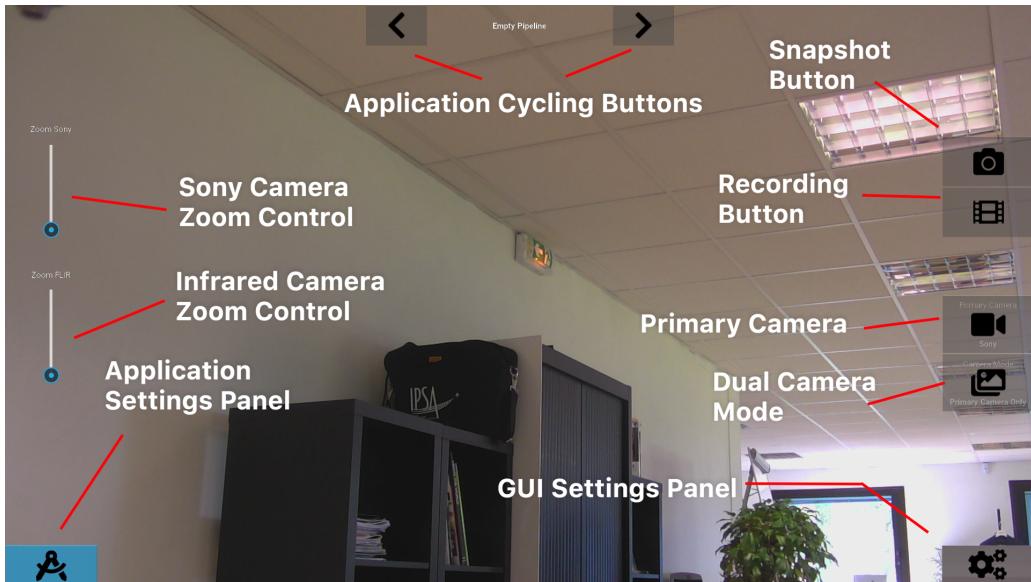
You can charge the devices in different ways. The most common ones involve using a wall power outlet with the chargers for both the batteries and the remote control. Alternatively, you can plug all devices directly into the wall power outlet to turn them on.



### 5.1.3 Using the Software

#### Operating the GUI (Graphical User Interface)

The GUI (Graphical User Interface) is the first thing to load when switching on the Pensar™. If not, refer to the section below (Using Linux Operating System) as you will be redirected to a Linux desktop.



In addition to the remote controller, you can operate the Pensar™ using the GUI. You will need a keyboard and a mouse to interact with the interface, such as clicking icons, dragging sliders, or typing text in applications. The diagram above annotates the icons you can interact with, which includes:

Name	Description
Application Cycling	In launcher mode, these arrows change the current GUI application. You can cycle between them freely – allow some time for the operation to occur.
Snapshot Button	Captures both images seen on the cameras without overlay.
Recording Button	Records both videos seen on the cameras without overlay.
Sony and Infrared Camera Zoom	Adjusts the zoom levels of each cameras.
Primary Camera Selection	Choose which camera to become the primary camera. It will be displayed as a full screen and the GUI will interact with it.
Dual Camera Mode	Choose how to display your cameras. Only one, Side-by-Side, Overlay or Picture in Picture (PiP).
Application Setting	Allows to interact with and change the settings of the currently selected application.

## GUI Settings

Allows to change the settings of the entire GUI, as well as the camera settings and the dual camera mode additional options. Feel free to experiment with the various utility buttons to gain more confidence with the controls. They will be described in detail in the next sections.

### General User Interface Actions

- Snapshot Button: simply click on the snapshot button to capture a snapshot from both cameras. Note: this will only record the raw image without the GUI overlay. They will be stored in the SD-card by default (*/media/nvidia/data/DCIM/100PENS/*) and will be labelled *Sony0000* and *Boso0000*, with the number progressing as more images are recorded. When available, they will also store the GPS location from which the snapshot was taken.
- Recording Button: similarly, click on the recording button to start recording from both cameras. Note: this will only store the raw video footage, without the GUI overlay. They will also be stored in the SD-card by default (*/media/nvidia/data/VIDEO/100PENS/*) and named *Sony0000* and *Boso0000* with a progressing number.
- Sony and Infrared Zoom: You can drag the sliders on the left to modify the zoom magnitudes. Note that due to the different cameras, they will not have an identical degree of magnification and resolution.
- Primary Camera Selection: This tab switches the primary camera from Sony to infrared and vice-versa. It also tells the GUI which camera to apply its functions to, from the AI processing to the settings modification.
- Dual Camera Mode: In this panel are indicated the various dual camera settings.
  - Primary Camera Only: Only displays the primary camera.
  - Side-by-Side: Allows both cameras to be displayed with similar sizes. The main camera is displayed above.
  - Overlay: Superimposes the infrared and Sony cameras on top of one another, allowing comparisons to be made. Additional adjustments can be made in the GUI settings tab.
  - PiP: Displays both cameras, with the secondary camera displayed in a smaller resolution somewhere on the screen. The positioning and size of this image can be edited in the GUI settings tab.
- GUI Settings: The settings on the bottom right edit the configuration for the cameras. They have been described in more details below.

## GUI Settings

You can modify many settings using the GUI. To do so, click on the bottom right corner. Inside the camera settings can be found 3 tabs, one for the Sony, one for the infrared (Boson) and one for the dual camera positioning and sizing. Below are displayed the available options for the different camera modes.

Table 1: Sony Camera Settings

Setting	Description
Mirror Mode	Mirrors the image around the vertical axis.
Flip Mode	Flips the top and bottom of the image. Useful when mounted above the drone rather than under.
Negative Mode	Changes the colors from positive to negative
Black & White Mode	Turns the image black and white.
Stable Zoom	Locks the speed at which the camera zooms, inducing smoother transitions
Backlight Compensation	Brightens the whole image to try to distinguish some otherwise poorly visible areas.
Hi-Speed Shutter	Takes control of the Sony pre-configured settings and allows snapshots to be quickly captured.
Image Stabilization	Records a smaller, stabilized image to compensate for any outside forces that may affect the video capture.

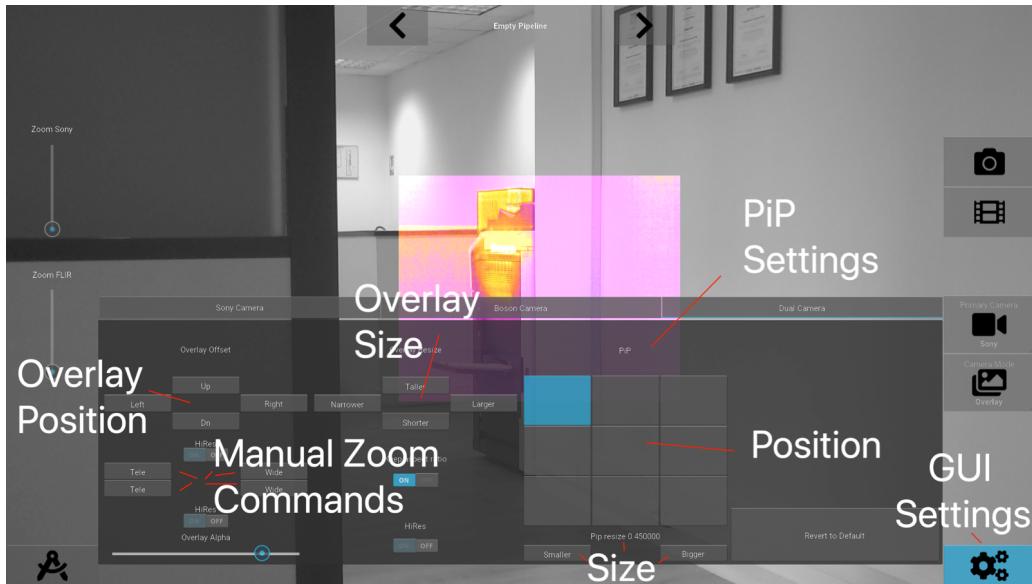
Table 2: FLIR Camera Settings

Setting	Description
AGC Linear Percent	Allocates a percentage of Linear color scale. A high value will take all colors palettes and display them, while a low value will only record the more important shades, creating a more ‘separated’ image.
AGC Outlier Cut	Defines the outer percentages of heat signatures to be ignored. 5.0 would exclude the 0-5 and 95-100% of the recorded frequencies from the displayed image.
AGC Max Gain	Determines the maximum slope of the transfer function between 16 bits to 8 bits. In other words, low-gain values seem blurred and high-gain images seem too defined.
AGC Dampening Factor	Adjusts the reaction time of the Boson to rapid changes of temperature. A quick burst of heat could lead to bright lights and dazzle the user. High percentages slow, or even stop, the temperature adjustments, while a low percentage would adapt rapidly.
AGC Gamma	Adaptive Contrast Enhancement (ACE) adjusts the contrast of the image. A value under 1 will darken the image and one above will brighten it.
AGC Detail to Background Ratio	Set the detail-to-background ratio. This defines the ratio of the detail (High Pass) gain and the maximum slope/gain of the background (Low Pass). The allowable range for this parameter is [0 inf] with a typical setting of 1.3.
AGC SigmaR	Set the smoothing factor. This defines the properties of the edge-preserving low pass filter used for the DDE (Digital Detail Enhancement) functionality. Higher values for this parameter will result in more aggressive low pass filtering which will cause higher amplitude signals to be present in the detail (High Pass) component. Allowable range is [0 inf] with a typical setting of 2000. Value should be proportional to imager responsivity.
Entropy-based Equalization	Activates the AGC (Automatic Gain Control) mode

## Dual Camera Settings

On the left side of the panel are all the settings associated with the overlay camera mode. You can adjust its positioning, opacity and size, as well as manually control both zoom options with the TELE and WIDE commands. There are also

the HiRes options, which increase the sensitivity of the gimbal. The right-side options are for the PiP camera mode: you can change the size and positioning of the square. On the bottom right is the ‘Restore to Default’ button, which will cancel any settings you have made.



#### 5.1.4 Pre-Installed Applications (Launcher)

The Pensar™ comes with several pre-installed ‘teaser’ application. They include the Optical Tracking, AI- based Optical Tracking, Facial Recognition and Object Detection. Each application has its own panel, which can be opened by clicking on the compass icon located on the bottom-left.

##### Dual Camera Mode (Empty Pipeline)

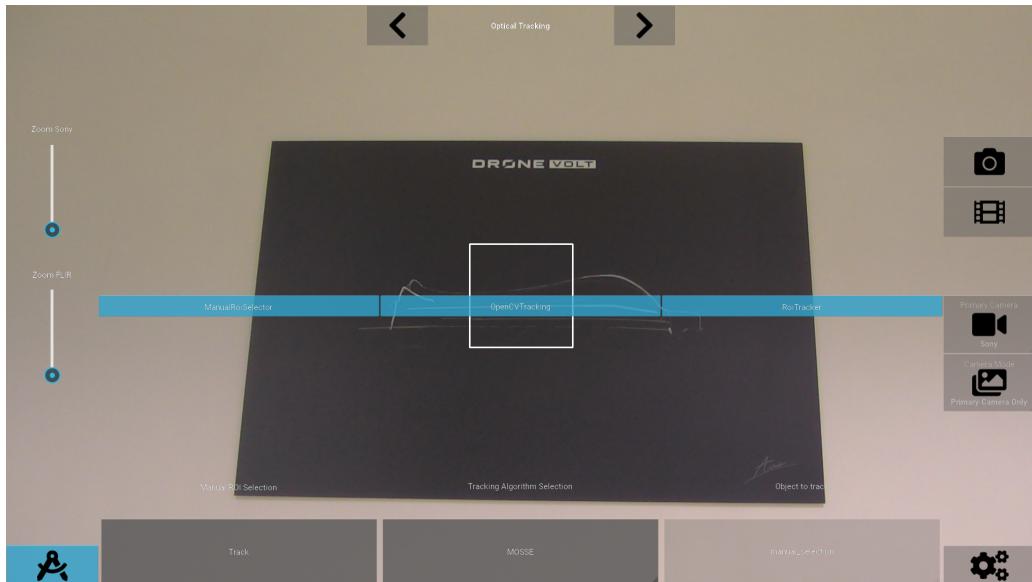
There is a simple application which allows the user to simply record images with both, or any individual camera. This does not use any AI software,

##### Optical Tracking

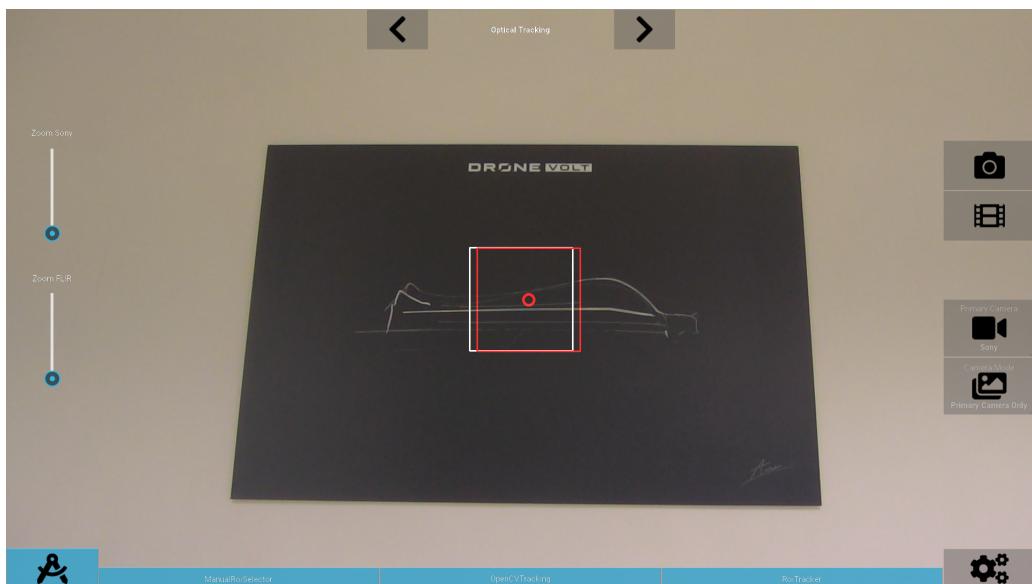
The first application in the cycling list is Optical Tracking (It is actually AI based tracking, but for clarity, manual tracking will be explained first). This allows the user to manually select a square at the center of the camera for the software to track. The tracking function can either be activated on the remote (switch 6 – pull down to track and up to stop tracking) or on the GUI with the Track button on the bottom left. The bottom-middle tab indicates the different tracking which you can choose from:

- BOOSTING
- MIL
- KCF
- TLD
- MEDIANFLOW
- MOSSE
- DLIB

The bottom-right one isn't selectable; it is related to automatic tracking. The middle buttons, ManualRoiSelector, OpenCVTracking ( [https://docs.opencv.org/3.4.5/d9/df8/group\\_\\_tracking.html](https://docs.opencv.org/3.4.5/d9/df8/group__tracking.html)) and RoiTracker toggle the interaction with their respective, vertically-aligned tabs.



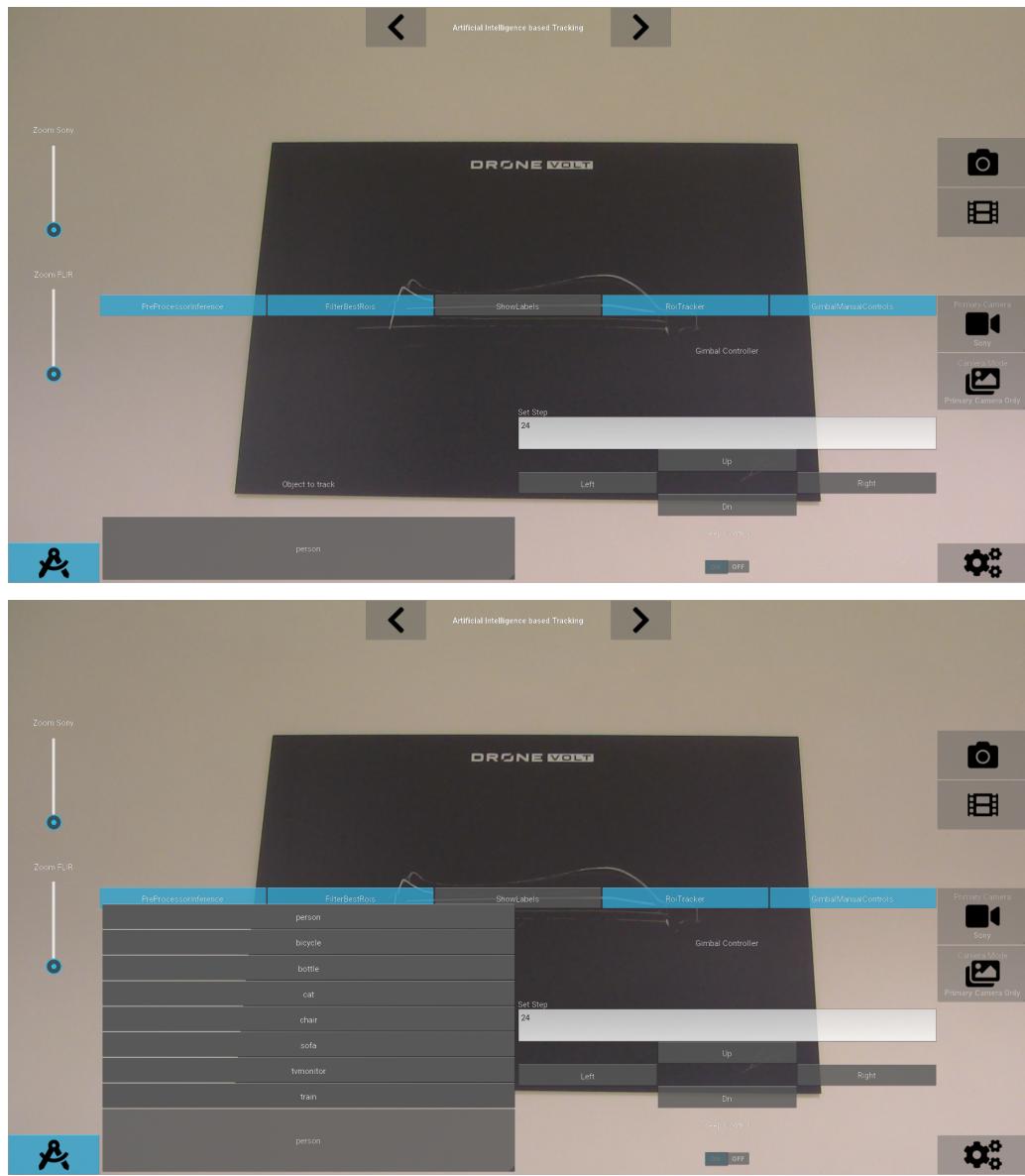
To track a target, simply activate the action button on the GUI or Application Interaction Button on the remote. A new, red square will appear which indicates a successful lock-on target. If the object, or the vehicle on which Pensar™ is mounted, moves when locked on a target, the gimbal will reposition itself to keep the red square aligned with the white square close to the center of the screen.



## Artificial Intelligence Based Tracking

The default, second application is Artificial Intelligence Based Tracking. The first step is to choose the object to be tracked. On the bottom left, the Object to Track tab can toggle between various, pre-installed objects, such as a person, a car, a cat, a monitor, a bottle, a cup, etc. The Pensar™ can be taught to recognize more, please ask us for support with regards to installing this feature. The right side controls the gimbal, where the buttons can reposition the gimbal

and the Set Step text box controls its reactivity. (A high value will track faster than a low value but will have greater computational costs). There is also an option to Keep Control of the gimbal: switching it off will give the software predominance over the pilot and hinder his controls when an object is actively being tracked.

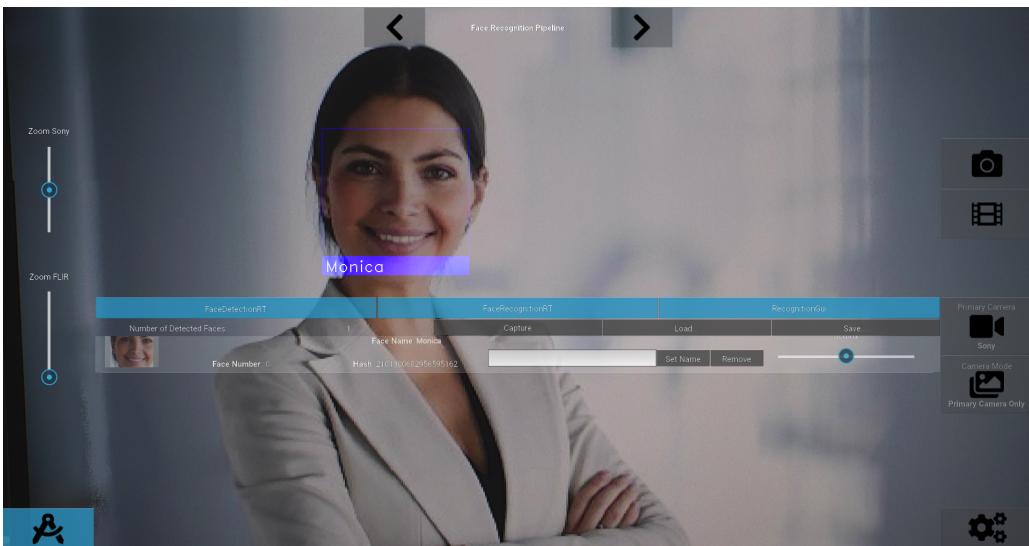


## Face Recognition

The next application is the Face Recognition. This application allows to detect, recognize, save and load faces in databases inside the Pensar™. The middle buttons activate the different mechanisms of the software: The left FaceDetectionRT tab activates detection, the middle FaceRecognitionRT activates the recognition while the Recognition GUI activates the overall interface.

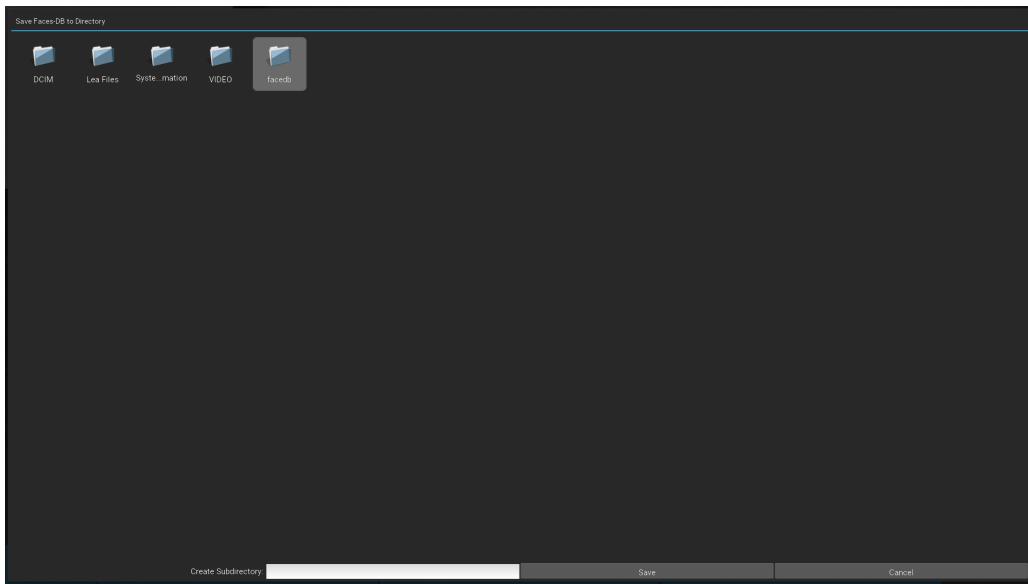


Under these tabs are the Capture, Load... and Save... tabs. When a face is detected, a blue square will surround it. If the face is in the database it will indicate its name. If the face is unknown it will indicate unknown; the Capture tab becomes available. This allows the user to record the image to the database. You can assign a name by typing in the text box on the right and clicking Set Name. You can remove an image from the database by using the Remove tab as well as assign its status (Friend, Neutral or Foe), which will change the box color from green, blue or red, respectively.

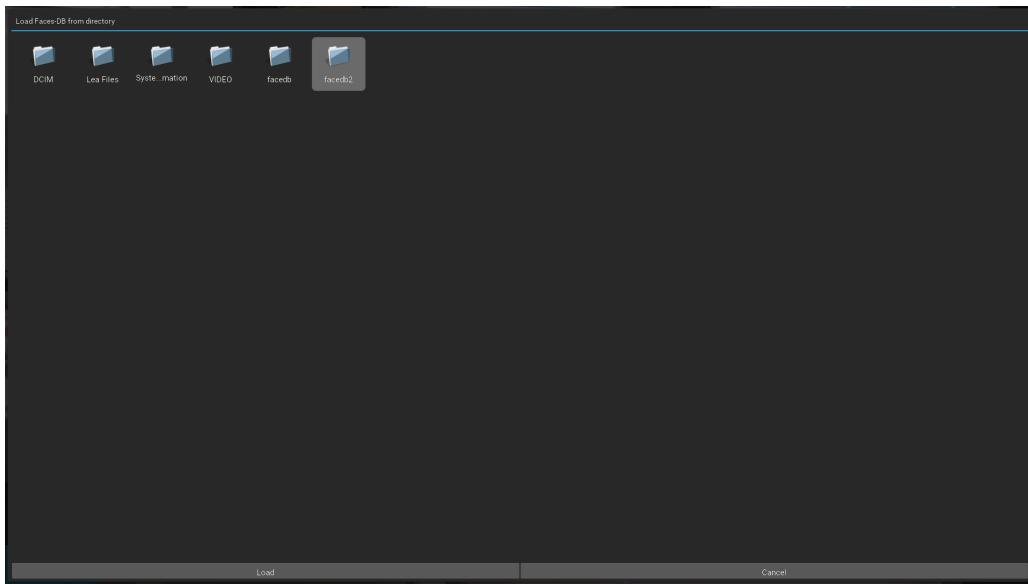


NOTE: The images above have been blurred for data privacy reasons.

These settings are not permanent until they are saved using the Save... button. This will open up the menu below: a Linux file path. All currently recorded images in the GUI will be stored in the same folder, or subdirectory. The subdirectory can be renamed with the Create Subdirectory text box and saved using the Save button. The Cancel button cancels the operation.

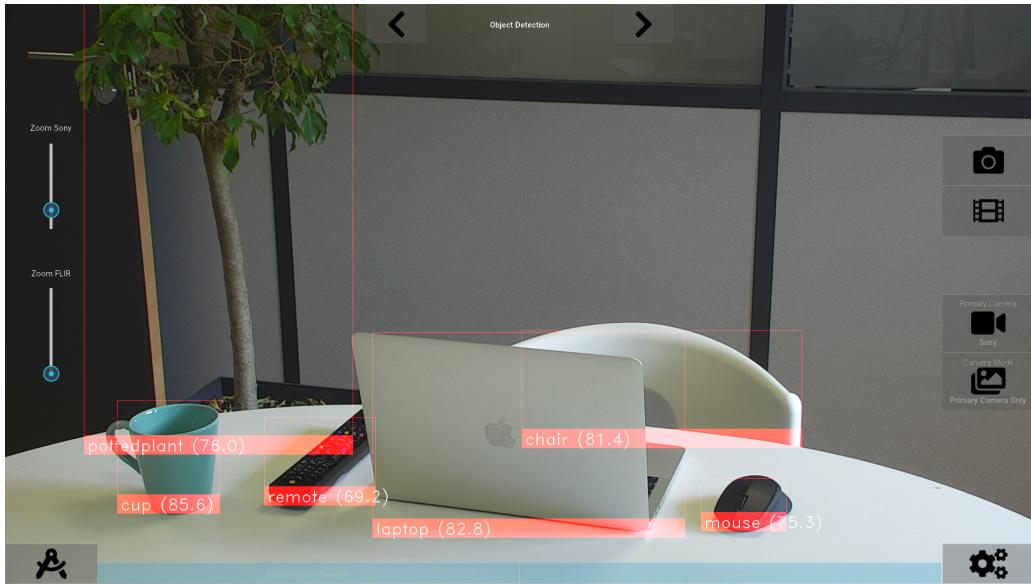


Similarly, you can Load databases using the Load... button. This will open up the panel below, with Load replacing Save and Create Subdirectory.

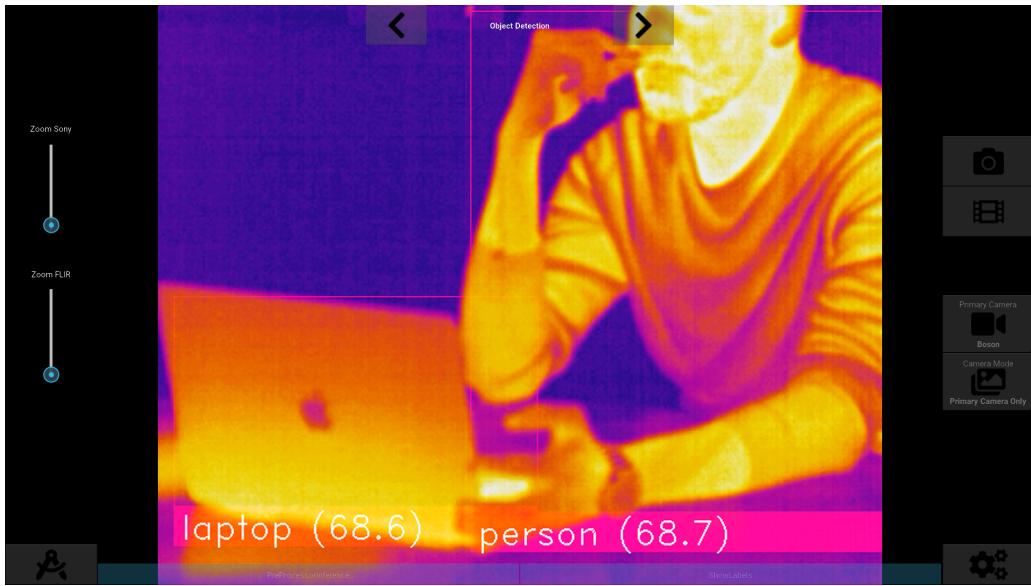


## Object Detection

The final application is Object Detection. It performs recognition and annotation of objects that are currently being filmed, as well as indicating a percentage of confidence. A score of 100 will mean that the software is certain that the object is correctly annotated. It can be seen in the picture below that more visible objects have greater degrees of confidence



Object Detection can be used with the Infrared Camera, as seen in the picture below. However, the degree of confidence is a little lower.



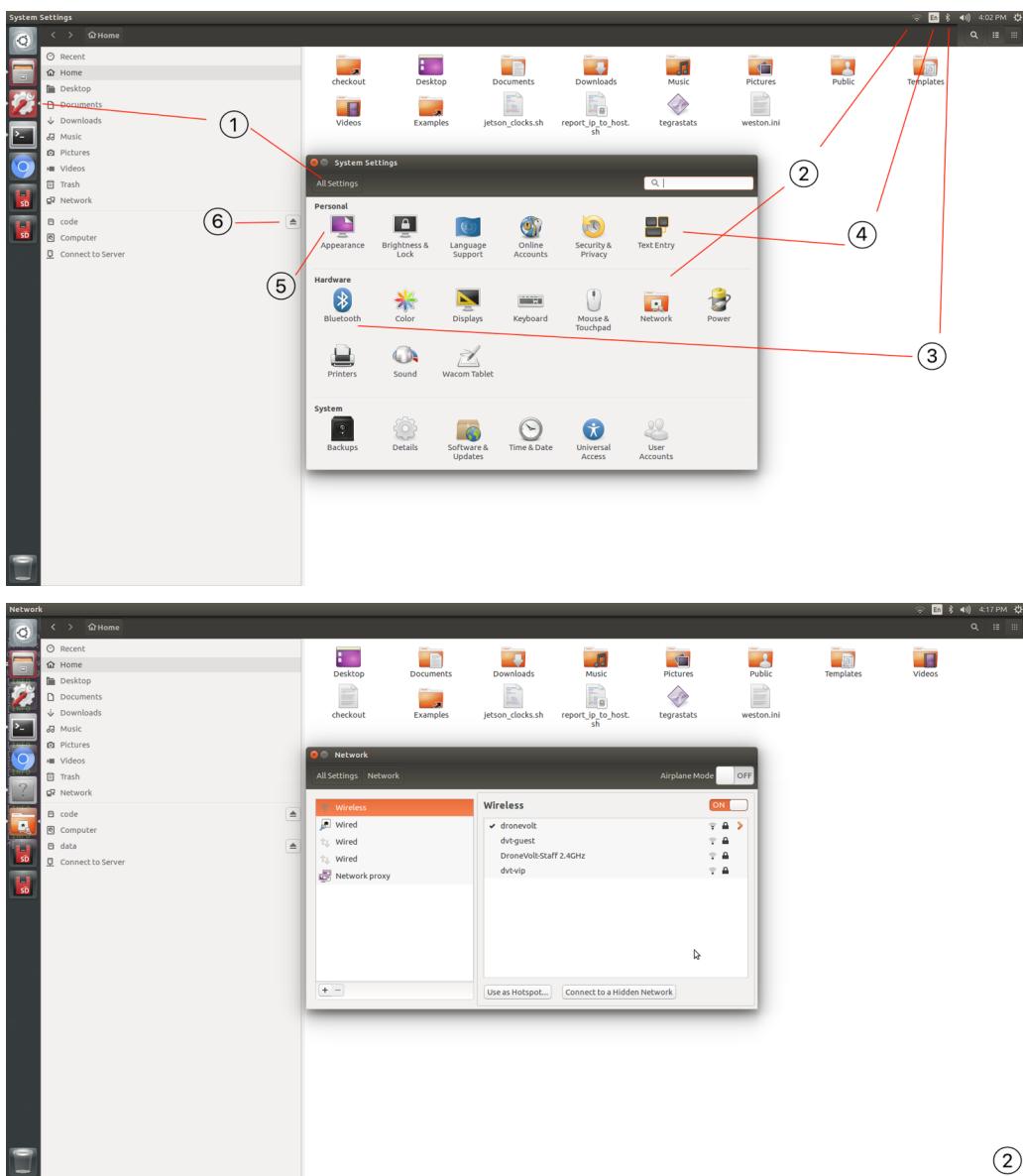
There are little interactions possible with the GUI, other than PreProcessorInference and ShowLabels. The first toggles the AI detection software between On and Off, while the second activates the labels.

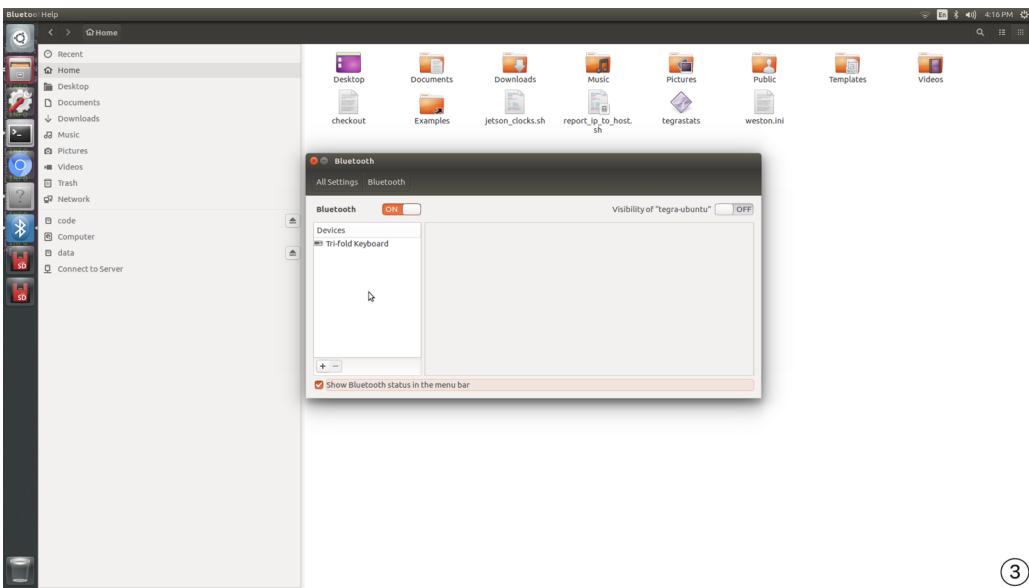
## Additional Applications

You can add more applications to the list of applications. To do so, do not hesitate to ask us, or to develop your own using the Pensar™ SDK.

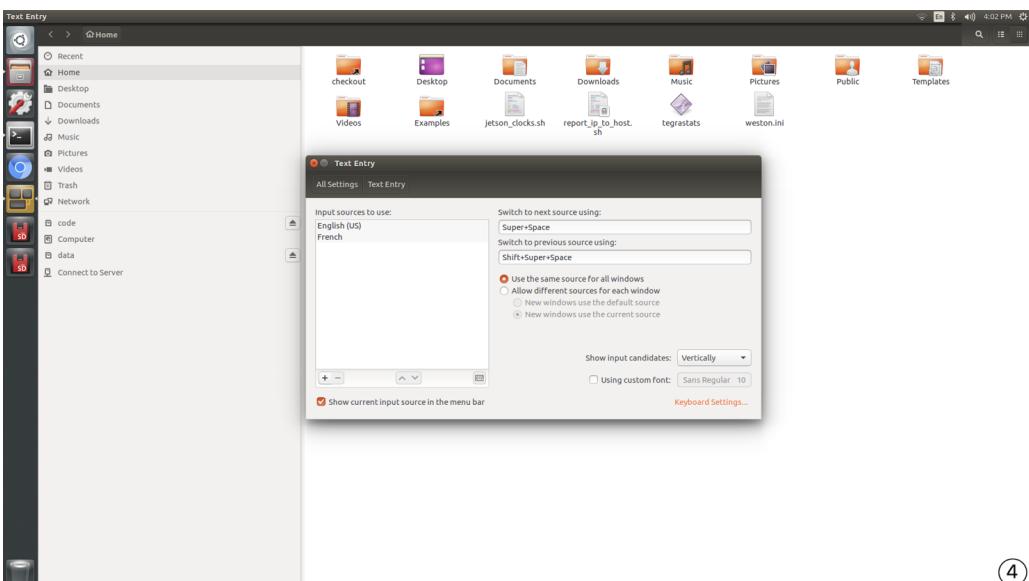
### 5.1.5 Using Linux Operating System

When you are not in the application mode (Press (Esc) on your external keyboard to leave application mode), you will be redirected to a Linux desktop . This is the integrated system from where all the Pensar™ actions are operated, as well as where data is stored and accessed. With the use of an external keyboard and mouse, it works like a normal computer; by going into the parameters (1), you can connect to a Wi-fi (2), Bluetooth (3), switch input keyboard language (4), modify display properties (5) and many other standard computer functions to customize your Pensar™ to be more productive. You can also use an SD card to load and save sets of data, such as facial recognition or object detection databases, additional software, etc. Remember to eject it if you want to remove it from Pensar™ (by clicking on the eject icon next to the file card (6)). N.B. Pensar™ will not turn on without inserting its original SD card.



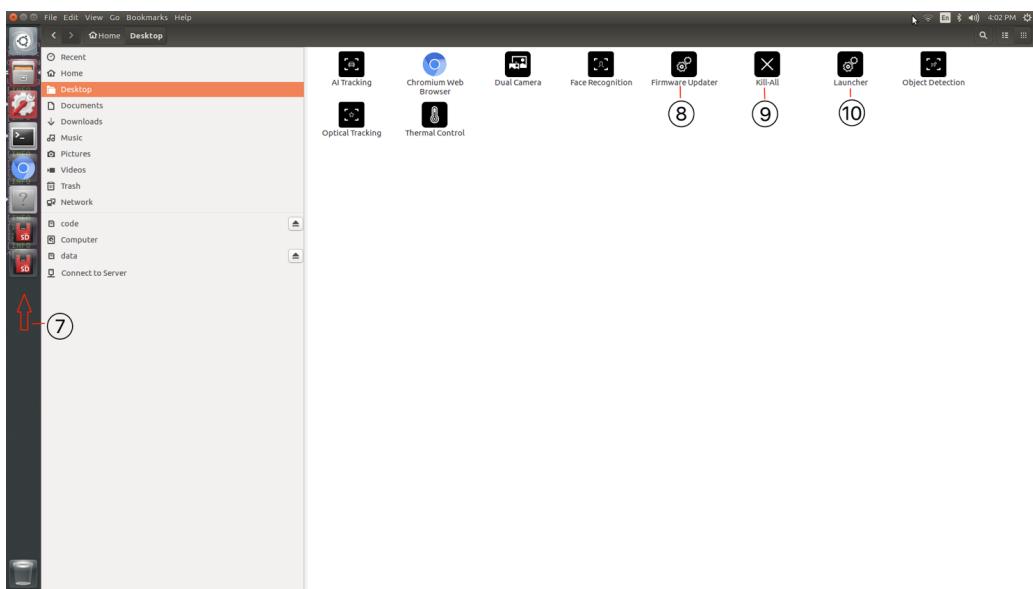


(3)



(4)

The desktop has an action menu on the left (7), where each tab indicates a running application (Linux application, not to be confused with the Pensar™ applications found in the Launcher). The menu is a convenient way to see which apps are running and cycle between them. To launch the Pensar™ applications, go to the desktop tab. You will find all individual applications, a Firmware Updater (8), the Kill-All function (9) and the Launcher (10) (which is a combination of all applications – the aforementioned application mode). Occasionally, when running too many applications or demanding software (such as AI- tracking), the operating system may run slowly or potentially, crash. The Kill-All function forces shutdown on all applications.



When you are finished using your Pensar™, you can turn it off. Remember that your Pensar™ is a computer and should be turned off like one. By going to the shutdown menu, you can either restart it or shut it down without any risks of damage to your software or recordings. Similarly, you can use the shutdown button on your remote (button 8).

### Gimbal Diagram



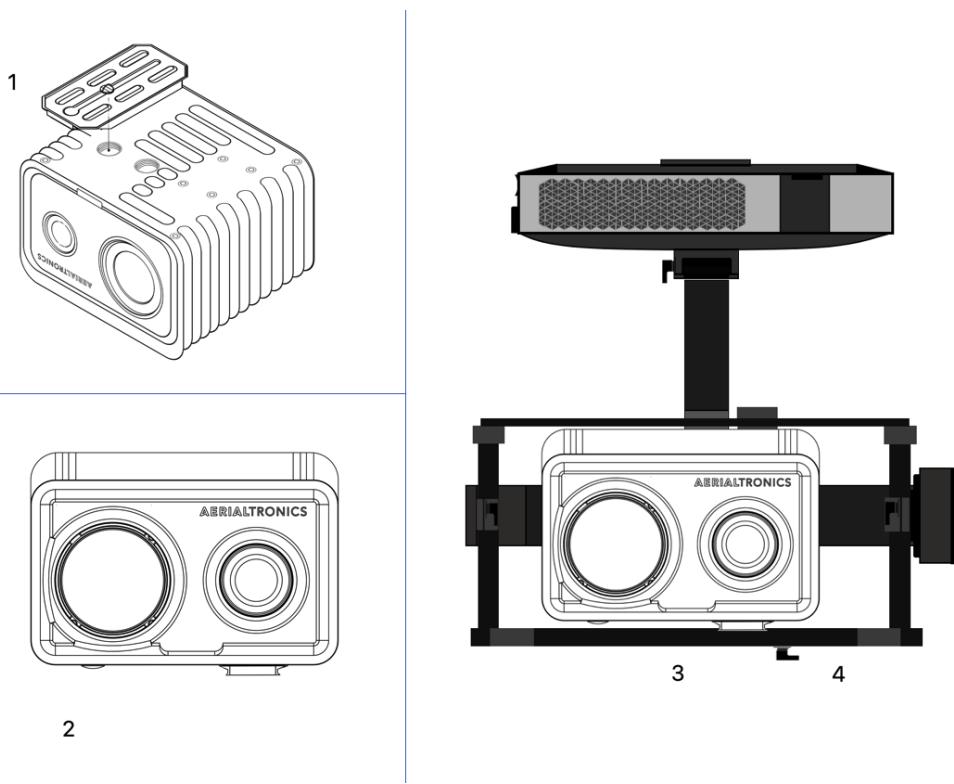
1. Hyper Quick Release
2. Pan Motor
3. Pan Adjustment
4. Roll Motor
5. Gimbal Controller
6. Roll Adjustment
7. Tilt Motor
8. Tilt Top Bar
9. Camera plate
10. Tilt Front-Back Adjustment

11. Tilt Vertical Adjustment
12. Top Camera Screw

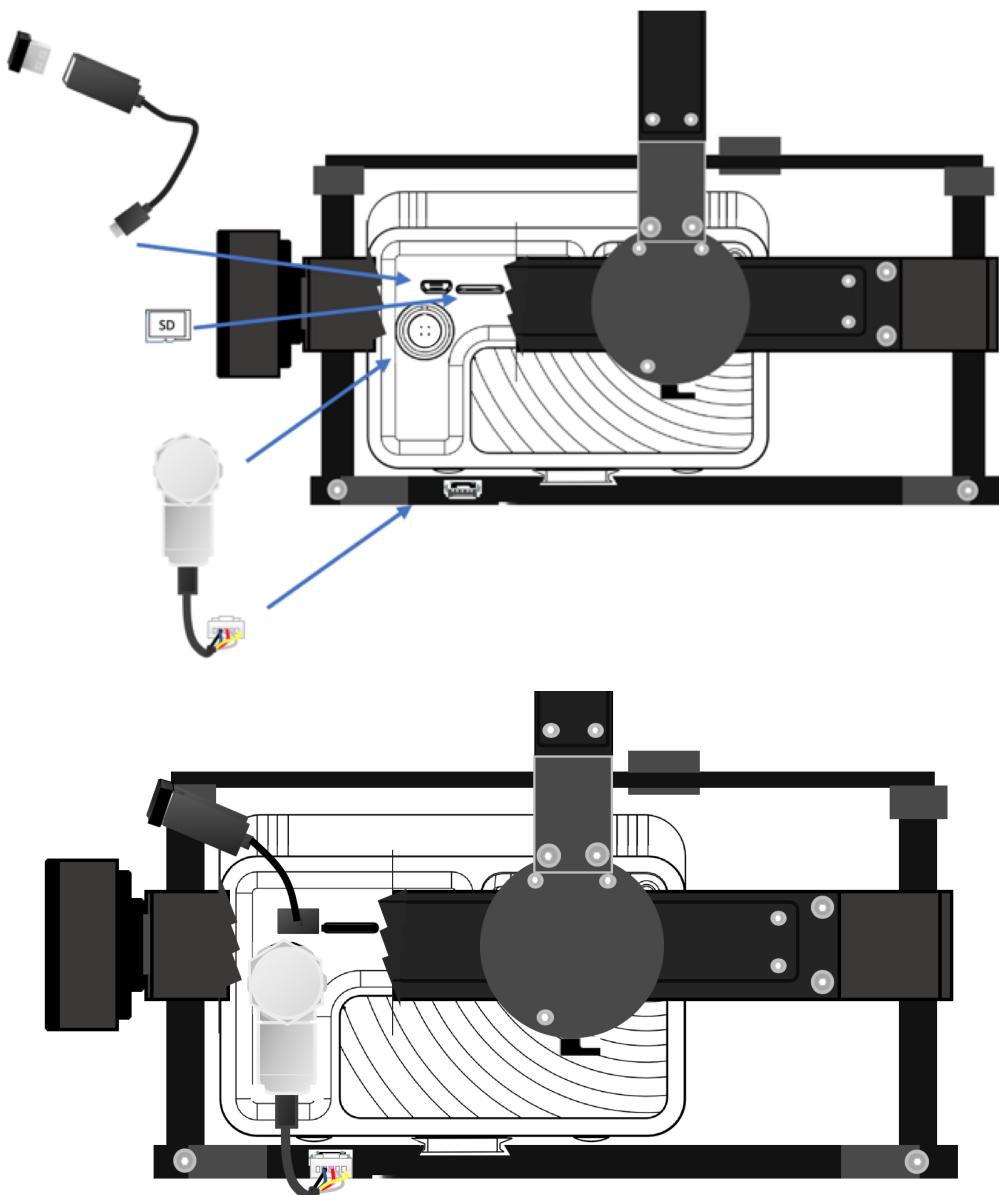
## Gimbal Set-Up

If you purchased a gimbal with your Pensar™, read the following steps to set it up:

1. Turn the Pensar™ upside down and screw the camera plate to it.
2. Reposition the Pensar™ in the upright position
3. Slide the mounting piece into the gimbal slot as shown in the diagram
4. Tighten the Pensar™ to the gimbal.

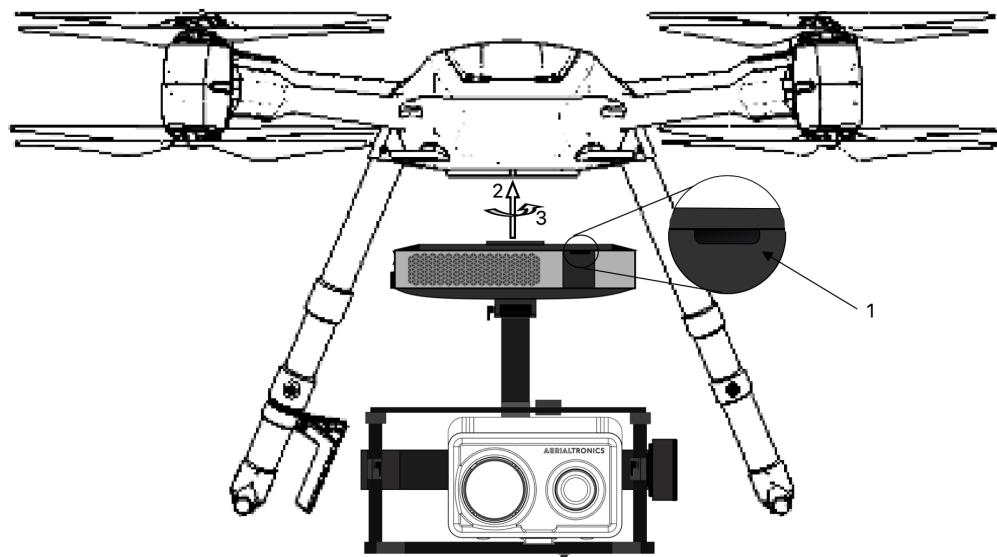


## Connector Set-Up



### Gimbal and Zenith set-up

1. Press the lock button on the side of the gimbal
2. Position the gimbal in its slot on the Zenith
3. Rotate it to secure the hold and release the button.



## 5.1.6 Appendix

### Advanced Configuration

Media Files and SD Card usage

All media files are saved by Pensar™ in the removable SD card. You can remove the SD card from the Pensar™ and plug it into any SD card reader, possibly using the included SD card adapter.

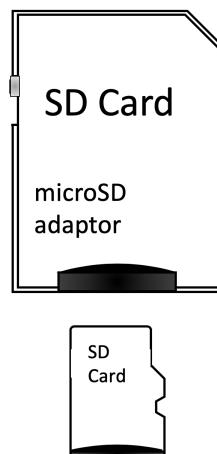


Image files are saved in the most common standard and as such your favorite photo import program should recognize immediately the SD content as “media” and allow a quick and effortless import. Should you need to manually import media files, notice that image files are saved in the “DCIM” folder and video files are saved in the “VIDEO” folder. The recommended procedure to remove the SD card from Pensar™ is to first turn off the camera, then remove the SD card. Removing the SD card while Pensar™ is running could damage the SD card file system and as such it is not recommended. N.B. Pensar™ requires its original SD card to be inserted when booting. If the original SD card is not inserted or a different SD card is used, Pensar™ will not boot.

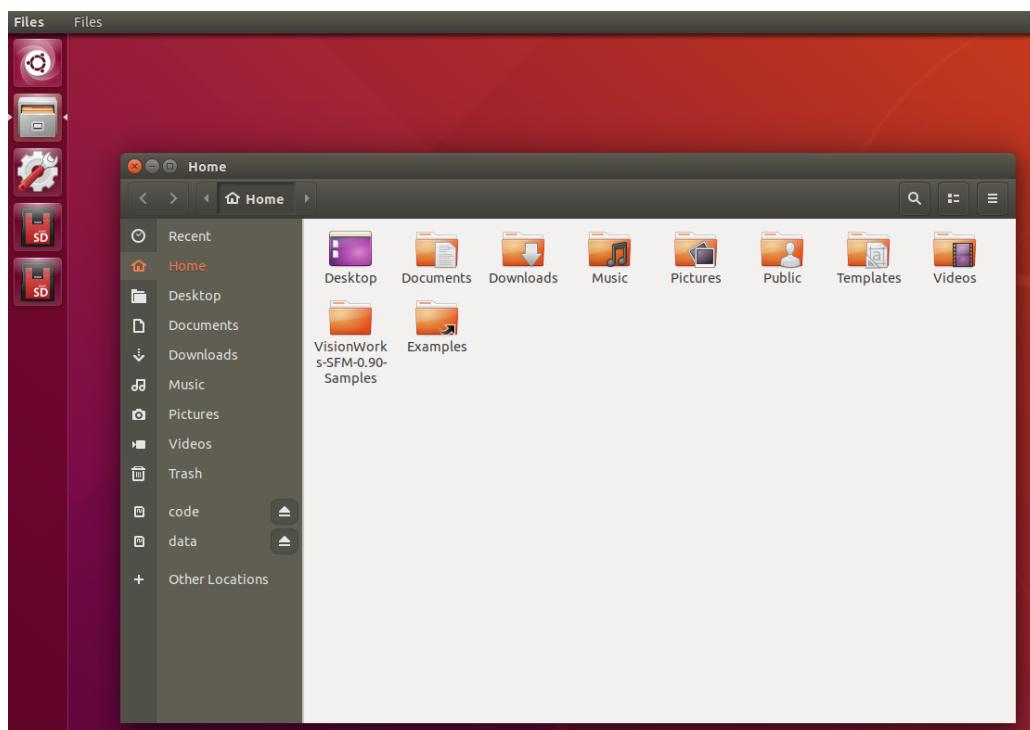
## SD card replacement

If, for any reason, the original SD card supplied with your Pensar™ is unavailable, you may use any of the commercially available micro SD cards, provided you go through a one-time SD card preparation step described below.

**Replacement SD card one-time preparation procedure:** For this procedure, you need a PC running a Linux operating system (Ubuntu 16.04 recommended). The procedure can be performed as well directly using Pensar™, but a mouse and keyboard will be needed.

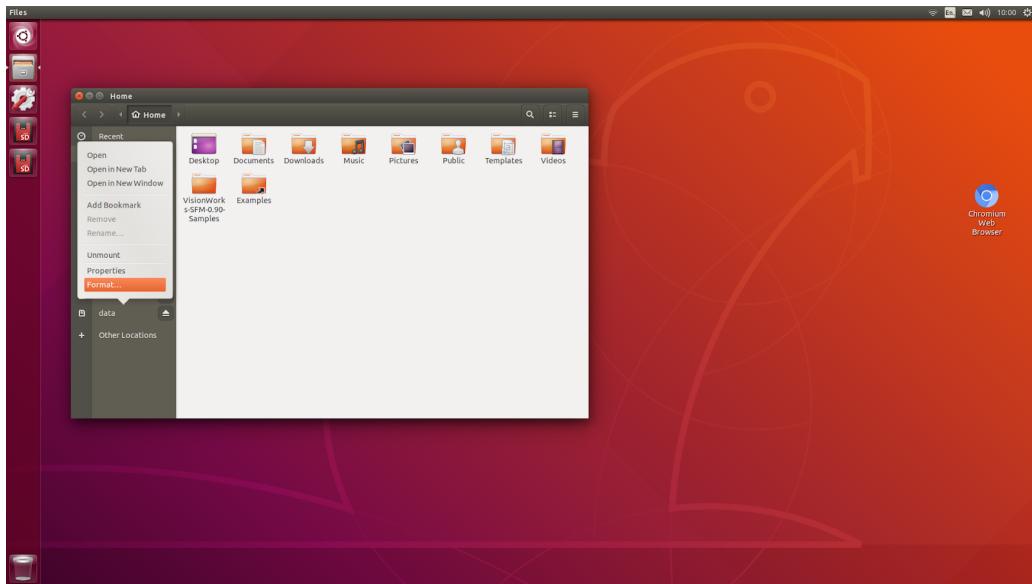
Note: This procedure will completely erase the content of the SD card.

1. Insert the SD card in the Pensar™ slot or in the PC SD card reader
2. Open Nautilus and identify your SD card in the grey column on the left, just below the “Trash” icon. The name assigned by the operating system depends on the producer/brand. In any case your SD card will be shown with an icon of the “eject” button, used to identify removable media.

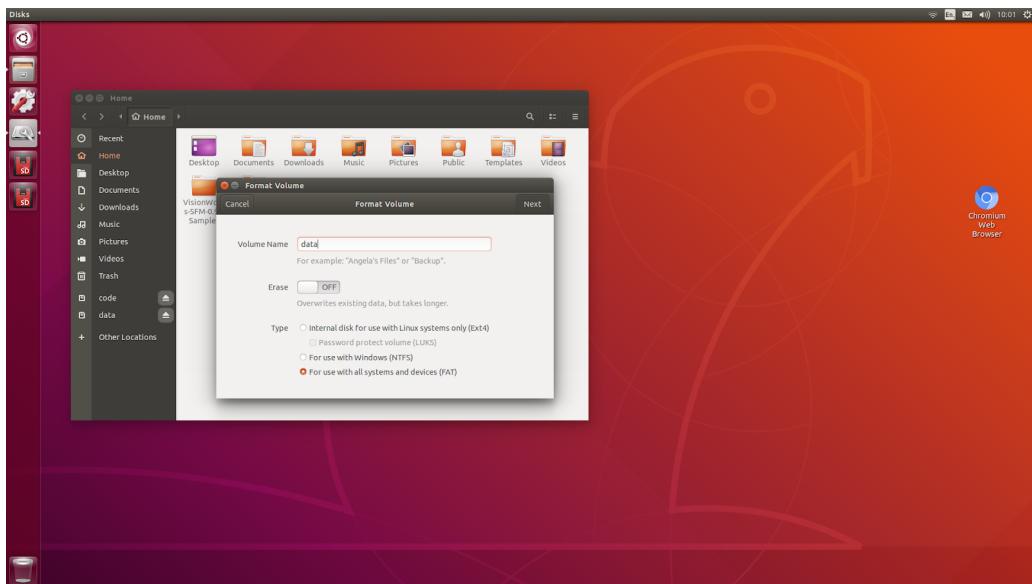


In this case, two SD cards are present, called “code” and “data”.

3. Right-click on the icon of your SD card and choose the “Format...” option



4. Assign the Volume Name “data” to your SD card and choose the “FAT” filesystem



5. Click on next and confirm. The format procedure will start and notify when finished. You can then start using your SD card on Pensar™.

### Application Launcher customization

At startup, Pensar™ loads a pre-defined sequence of applications that you can cycle through using the remote control and/or the GUI using the mouse (see chapter Pre-installed Applications on page 9). This sequence can be customized by the user to suit its need. Applications can be removed, or their order can be changed, by editing the file /etc/plugin-manager/pipelist/launcher.xml.

```
<?xml version="1.0" encoding="UTF-8"?>
<plugin_manager_pipelines>

    ...<plugin_manager_pipeline>pipe/void.xml</plugin_manager_pipeline>
    ...<plugin_manager_pipeline>pipe/ai_tracking.xml</plugin_manager_pipeline>
    ...<plugin_manager_pipeline>pipe/optical_tracking.xml</plugin_manager_pipeline>
    ...<plugin_manager_pipeline>pipe/face_recognition_rt.xml</plugin_manager_pipeline>
    ...<plugin_manager_pipeline>pipe/object_detection.xml</plugin_manager_pipeline>

</plugin_manager_pipelines>
```

Contents of the “launcher.xml” file.

WARNING: before editing this file, it is recommended to perform a backup. Open a terminal with CTRL+ALT+T and type the command “sudo mv /etc/plugin-manager/pipelists/launcher.xml /etc/plugin- manager/pipelists/launcher.xml.bak”. In case you need it, you can restore the original file with the command “sudo cp /etc/plugin-manager/pipelists/launcher.xml.bak /etc/plugin- manager/pipelists/launcher.xml” In order to edit the file, it is recommended to use the embedded text editor of Pensar™. You can launch the editor with the command “sudo gedit /etc/plugin-manager/pipelists/launcher.xml”. Reorder the lines based on your needs or remove the applications you don’t need and save the file. You need to leave at least one application. Pensar™ at reboot will only cycle through the applications you have specified.





**--Footers--**

1. Additional Feature (Presentation - ‘Pensar SDK 1’)
2. You can relaunch the Application mode by using Launcher found in the desktop (10) (Using Linux Operating System - ‘redirected to Linux Desktop 2’)
3. Additional information can be found in the appendix (Using Linux Operating System - ‘inserting its original SD card 3’)

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**CHAPTER  
SIX**

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**RELEASE NOTES**

description .....

See the latest features and updates for this version of Pensar SDK.



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**CHAPTER  
SEVEN**

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**COPYRIGHT AND LICENSE NOTICES**

description .....



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**CHAPTER  
EIGHT**

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**INDICES AND TABLES**

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