airelectronics

UAV AUTOPILOTS

U-Sim Manual

V 1.1

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1 General System Introduction

Airelectronics has developed a complete solution for both rotary and fixed wing UAVs. The system is composed of:

- U-Pilot or U-Pilot OEM
- U-Ground or U-Ground OEM
- U-See Software

U-Pilot manages and controls the vehicle from Take-off to Landing, being capable of controlling any kind of aircraft including fixed wing, helicopters and multicopters.

U-Pilot is completely capable of following a flight plan with up to 200 real-time editable points. Once the flight plan is loaded on U-Pilot, it is independent of operator instructions, ad in case o a communication failure, U-Pilot starts a Return Home, with the possibility of following a predefined path or sequence of actions, and Land manoeuvrers which would safely land de UAV on the Runway Point.

Thanks to its versatility, U-Pilot can control any payload on board the UAV such as cameras, parachutes or sensors. These devices can be real time controlled by a computer operator or by U-Pilot automatically.

The FPGA technology used in U-Pilot and U-Ground allows the system to have several logic working in parallel with the main processors. U-Pilot has working in parallel:

- Up to 26 PWM (Pulse-Width Modulation) or GPIO (General Purpose Input/Output).
- 3 ADC inputs (Analogical Digital Converter) to monitor the voltages of 3 batteries on the UAV.
- Up to 8 serial ports RS232 of 4 full duplex RD-485 (configurable), to communicate with payloads, external sensors, specific electronics, etc.
- A radiolink capable of reaching 100 km[1] between receptors. Information sent using this radiolink can be protected using AES-128-CCM encryption.
- GPS with RTK capability[2], dynamic and static pressure sensors, gyroscopes and accelerometers.

U-Pilot is built using a two parallel microprocessor approach:

- One processor handling the estate estimation and control of the UAV, using hardware acceleration to calculate high speed algorithms.
- A second processor handles of the mission at high level, communications with U-Ground and the Payload.

The processors do not spend time handling low-level task, as these task are processed in parallel by dedicated logic of the FPGA.

Due to the fact that those two processors are working in parallel and there is dedicated electronics processing the serial ports, sensors inputs and outputs, the system is capable of recalculating its position, orientation and closing control loops at 1000 Hz. This control speed provides a great navigation accuracy and control.

On the ground segment, Airelectronics has both U-Ground and U-See.

1 Range may vary with the frequency band used. Default is 900 MHz but legal limitations in some countries may change this.

2 Disabled by default. Contact Airelectronics to acquire this capability.

U-Ground is a ground station that mainly act as a relay of command and data between U-Pilot and U-See software. Besides acting as data relay, U-Ground provides useful information to U-Pilot such as U-Ground position and pressures. U-Ground hardware is also capable of handling several peripheries, as an Antenna tracking system.

Finally, U-See software is a user friendly program that runs in any personal computer running Windows or Linux. Using U-See, the UAV operator can monitor the current state of the vehicle, control the UAV or modify the vehicle mission in real time.

1.1 Hardware in the loop simulator concept

In real operation, U-Pilot controls the UAV platform. However, for training and mission planning purposes, it is not recommended to use the real platform. In those cases, the use of a Hardware in the Loop (HIL) simulator is the indicated approach. For this purposes, Airelectronics provides U-Sim.

U-Sim is a computer with an embedded U-Pilot that behaves as a real platform would do. Using the same radio-link as any other U-Pilot, U-Sim can “replace” any aerial vehicle without the need of modifying the rest of the system: U-Ground and U-See will not difference a U-Sim from a real vehicle.

With this approach, training and mission planing becomes much more affordable, being able to perform multiple missions without the risk of loosing a real aircraft. U-Sim provides the user this capability.

2 Hardware

2.1 U-Sim hardware

U-Sim is based on a standard CPU tower which is modified to host specific U-Pilot hardware. The enclosure is a specific modification to host specific U-Pilot hardware in one of the front 3.5” bays. This U-Pilot communicates with the simulator like it would do with a real aircraft, so the operation of the system is identical of the real one.

The 3.5” bay where U-Pilot is installed in U-Sim has a front panel which contains:

- **On/Off switch**: Turns on and off U-Sim specific harware (the U-Pilot embedded in the computer). The computer itself can be used without powering U-Pilot, but it is required to be powered on to use the simulator.
- **SMA connector**: for the communication antenna to establish connection with U-Ground.

Figure 1: U-Sim Modified Computer

U-Sim computer delivers the power supply needed by U-Pilot, so the installation is easy, just power up the computer and toggle the on/off switch to power the U-Pilot.

IMPORTANT: The antenna must be connected before powering U-Pilot.

2.2 U-Ground hardware

In order to interface with U-Sim, U-Ground or U-Station hardware is required as it would be to communicate a regular U-Pilot with U-See. The U-Ground will act as a relay of command an data between U-Pilot and U-See software. U-Ground hardware relays the data it receives from the U-Pilot through a serial interface. This data is processed in U-See running on a standard PC which should have a port available (we include a USB to RS232 converter in the installation kit). U-Ground will communicate with U-Pilot through a radio-link as it would do in a real operation.

For more details on how to connect U-Ground / U-Station with U-Pilot please refer to their manuals which can be found in our website.

In order to interface with U-Sim, U-Ground or U-Station hardware is required as it would be to interface with a regular U-Pilot. Guidelines to properly connect U-Ground / U-Station can be found in their manuals.

Figure 2: U-Ground

3 Software

This section only describes the software installed on the U-Sim computer. The guide to use these software applications is contained on section 4.

3.1 U-Sim Link

U-Sim Link is the software interfacing between the flight simulator and U-Pilot hardware. The upper section of the interface shows the Pitch, Roll and Yaw angles along with an artificial horizon.

On the lower part of the window, the software shows the links status and allows the user to select the serial port communicating with the embedded U-Pilot. The link indicators are:

- **Serial**: The serial port for the communication with U-Pilot is properly opened if green.
- **Sim**: The communication with the Flight Simulation software is properly established.
- **U-Pilot**: U-Sim Link is communicating properly with U-Pilot.

The indicators will change its color depending on the status, green indicating that it is correct and red indicating that it is not operative.

Note that the Serial Link may be green while U-Pilot is red if U-Pilot hardware is not answering. U-Pilot not being powered up is an example of this situation.

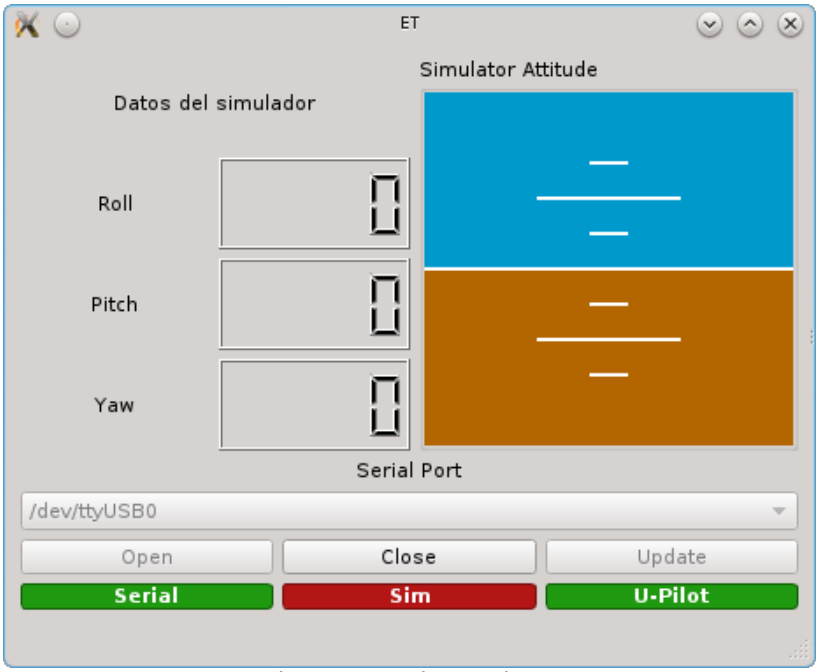

Figure 3: U-Sim Desktop

3.2 Airelectronics Master 

When Airelectronics Master is started, the simulator starts at San Francisco Airport. The simulation begins with the engine running, so there is no need to modify anything on this window.

The camera view used in Airelectronics Master matches the camera commanded by U-Pilot.

3.3 Airelectronics Slave 

Airelectronics Slave is an optional software that replicates the data presented on Airelectronics Master in order to obtain external camera views. This software is not required to run the simulator, although is recommended in order to obtain an external view of the aircraft.

The user can modify the camera position and view in this software, while Airelectronics Master forces the camera to behave like a payload camera view.

U-Sim allows to open up to 2 Airelectronics Slave instances. Any additional instance will not replicate the simulation data.

3.4 U-See software 

In order to interface with U-Sim, U-See software is required as it would be to interface with a regular U-Pilot. U-See will be installed in a different computer than U-Sim.

U-See is the software the operator will use to monitor and command the mission. All the information displayed by U-See comes from U-Pilot (installed in U-Sim computer). U-See runs on a stadard PC, the recommended hardware specification is:

- Intel Core i5 5th generation (or later) processor.
- 4 GiB RAM (8 GiB to enable video recording).
- 4 GiB free hard drive.
- OpenGL capable graphics Video Card.
- 15-inches (720p or greater) screen.
- 1 RS-232 port or an available USB port with a serial USB to RS-232 converter.
- 1 Extra free USB port for license dongle.

For more information about U-See or U-Ground pleas refer to its manuals which can be found in our website.

4 Running U-Sim

4.1 Starting U-Sim

This guide shows the steps required to properly start a simulation.

1. Power up the computer: ensure that the power supply of the computer is properly connected and all peripherals needed are plugged in, then press the power button of the computer located on the front panel.

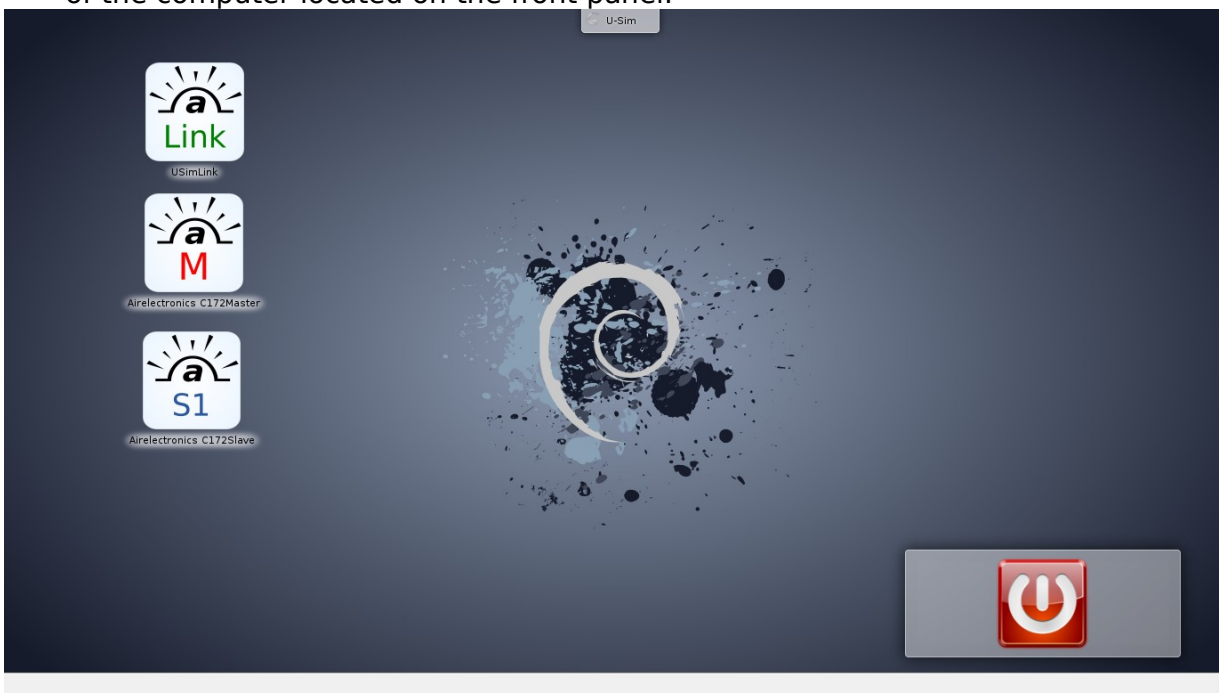

Figure 4: U-Sim Desktop

2. Wait until the computer boots and present the desktop: once U-Sim boots up you will see the desktop (see Figure Figure 4).
3. Start U-Sim Link: click on the U-Sim Link.

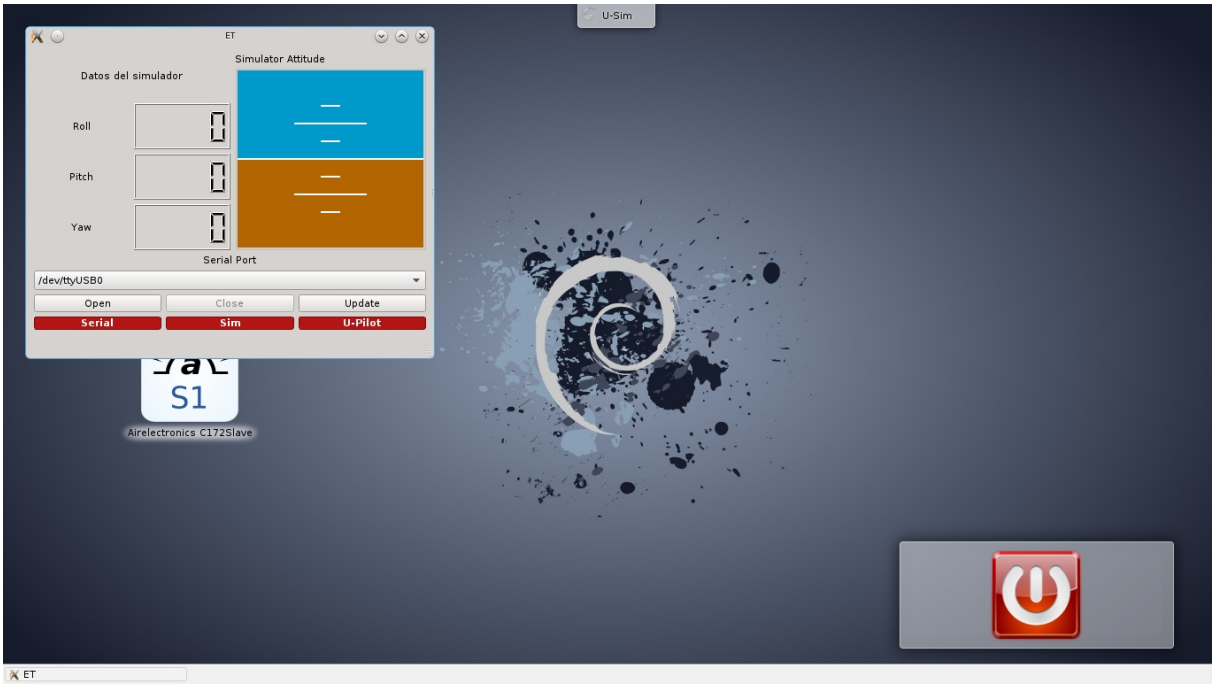

Figure 5: U-Sim Link software

4. Power-up U-Pilot: on the front panel of the computer, in the 3.5” bay where the U-Pilot is installed there is a toggle switch for this purpose. Please note that when powered the toggle switch will light up.
5. Open U-Pilot serial port in U-Sim Link.
6. Wait until U-Pilot Serial and U-Pilot indicators are green: see figure Figure 6.

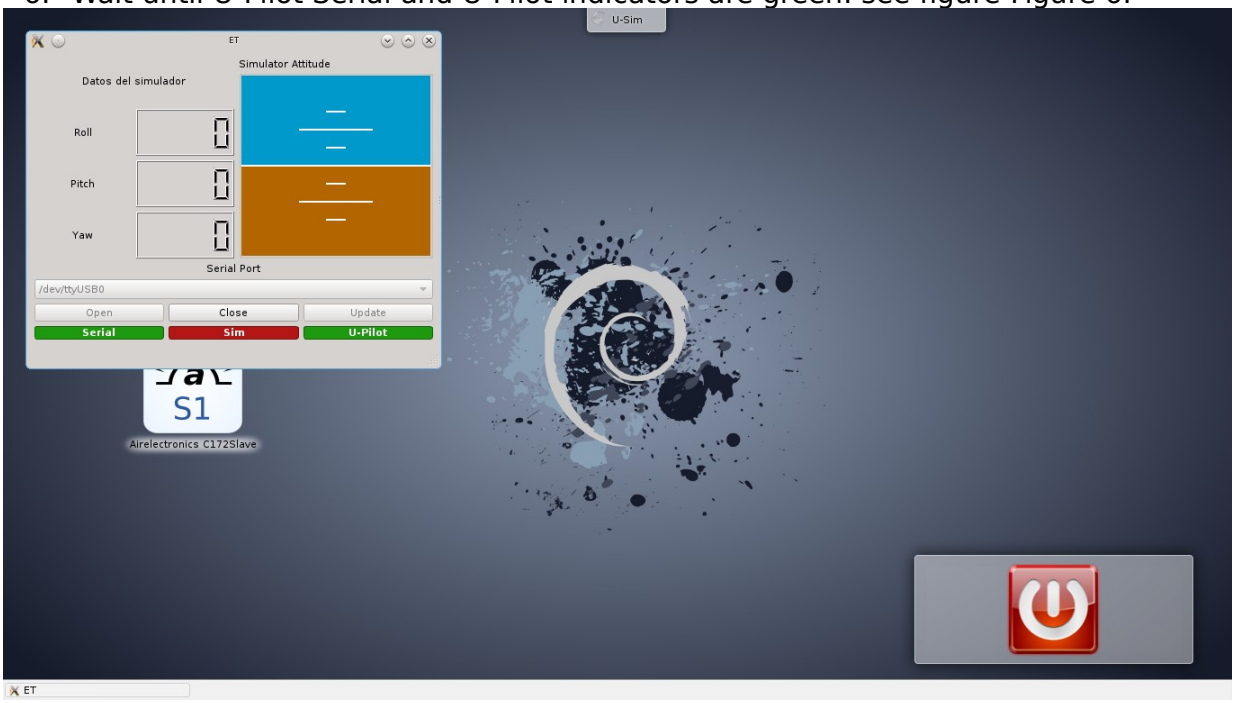

Figure 6: U-Sim Link communicating with U-Pilot

7. Start Airlectronics Master software.
8. Wait until “Sim” indicator is green.

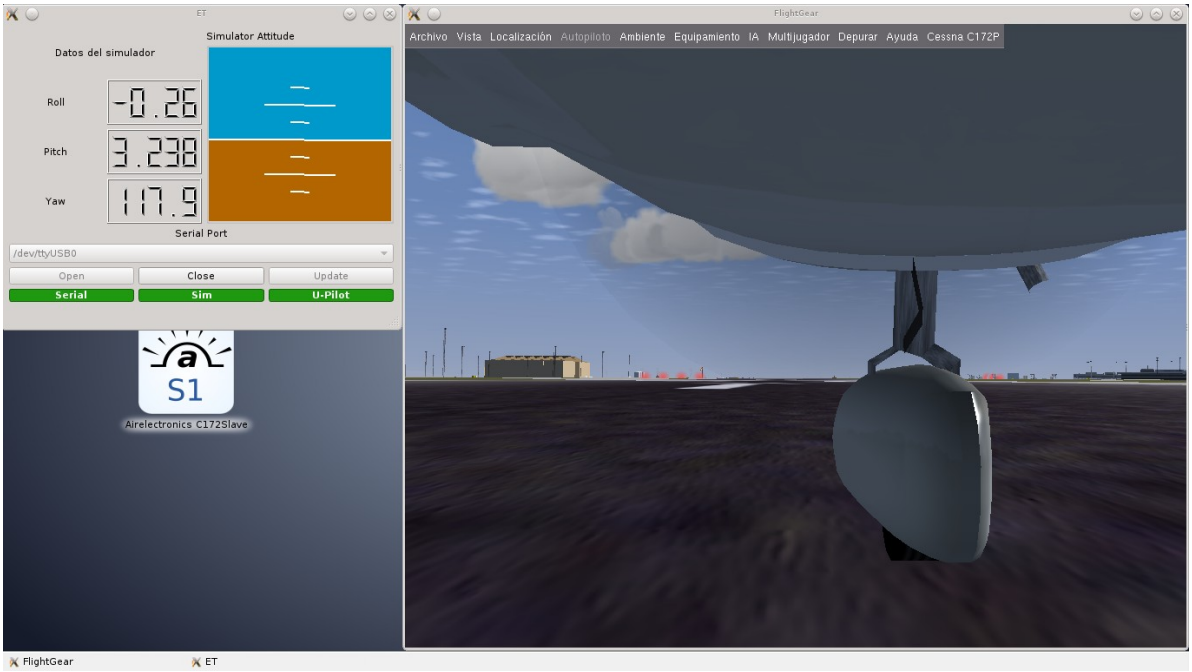

Figure 7: U-Sim Link and Airelectronics Master.

9. The simulator platform should be now ready to flight.
10. If desired, open additional Airelectronics Slave instances.
11. Redistribute the Simulator windows over other windows (if desired).

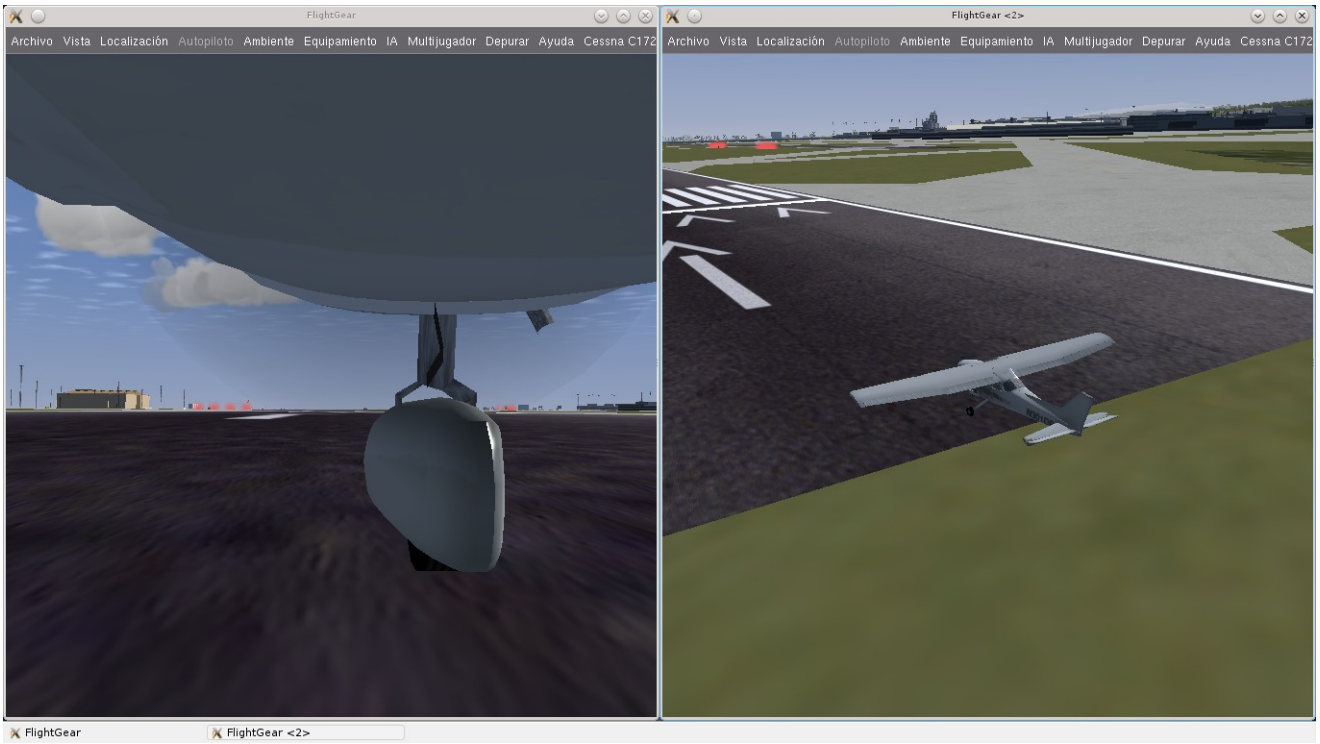

Figure 8: U-Sim with master and slave instances

In case the aircraft crashes during the simulator, the embedded autopilot can receive erroneous data from the simulator. If the user tries to start a new flight in this state, maybe the behaviour of the aircraft is not the proper one.

In order to start a new flight after an accident, the user has to:

- Power down the embedded U-Pilot.
- Close the simulator.
- Power up the embedded U-Pilot.
- Open the simulator.

4.2 Shutting down U-Sim

To power off U-Sim, close all the windows (U-Sim Link, Airelectronics Master and Slaves) and click the power-off button on U-Sim desktop.

5 U-Sim settings

The user can configure some options in U-Sim related to the simulation itself. With these options, the operator can simulate different conditions for the flight. These options are mainly located on the menu bar placed on top of the simulator window (see figure Figure 9).

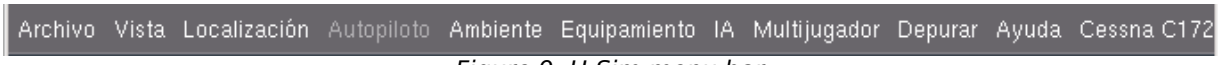

Figure 9: U-Sim menu bar

5.1 Fuel settings

The U-Sim simulates the spent fuel during a mission, so the user has to be careful about the remaining fuel in order to avoid an accident.

The information about the current fuel can be found in *Equipment > Fuel and Payload*

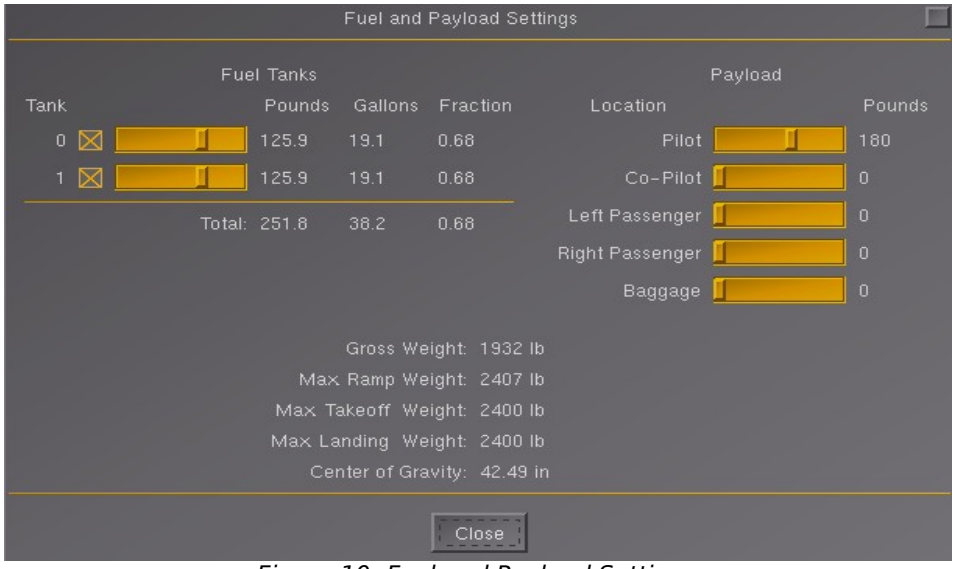

Figure 10: Fuel and Payload Settings

In the ‘Fuel tanks’ options, the user can select the total fuel in a maximum of two tanks thanks to the slides associated to each one. Check these settings regularly and avoid a low remaining fuel quantity.

5.2 Weather settings

Being able to select a specific weather for a simulated mission could be useful in order to simulate a more accurate mission or practice under more demanding conditions. U-Sim offers some options related to weather conditions in *Environment* > *Weather*.

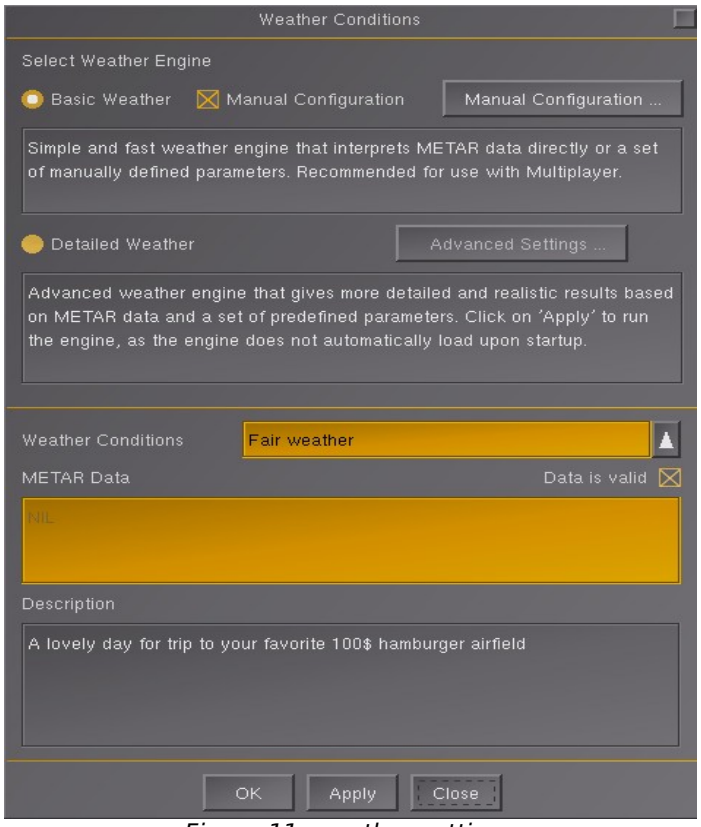

Figure 11: weather settings

The user has two main configurations:

- Basic weather: the default weather system.
- Detailed weather: a secondary weather options that lets the user select some preconfigured weather scenarios.

About the basic weather, the user can modify values related to wind clicking in 'Manual Configuration' checkbox. Once is clicked, the button with the same name will be available. Clicking on the button, a new window will appear.

Figure 12: Basic weather: Manual Configuration window

The boundary and aloft tables can be filled with information on altitude (elevation AGL), wind direction, speed and turbulence. These values will be interpolated for the heights in between.

About the detailed weather, clicking on the 'Detailed weather' checkbox the user will be able to select some preconfigured weather scenarios available in the 'Weather conditions' combobox.

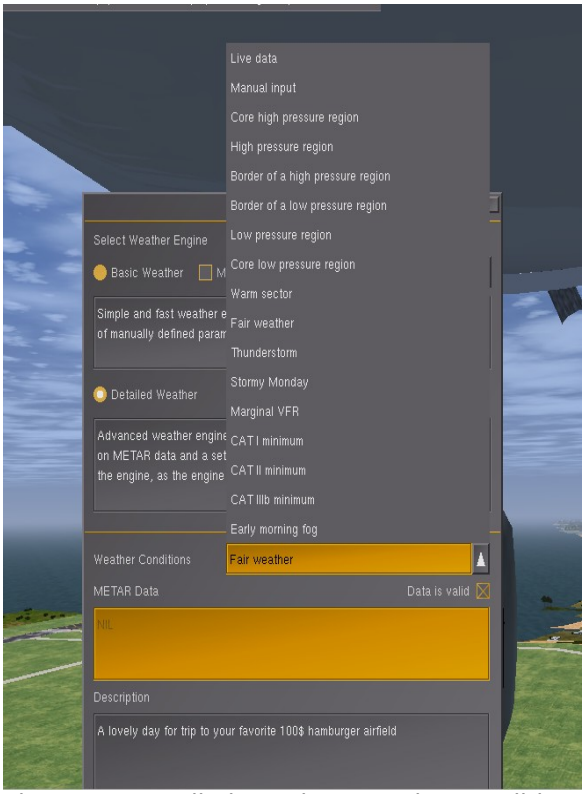

Figure 13: Detailed weather: weather conditions options

Appendix A Shortcuts

Airelectronics Slave shortcuts:

V / v	Switch to next view / previous view
Ctrl + V	Select payload view
X / x	Zoom in / zoom out
Ctrl + X	Reset zoom to default
Mouse Right Drag Button	Change camera position

Appendix B Changelog

This annex describes changes introduced to this document.

Date	Changes
2020/09/23	• Version up to 1.1 • Synced with other manuals of the system (System Concept and so) • Detailed a bit the process of starting the simulator
2019/10/06	• Added info about fuel settings and weather settings
2015/12/16	• Created Document

If you need a previous version of documentation, please, contact us at info@airelectronics.es