Project ICAROS **Report Code**	[GR-EA-2017-05-16]
Title	**“Drop Test Studies” with ICAROS**
Start/End Date	March/April/May 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	Drop Test Studies - definition Drop test studies evaluate the effect of the impact of a part or an assembly with a rigid or flexible planar surface. Dropping an object on the floor is a typical application and hence the name. **IN THIS ACTIVITY THE BATTERY IS MOUNTED ON THE FRAME BUT IS NOT CONNECTED. THE FLIGHT CONTROL BOARD IS POWERER BY A LONG USB CABLE (TOTAL LENGTH OF 1-2METERS) WHICH IS CONNECTED TO A PC. ATTENTION SHOULD BE GIVEN TO PROPERLY SECURE THE USB CABLE SO THAT IT DOES NOT DAMAGE THE FLIGHT CONTROL BOARD** In this activity students are introduced to a common engineering method and practice it using ICAROS and the data they collect accordingly. They also apply the basic elements of statistics that they learned in a previous activity. Students collect data from the Flight Control Board, in particular from the on-board accelerometer, which is connected to a PC with a long USB cable. They then analyze them and finally present their findings. For Naze32 FCB data can be accessed through the Baseflight-Configurator software. In particular as shown in Screenshot 1, they have to use the Sensor Data tab of Baseflight-Configurator, where they can familiarize themselves with the available sensors and see in real-time the values as they move or shake ICAROS. The activity is divided in 4 main tasks and is done by students split into groups of 2 or 3 persons. <u>Task 1 – Preparation</u> 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 (see relevant Screenshot 1 attached below) 2. OpenOffice-Calc or Excel to analyze the data and to produce the relevant graphs

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3. OpenOffice-Impress or Powerpoint to create the presentation of their findings

In this task students also have to decide, agree and assign specific responsibilities to each member of the group (e.g. one person is responsible to hold and drop ICAROS, another person is responsible to start and stop the data logging software, another one is responsible to synchronize actions e.g. to count down)

<u>Task 2 – Data collection</u>

In this task students collect data following the paper worksheets (attached at the end). For each drop-height (h=10-20-50-100cm) they collect data for about 5 secs and for 3 different rates (10-20-50msec).

Students have to use the Logging tab of Baseflight-Configurator as shown in Screenshot 2. There the user can select which data to collect, the recording rate and the log-file where the data will be saved in .csv format. From this tab the user also starts and stops the data logging.

Screenshot 3 shows 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. The ones that we are interested in this activity are: timestamp, accelerometerX, accelerometerY, accelerometerZ

<u>Task 3 – Data analysis</u>

Students use spreadsheet software to analyze the collected data, do the statistical analysis needed to fill-in the values in the corresponding worksheet. They transfer the collected tables of values from the paper worksheets to a spreadsheet for further analysis.

For the recorded sample of values students have to make various studies and graphs as listed in the "Things to do" attached at the end.

<u>Task 4 – Presentation of findings</u>

In this task each student group presents its findings and discusses them (see "Things to do" attached at the end), compare their results and conclusions with the ones of the other groups.

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Learning outcomes

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Through this activity students learn a common engineering practice and apply it using data they collect with ICAROS.

Students learn also to use common spreadsheet software tools to analyze data, to make graphs, to present and interpret their findings.

Also as they work in groups to perform the assigned tasks they practice and develop their skills of collaboration, communication, presentation.

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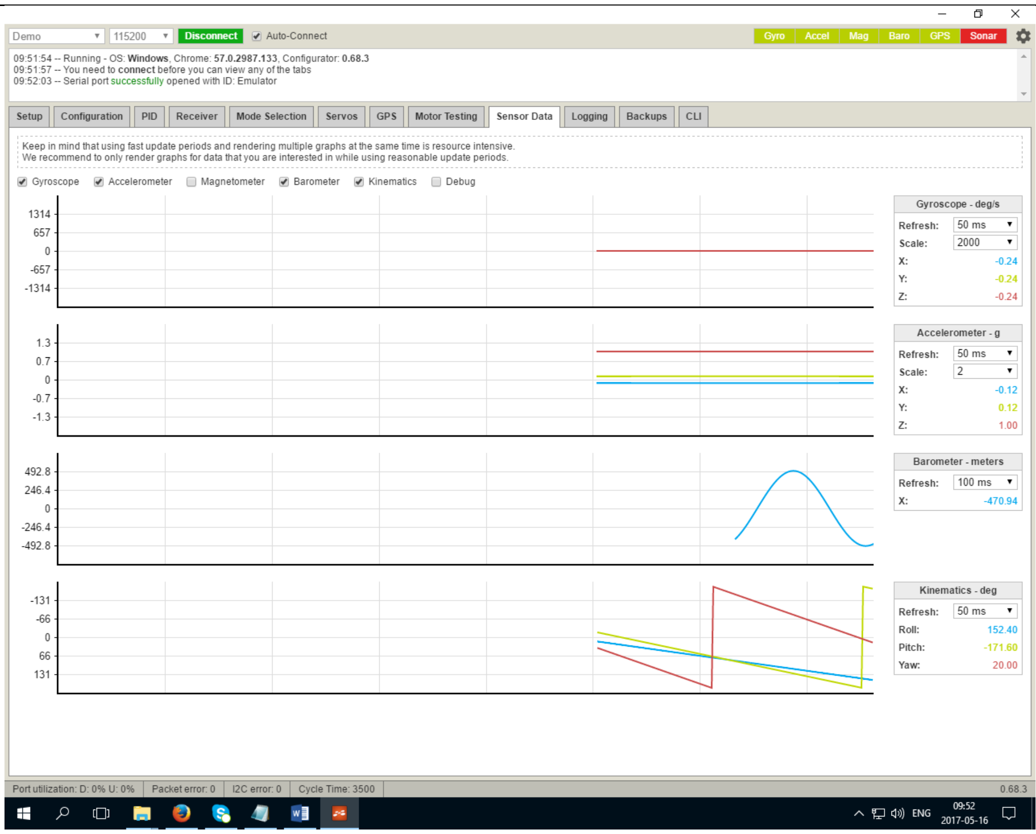
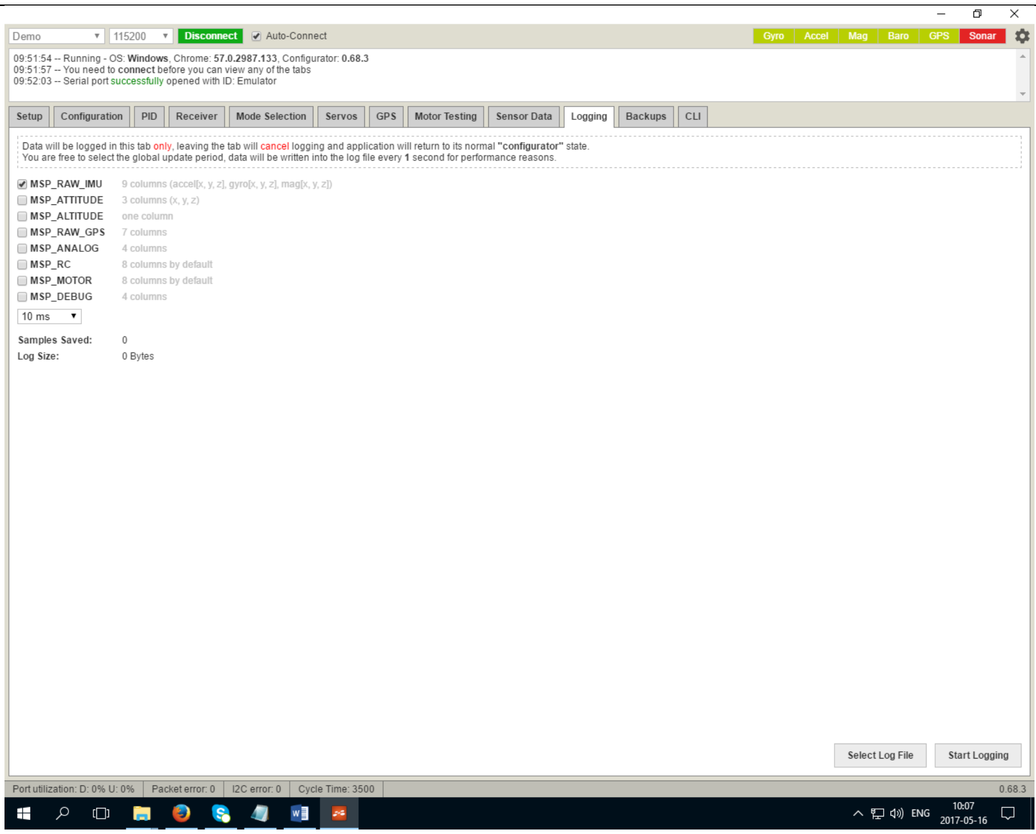
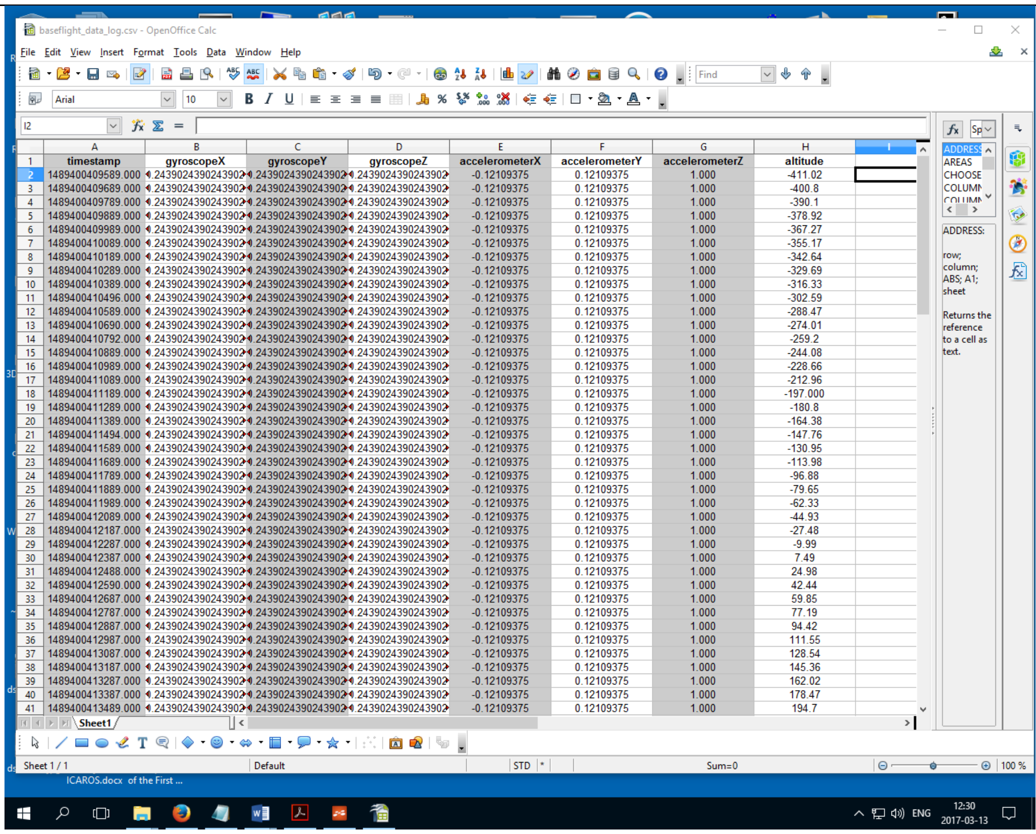
Photos or other relevant material



(Screenshot 1. The Sensor Data tab of Baseflight-Configurator. The user can see in real-time the values of each sensor)



(Screenshot 2. The Logging tab of Baseflight-Configurator. The user can select which data to collect, the recording rate and the log-file where the data will be saved. From this tab the user also starts and stops the data logging



	timestamp	gyroscopeX	gyroscopeY	gyroscopeZ	accelerometerX	accelerometerY	accelerometerZ	altitude
2	1489400409589.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-411.02
3	1489400409689.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-400.8
4	1489400409789.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-390.1
5	1489400409889.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-378.92
6	1489400409989.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-367.27
7	1489400410089.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-355.17
8	1489400410189.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-342.64
9	1489400410289.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-329.69
10	1489400410389.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-316.33
11	1489400410496.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-302.59
12	1489400410589.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-288.47
13	1489400410690.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-274.01
14	1489400410792.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-259.2
15	1489400410889.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-244.08
16	1489400410989.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-228.66
17	1489400411089.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-212.96
18	1489400411189.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-197.000
19	1489400411289.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-180.8
20	1489400411389.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-164.38
21	1489400411494.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-147.76
22	1489400411589.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-130.95
23	1489400411689.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-113.98
24	1489400411789.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-96.88
25	1489400411889.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-79.65
26	1489400411989.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-62.33
27	1489400412089.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-44.93
28	1489400412187.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-27.48
29	1489400412287.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	-9.99
30	1489400412387.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	7.49
31	1489400412488.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	24.98
32	1489400412590.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	42.44
33	1489400412687.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	59.85
34	1489400412787.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	77.19
35	1489400412887.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	94.42
36	1489400412987.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	111.55
37	1489400413087.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	128.54
38	1489400413187.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	145.36
39	1489400413287.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	162.02
40	1489400413387.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	178.47
41	1489400413489.000	.2439024390243902	.2439024390243902	.2439024390243902	-0.12109375	0.12109375	1.000	194.7

(Screenshot 3. 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

Paper worksheet

Drop Test Study - Report Tables

Drop height (cm) = 10 Velocity at impact (m/sec) = Velocity at impact (km/hr) =				
		Data rate 10 msec	**Data rate 20 msec**	**Data rate 50 msec**
AccelerationX	Maximum value			
	Average value			
	Standard Deviation			
AccelerationY	Maximum value			
	Average value			
	Standard Deviation			
AccelerationZ	Maximum value			
	Average value			
	Standard Deviation			

Drop height (cm) = 20 Velocity at impact (m/sec) = Velocity at impact (km/hr) =				
		Data rate 10 msec	**Data rate 20 msec**	**Data rate 50 msec**
AccelerationX	Maximum value			
	Average value			
	Standard Deviation			
AccelerationY	Maximum value			
	Average value			
	Standard Deviation			
AccelerationZ	Maximum value			
	Average value			
	Standard Deviation			

Drop height (cm) = 50

Velocity at impact (m/sec) =

Velocity at impact (km/hr) =

		Data rate 10 msec	**Data rate 20 msec**	**Data rate 50 msec**
AccelerationX	Maximum value			
	Average value			
	Standard Deviation			
AccelerationY	Maximum value			
	Average value			
	Standard Deviation			
AccelerationZ	Maximum value			
	Average value			
	Standard Deviation			

Drop height (cm) = 100

Velocity at impact (m/sec) =

Velocity at impact (km/hr) =

		Data rate 10 msec	**Data rate 20 msec**	**Data rate 50 msec**
AccelerationX	Maximum value			
	Average value			
	Standard Deviation			
AccelerationY	Maximum value			
	Average value			
	Standard Deviation			
AccelerationZ	Maximum value			
	Average value			
	Standard Deviation			

List of things to do

1. For a given Data Rate setting and for each direction X, Y, Z, plot:
   Maximum and Average Acceleration vs Height
   Maximum and Average Acceleration vs Velocity at impact
   Standard Deviation of Acceleration vs Height
   Standard Deviation of Acceleration vs Velocity at impact
2. Repeat 1 for the other Data Rate settings
3. For a given direction X or Y or Z, and for each Height, plot:
   Maximum and Average Acceleration vs Data Rate
4. Repeat 3 for the other Height values
5. Write some conclusions about what you observe from the data and the graphs.
   In which case and direction is the maximum shock?
   Are maximum and average values differ a lot?
   Is there any difference with collecting data at different rate? If yes, then why is this happening?
   Can you make any prediction of the shock experienced when the drop height is 2m?
6. Do your team's main observations differ with the ones from the other teams?