Blind Object Recognition with LabArm

Description:

This project focus on object identification based on the arm feedback only (no camera). The idea is to provide additional features to the camera in order to confirm and/or add more information about the grabbed object. Because I only use the gripper to create this feature, there is no need to buy new materiel. This work can be implemented as a normal function in the LabArm library, without cost.
I focus on 3 informations for the object recognition :

- Size
- Toughness
- Weight

The data set was really small (around 15 different object (stone, metal, chestnuts, foam)), and the different measurement are not too precise but I was able to make the difference between a chestnuts and a stone.

In the following report, I will describe the different steps for measuring,their limitations and the technical problems I am encountering. The next step will be to harvest more data, and implement the classifier in C++.

If you had any idea to overcome the problem, or want to participate in this project please contact me :)

Thanks to Rasheed and Piotr for their help on the robotic part.

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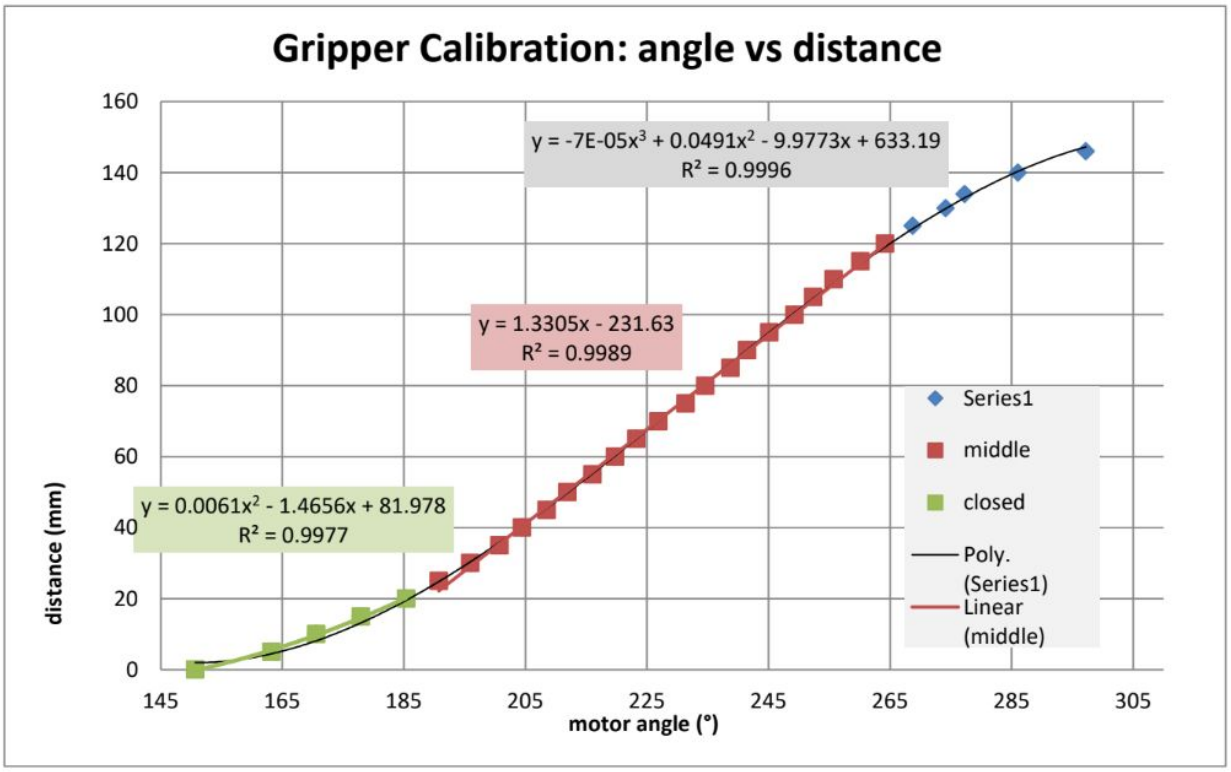
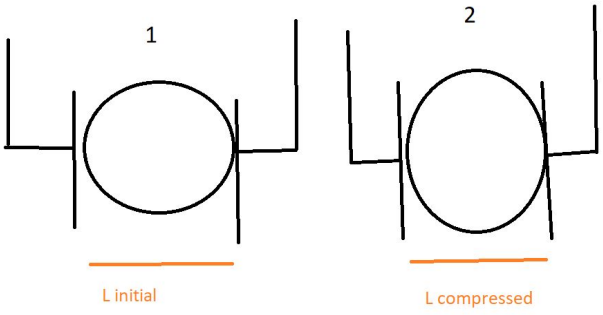
1) Size Measurement

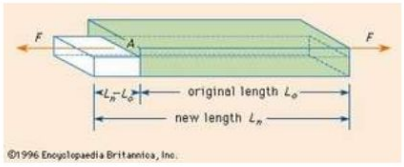
In order to obtained the size of the grabbed object I established experimentally the relation between the gripper motor's angle and the space between the gripper's jaw. After experimental measurement on real object, the measuring accuracy is around **+/-1.8mm**



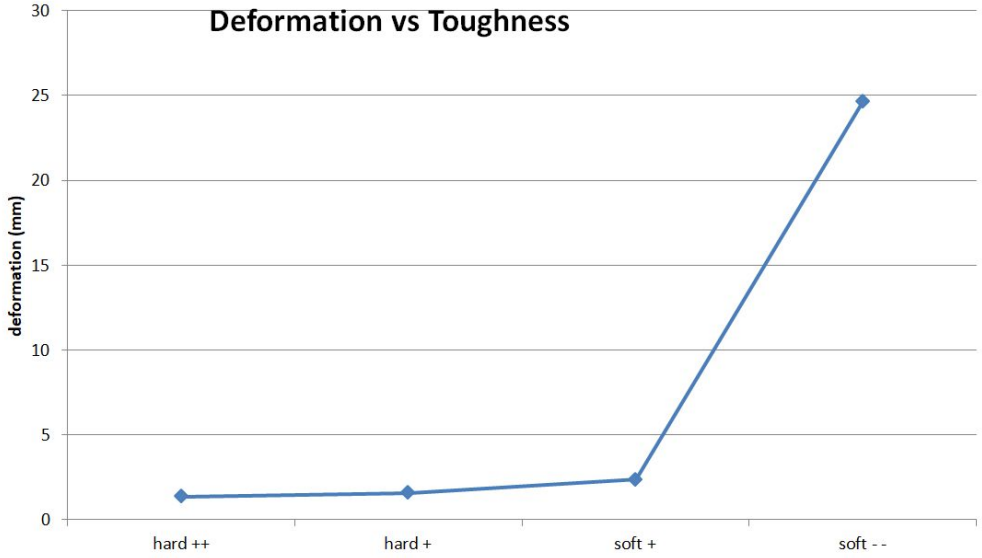
2) Toughness Measurement

Estimating the toughness of the object can help use to differentiate soft and hard material for example glass or plastic bottle whose can have the same size and weight but not the same toughness. The idea is to compress the object like an human will do, with a moderate torque and measure the deformation. To do so, I just set a higher current in the motor for a short instant. The idea is demonstrated in the next scheme (sorry for my poor drawing skills)



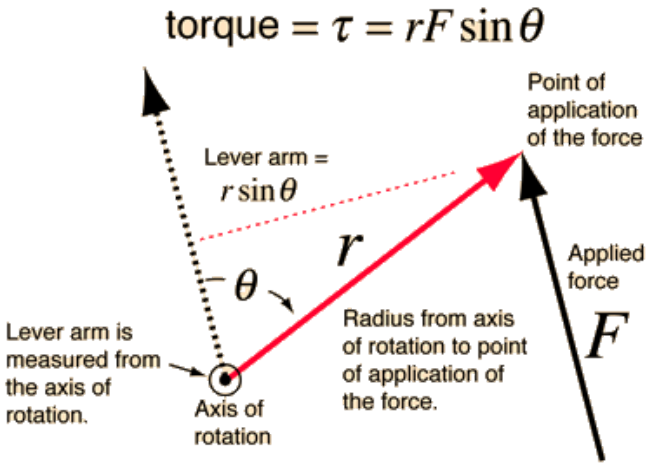


I conducted experimental result and compare the deformation between the different object. The result are not as good as expected. This can be explained by mechanical loss, and the object are not flat and so the pressure force is not perfectly horizontal. I will try to solve this problem by using a step measurement, and/or modified the gripper's jaws to have a better gripping surface. Nonetheless, I still think that if the toughness is different enough we can use this function.



3) Weight Measurement

Measuring the weight of the grabbed object is done by measuring the current inside the motors when the arm is stop in a particular position. The theory is described in the following figure:



In the fixed position and based on the motors documentation, we can establish the following equations:

1. mechanical expression of the torque(N.m), the distance between the motor and the grabbed object armLenght(m), m the mass of the object (kg) and g the gravity (m/s)

Torque = armLenght * m * g

2. motors performance courbe

Torque = a * Current + b

3. relation between the real current and motor variable:

Current = 2.65e-3 * signedCurrentMotor

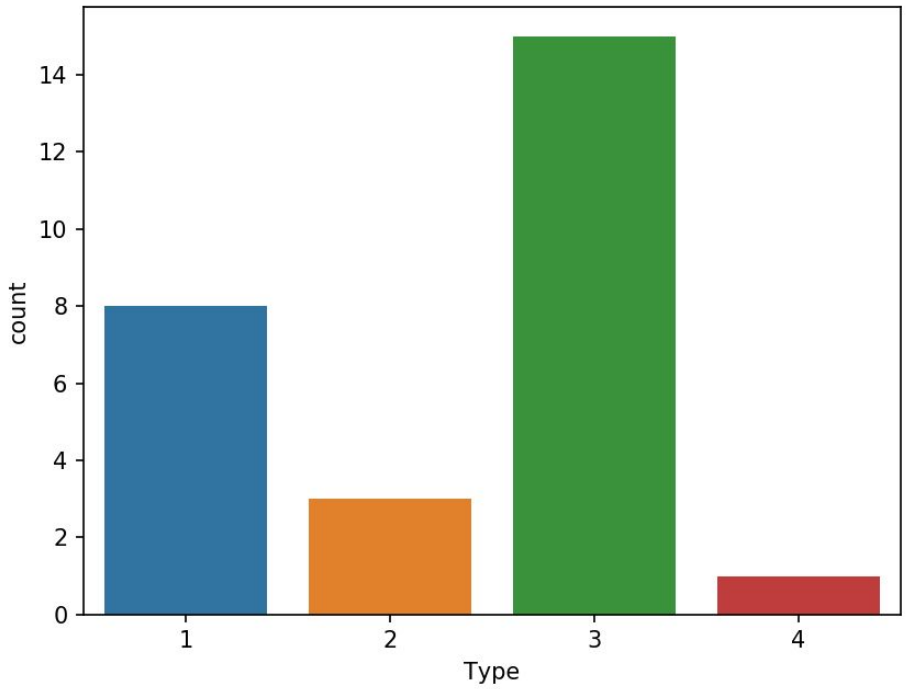
After several test on different motors and configuration, I was able to obtained the weight of the grabbed object but with a error as you can see on the graph. Because the correction is linear, the error is probably due to a missing or error in the previous equation.

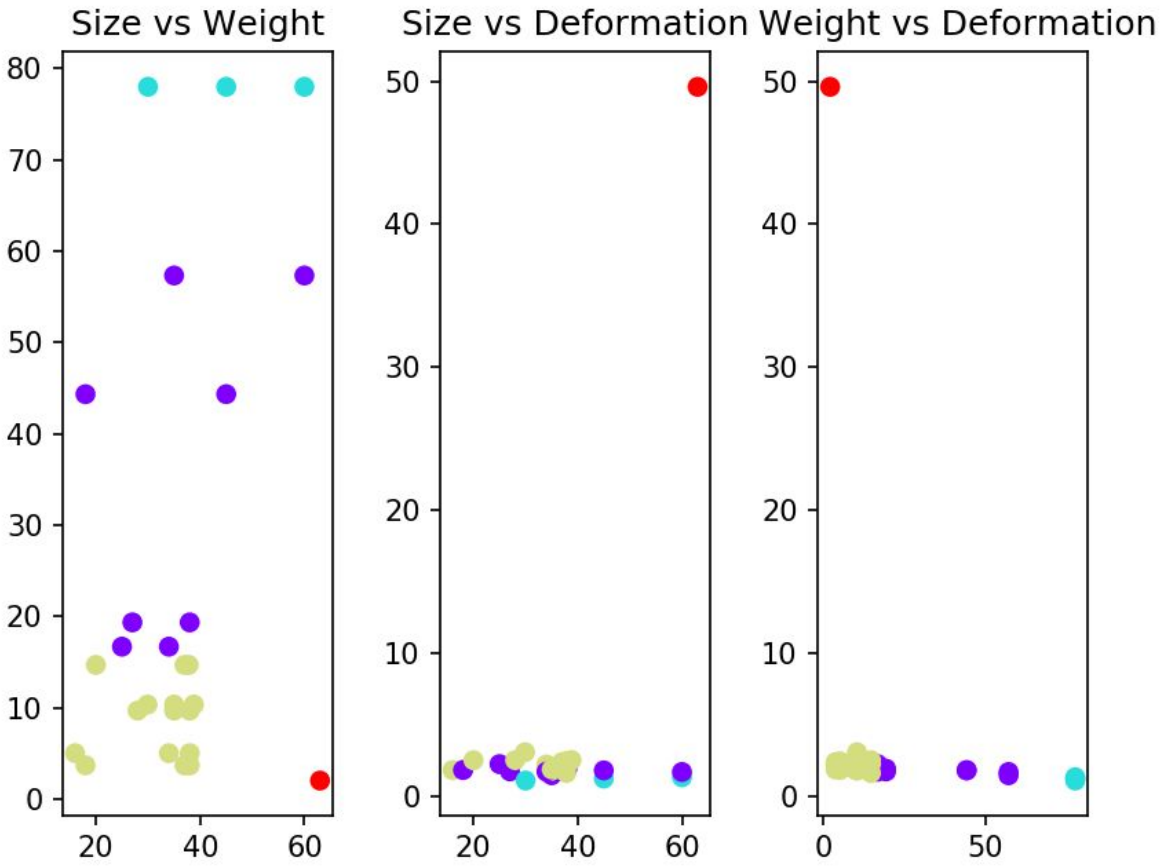
It seems like we can estimate the weight of a grabbed object, but after some test I noticed that the ground value (weight measure when the the gripper is empty) changed time to time (after several measurement or reboot of the arm). This problem can probably be solved by tuning the PID, and regularly updating the ground value.

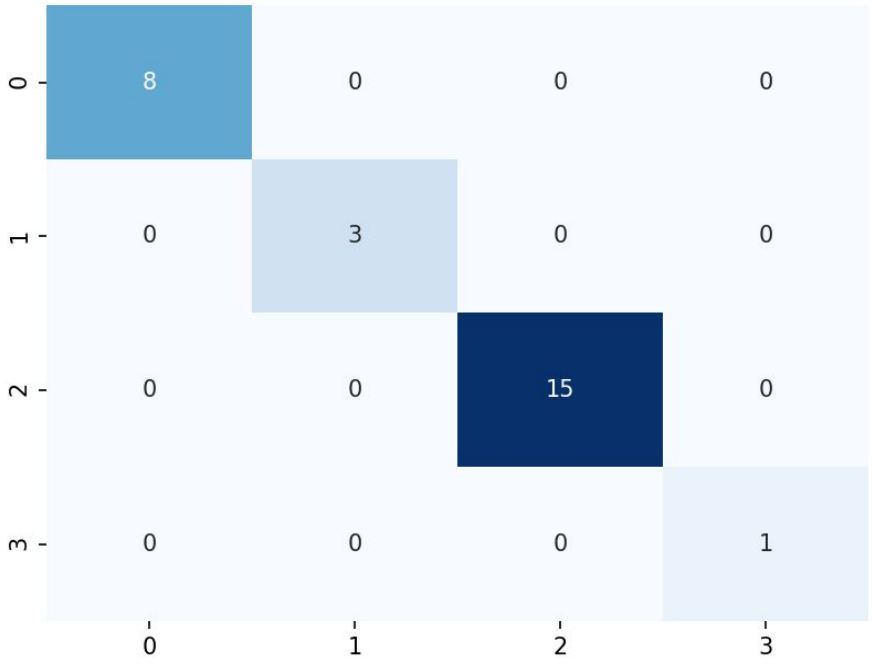
4) Classification

I finally try to classify the different object based on the 3 features. The dataset is composed by 15 objects (5 chestnuts, 4 stones, 1 metal object, 1 foam). I used several measurement because the stone or chestnut are not symmetric. The next figure shows all dataset object with their features. Finally I trained a SVM classifier using the sklearn framework. The scores are

perfect, so this can be explained by the small dataset size but show that we can achieved object detection based only on the arm feedback.







Test	Score
Accuracy	1.0
Precision	1.0
F1 Score	1.0