Experiment M-1

The Physics of Jumping

Objectives

- To examine how the acceleration changes while jumping up and down.
- To analyze the graph with the help of sound intensity levels (during the landing of the feet).

Modules and Sensors

- PC + Panda application (if possible)
- PANDA-1 Panda Multi-sensor

Introduction

Acceleration is the rate at which an object changes its velocity.
The direction of the acceleration vector depends on two things, whether the object is speeding up or slowing down, and the direction of motion (+ or -). If an object is slowing down, its acceleration is in the opposite direction of its motion.

Direction of motion	Positive	Negative	Positive	Negative
Speeding up / slowing down	Speeding up	Speeding up	Slowing down	Slowing down
Positive / negative acceleration	Positive	Negative	Negative	Positive

The Panda acceleration sensor (an accelerometer) measures static acceleration due to gravity and dynamic acceleration due to the sensor's motion (as described above). By measuring static acceleration, one can find out the angle at which the sensor is tilted with respect to the Earth. By measuring dynamic acceleration, one can find out how the velocity of the sensor changes with time.

When the sensor is not moving and is facing upwards, the reading is 9.8 m/s^2 (because it includes static acceleration). When the sensor is at free fall and is facing upwards, the reading is 0 m/s^2. If we are interested only in the vertical axis (Z axis) and in the dynamic acceleration, we can subtract 9.8 m/s^2 from the readings and get 0 m/s^2 when the sensor is not in motion and -9.8 m/s^2 when the sensor is at free fall. That is exactly what the sensor offset does.

In this activity you will measure sound and acceleration while jumping up and down. The sound level graph will help analyze the acceleration graph.

Procedure

Experiment setup

1. It is recommended to wear sports shoes for this experiment.

   Do not conduct this experiment if you have any physiological health issues.

Settings

2. Press on the **Sound sensor** icon on the top left of the screen.

3. Use the arrows to select the acceleration sensor.

4. Press on the **m/s²** icon.

5. Change the range to '**Z axis**'.

6. Press on the **m/s²** icon  again.

7. Make sure that the Panda's screen is facing up (on the table) and press on the **Offset** icon  to offset the sensor's acceleration to 0 m/s^2.

8. Press on the **Record** icon  .

9. Set the duration of 5 seconds using the arrows   .

10. Press on the **Add sensor** icon  on the top right of the screen.

11. Select the sound sensor (it should be set on **Level**)

Testing and measurements

12. Click on the **Record** icon  to start the measurement.

13. Hold the Panda with its screen facing up, and jump up and down once.

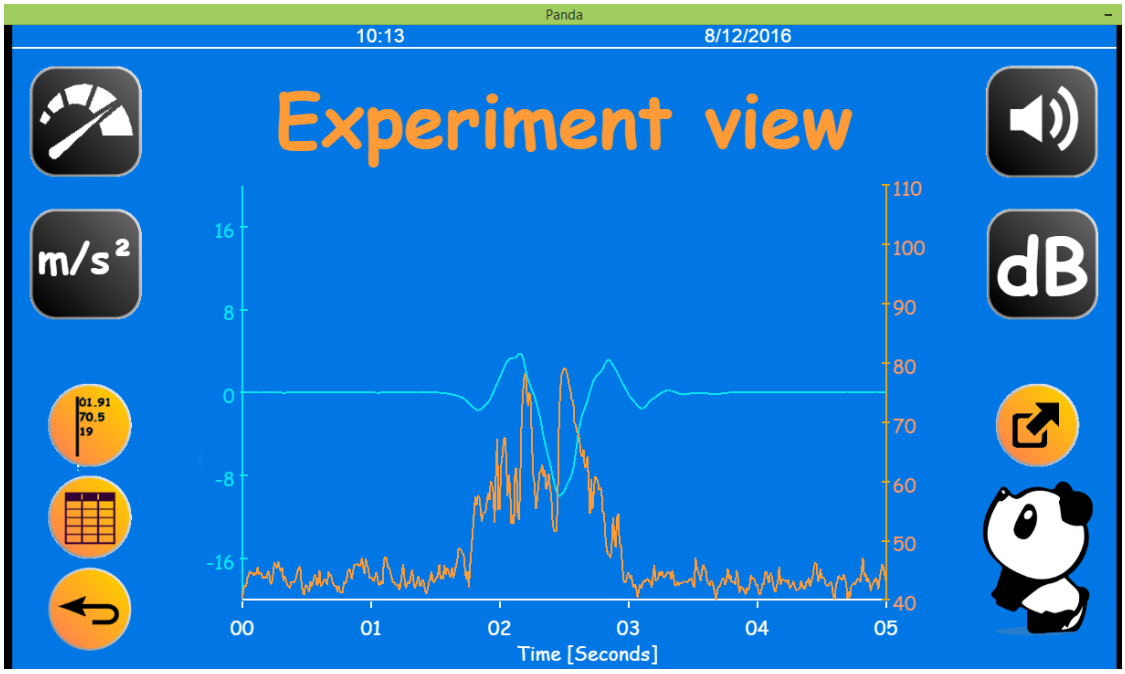
14. You should see the sound and acceleration graphs together.

15. Your graph should be similar to the following:

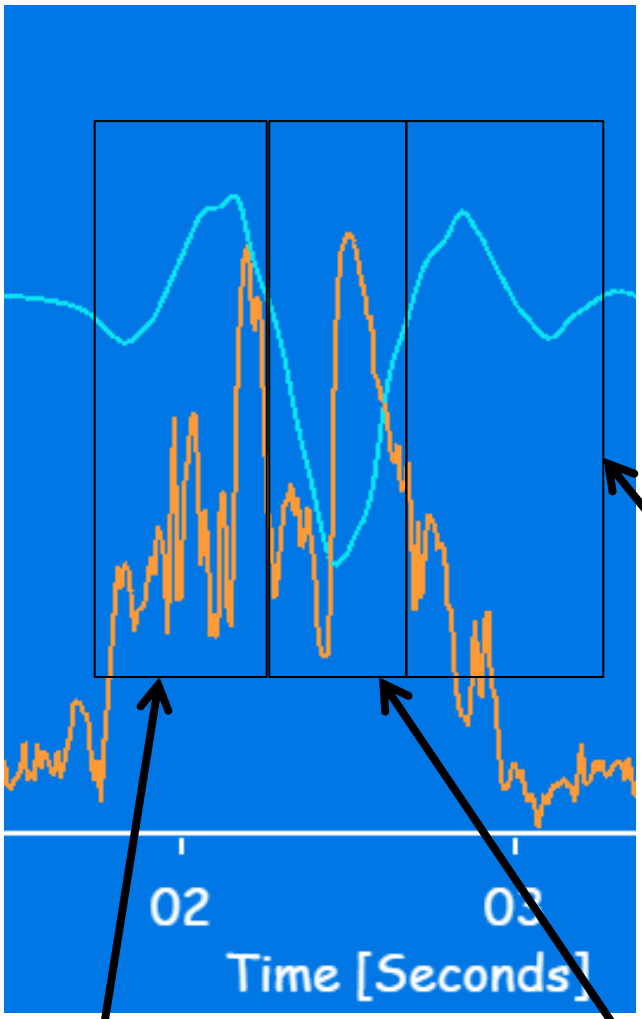
16. If possible, connect the Panda to a PC, using the USB cable that comes with the Panda.

17. Open the Panda application (can be found in the NeuLog website).

18. Click on the **Upload** icon and select the last experiment.



Zoom of the graph:



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The student gets ready to jump while lowering down the Panda. The acceleration is negative while the velocity is increasing, then the velocity is decreasing (to the same direction) so the acceleration is positive. At the end of this step the feet push against the floor, which makes the first sound.

The student is in the air with negative g acceleration. You can see the next sound when his feet hit the floor.

Summary questions

1. Analyze the third part of the graph according to what you learned about acceleration and according to the movements during a jump.

2. Does the sound sensor data correlate with the acceleration sensor data? Explain.

3. Compare your graph to other students' graphs.