Project ICAROS	
Report Code	[GR-EA-2017-03-13]
Title	**Teaching "Basic Statistics" with sensor data from ICAROS**
Start/End Date	1 – 31 March 2017
Coordinator name and email	Georgios Mavromanolakis (gmavroma@ea.gr)
Name of teachers	GM
Number and age of students	12 students, 16-17 years old
Description of activities	In this activity students learn the basic notions and terms of statistics such as: sample, distribution of values, sampling, average/mean value, variance, standard deviation etc. They use ICAROS' on-board sensors to collect data in various conditions, they then analyze them and present their findings. The sensors at the Flight Control Board are the gyroscope, the accelerometer and the barometer/altimeter. For Naze32 FCB the sensors can be accessed through the Baseflight-Configurator software and their data can be logged and saved as .csv (comma separated values) files. The .csv files can then be read with common spreadsheet software like Excel, OpenOffice etc. **ATTENTION – Before starting make sure to remove all propellers from ICAROS. This is the first thing you should do. Always remember "SAFETY FIRST"** **WARNING-NOT REMOVING THE PROPELLERS WILL RESULT IN SERIOUS INJURY** The activity is divided in 4 main tasks and is done by students split into groups of 2 or 3 persons.

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	Task 1 – Preparation All student groups familiarize themselves with the tasks they have to perform, the procedure they have to follow, and the relevant software that they will use. This is: 1. Baseflight-Configurator to connect and communicate with the Flight Control Board, and to collect data from its sensors (see relevant screenshots attached below) 2. OpenOffice-Calc or Excel to read the .csv data files, to make the statistical analysis of the collected data and to produce the relevant graphs 3. OpenOffice-Impress or Powerpoint to create the presentation of their findings Task 2 – Data collection In this task students collect sensor data (gyroscope values at X, Y, Z axis; accelerometer values at X, Y, Z axis; barometer/altimeter values) for about 30 sec for the following cases. Case 1: collect data when ICAROS is leveled on the ground and all motors are OFF. Case 2: collect data when ICAROS is leveled on the ground, all motors are OFF and the craft is shaken gently by hand. Case 3: collect data when ICAROS is leveled on the ground and all motors are spinning at 2000 RPM or THROTTLE value is set at zzz at the Motor Testing tab of Baseflight. ATTENTION: ALL PPOPELLERS ARE REMOVED. If time permits Case 3 may be repeated for different values of motor spinning. Task 3 – Data analysis Students use spreadsheet software to analyze the collected data which are stored in .csv files. For each recorded sample of sensor values students have to calculate the following parameters: mean/average value, variance and standard deviation. They also have to plot the collected data in time-series graphs. Task 4 – Presentation of findings In this task each student group presents its findings and discusses them.
Learning outcomes	Through this activity students learn the basic notions of statistics such as: sample, distribution of values, sampling, average/mean value, variance, standard deviation etc. Students learn also to use common spreadsheet software tools to analyze data, to make graphs, to present their findings. Also as they work in groups to perform the assigned tasks they practice and develop their skills of collaboration, communication, presentation.

Photos or other relevant material
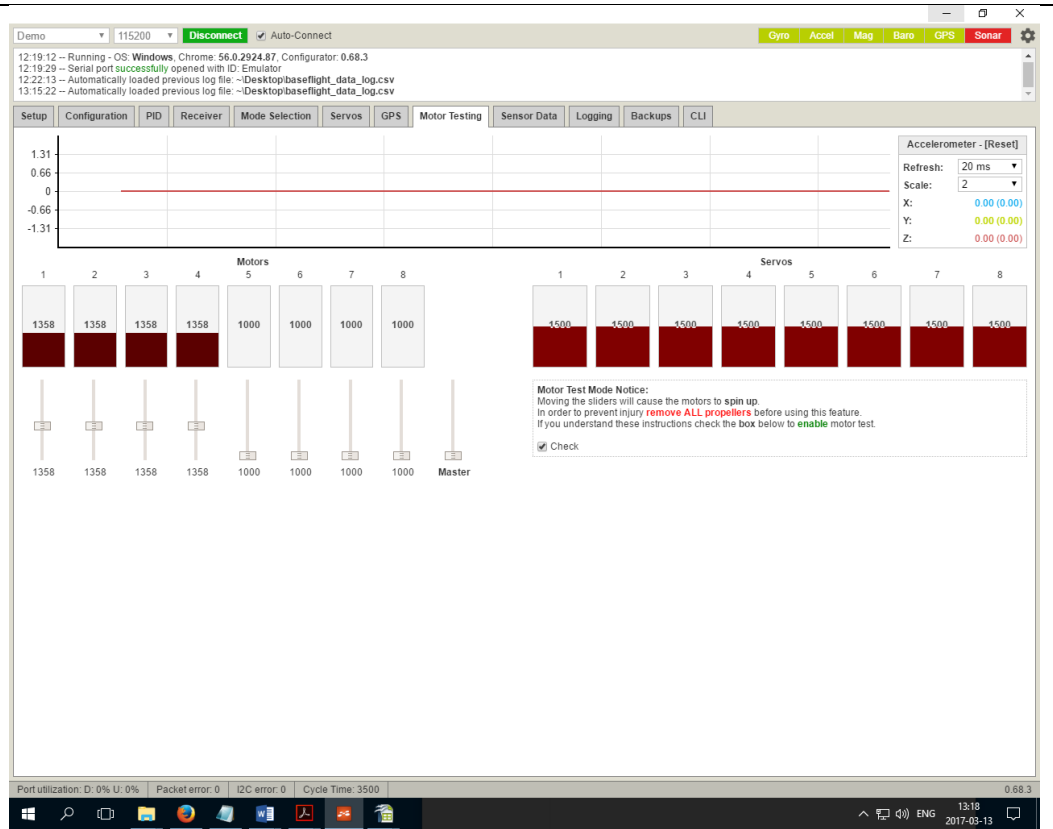
(Screenshot 1. The Motor Testing tab of Baseflight-Configurator. The user can set the throttle value for all motors simultaneously or one-by-one)
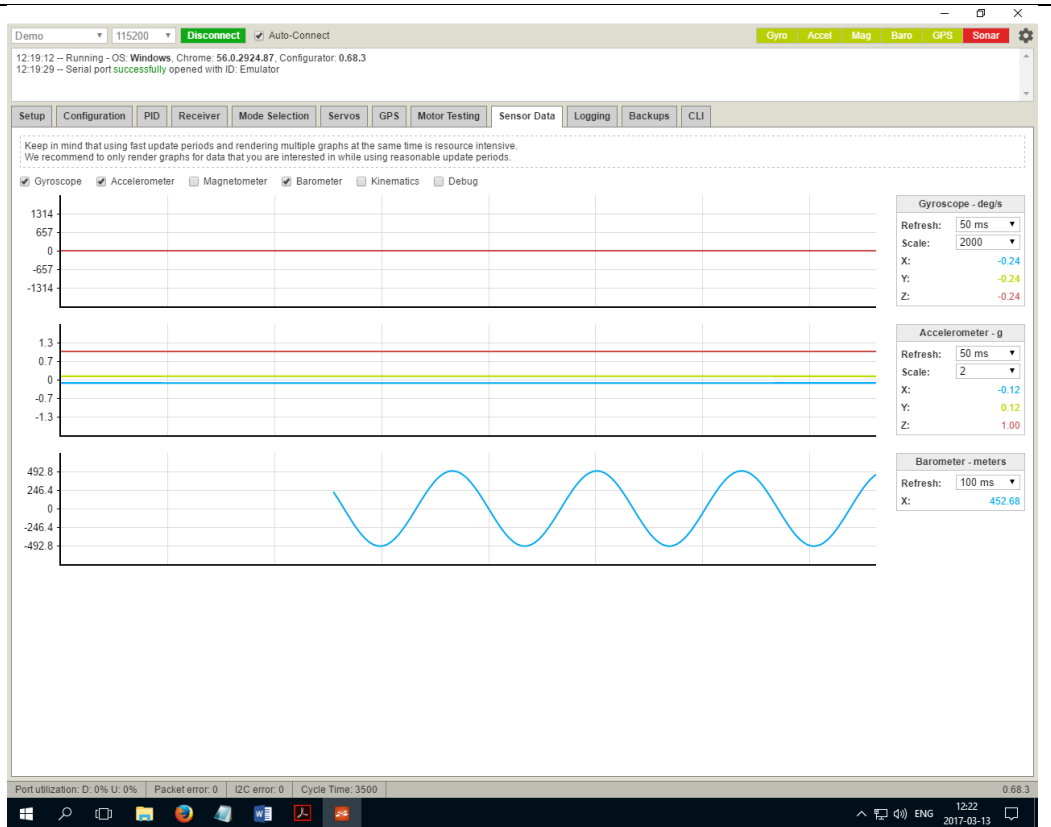
(Screenshot 2. The Sensor Data tab of Baseflight-Configurator. The data from the various sensor on-board are visualized in real time)
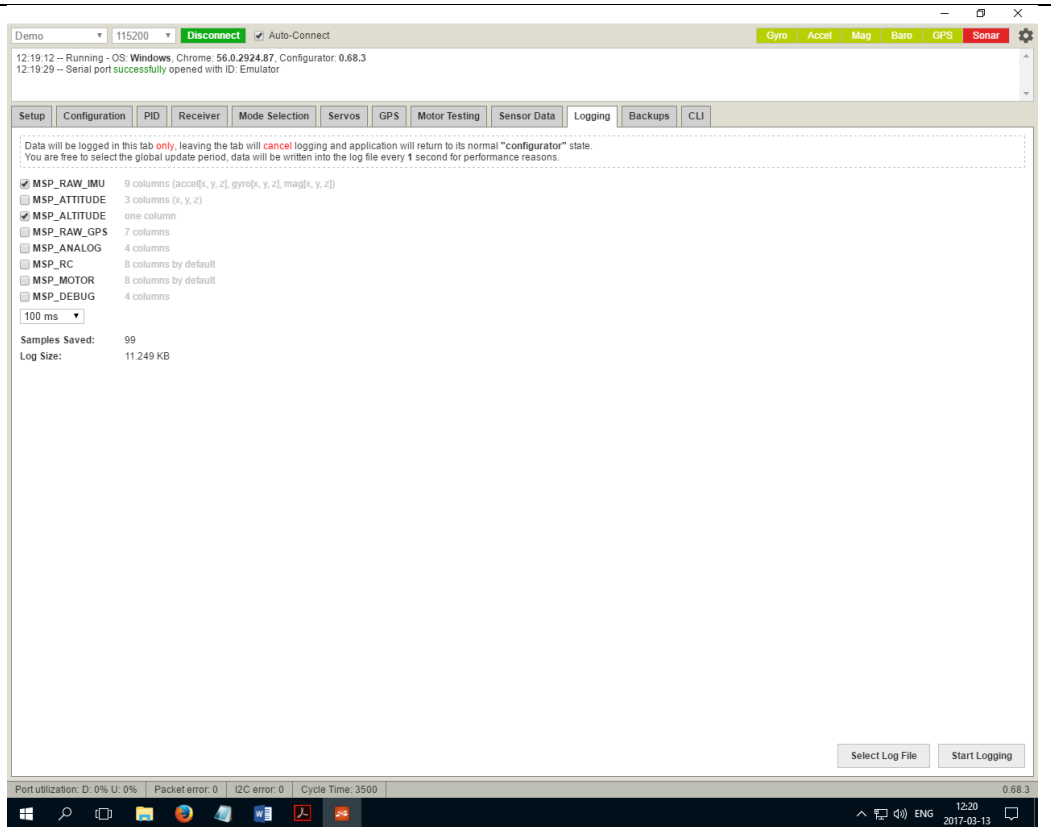
(Screenshot 3. The Logging tab of Baseflight-Configurator. Here the user starts/stops the logging of data, can choose which sensor data to log/collect, and where to store the corresponding .csv file)
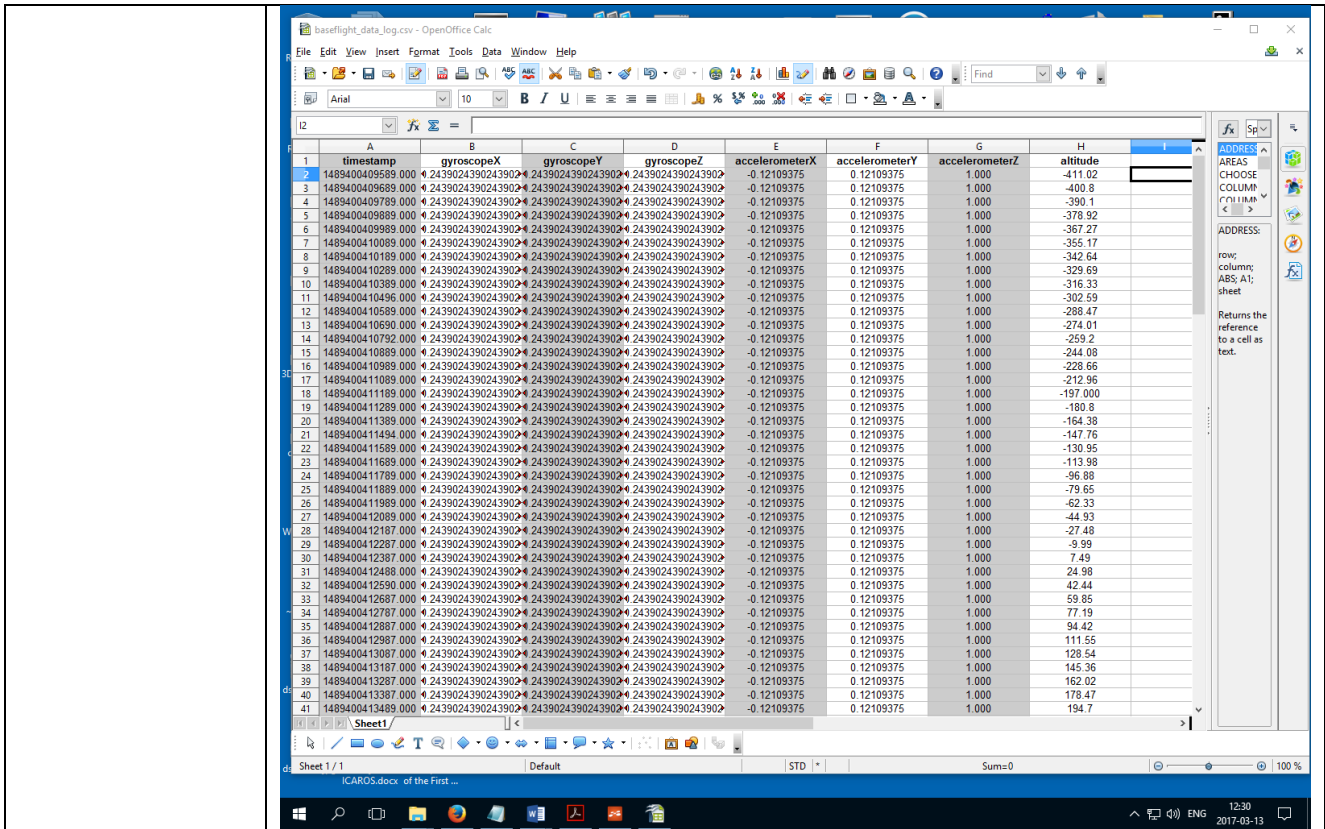
(Screenshot 4. An excerpt from an example .csv file as opened with OpenOffice-Calc. The sensor data are arranged in columns and their labels are shown on top, these are: timestamp, gyroscopeX, gyroscopeY, gyroscopeZ, accelerometerX, accelerometerY, accelerometerZ, altitude