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Biosensors FDV

Project Proposal

Goal : To study the differences in pressure/force sensing between lents and Movuino.
We plan on using the Jeremfuge to provide additional gradual force to lents in the germinal phase and observe their development.

The project is divided into several parts:

1. First, we have to prepare the support by doing the plate fabrication, the smoke sensor, the rpm sensor, but also to begin the lentils germination.
2. Then we will begin the experiments proper that will last several days.

Support preparation:

Plate fabrication

The plate would be design in 3D with the software Fusion360 and printed with the 3D printer. We choose to make it in plastic in order to have a light support and not to overheat the motor. The plate will look like a series of 3 concentric circles with holes equally spaced along its 45° inclined sides. The plate has a 20cm diameter and will have consecutive rings of 6, 20 and 35 pits for one lentil in each hole for a total of 61 lentils.

Configuration of the movuino:

The movuino is a device concepted by Kevin and Andrien, and is in open-source on GitHub, those are the explanations we follow. To use it, you should initiate it by downloading packagings and libraries on this link : https://github.com/hssnadr/Movuino

To use it and keep the data, the setup need to use at the same time Arduino, Python, the movuino connected to the computer and the computer connected to a specific wifi related with the movuino.
You should change the script to write the data collected into another file. This would be accessible on our github.
We connect the movuino and the computer to the same wifi Movuino_3020_6CC0C0. We "televerse" the code in the movuino (CODE) and we open 2 python programs we found on the Github. One "OSC_communication.py" is necessery for the second one "Main.py" to work. The program Main.py put the data received by the movuino in CSV file. In the "OSC_communication.py" program we need to change the IP address of the computer.
We find the Arduino code thanks to the library we downloaded, in examples of the arduino software. We change the IP of the computer, the wifi code and the Arduino reference.

RPM Sensor

The rpm sensor is an infrared ray emitter and receptor that counts the number of time it's ray has been cut by a physical object over a certain period of time.. This measure of RPM will later serves to measure the forces applied to the lentils.
The setup used is available on our GitHub.

Lentils Germination

We prepared in advance some lentils in humid cotton to trigger their germination prior to their hyper-gravitation experience. This will ensure a certain basic level of growth and will allow us to chose lentils that are perfectly healthy for the experiment. This will also provide a basic height for the stalk that will allow us to better measure further growth. For lentils growing do not hesitate to wet the cotton ! We do not put enough water on the lentils at the beginning and they take more time to growth

Security

We plan on installing a security system in case the centrifuge rotor might overheat and cause a fire. We are still discussing with Kevin about the installation of a smoke detector or a webcam to ensure that

any problem that might arise during the night can be dealt with efficiently and quickly.

Protocol

Using the Jeremfuge, we will grow up lentils with a constant rotative movement during 4 days. The further the lentil is from the center of the centrifuge, the stronger the force on the lentil will be. This is why we chose to have « different layers » of lents, on which each force could be calculated. The rotation of the centrifuge is controlled by an arduino and will not stop until at least 4 days have passed. We find the arduino code on Internet and we adapt it to our situation : we change the speed of the motor.

Our positive control will be (21) lentils growing in normal conditions, which means without an additional new force applied.

We plan on measuring the length of both the stalk and the roots as a measure of growth over time. In addition, we plan on weighting the lentils as a measure of biomass. Thus the comparison will allow us to see how lentil stalks grow under different amounts of "gravity" and that can be used as a sensor.

For the movuino, we planned on using its internal 3 axes accelerometers to determine the force exerted by the centrifuge. (F = m*a)

Material

- 3D printer
- Computer(s) with arduino, python, a webcam and Fusion 360 (optional)
- 2 arduinos (at least)
- A Jeremfuge (any DIY centrifuge will do provided the motor is strong enough)
- A Movuino (accelerometer)
- Lentils beans
- Cotton
- Infrared ray emitter/receiver

Preparation of the setup "Centrifuge + lentils":

Actually, we chose to have 2 layers on the plate, because of the motor strength to support the weight. The first layer, closer to the center, can contain 6 eppendorfs; the second one can contain 20 eppendorfs. When

the support was printed by the 3D printer, we glued it to a nema 17 motor. The setup of the centrifuge was made in another project, "Jeremfuge", and if you want to have more information about it, you should reference to the Literature on the Open Lab website or contact nikola.zarevski@cri-paris.org. For our experiments, we just changed the motor for a motor stronger able to turn for four days without pause, however we use the generator 12V 2A of the jeremfuge project and we add an EasyDriver.

After that, we scotched a small rectangular paper at the edge of the support, and placed the rpm sensor setup next to the centrifuge in order to the paper could pass between the rpm sensor fork. Then we took the measures on Arduino by starting the motor.
Next, we removed the paper and the rpm sensor setup in order to begin our experiment with lentils. With lentils germinated previously, we prepared 47 samples: each lentil was put in an lid cut eppendorf with cotton and 0.6 mL of water. 26 samples were annotated and put into the centrifuge. 21 others were used as positive controls. Every samples were placed in the same place in order to have the same amount of sunlight. Each sample would be sprayed with 0.6mL of water everyday.

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