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Object classification using multi force sensor with two finger KUKA Youbot gripper

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ABSTRACT – Human known with multitude of sensors such as vision, audition, taste, olfaction and touch. Vision sometimes asserted to be the most important human sensory modality perhaps underestimating the role of the sense of touch. Human are expert both as determined into what classes an object may to categorize while robot are not so in this paper we focus on classify the daily object with different rigidity. We focused on sense of touch, which is using force sensitivity resistive sensor along with KUKA Youbot gripper. The problem occur when the natural of the force sensitivity resistive sensor has high sensitivity.

1. INTRODUCTION

In this era, there are many industry exposed to the radioactive or chemical environment where this field will be harmful or even lead to death for human being if they are exposed to it. Therefore, to avoid such event human is replaced with robot in harmful environment to perform task. Human known to have sense of touch, visual, audition, taste and smell while in the robot we need to teach them to have this sense to know how to classify and recognize.

Touch lies at the core of many human skills like grasping, temperature detection, classify object and material identification, among others [1]. In the article [2] state that grasping as an eye-hand coordination, which means that the perception (eye) drives the motion of the manipulation end effector and the design and construction of robotic hands is a critical issue in robot because different hands lead to quite different grasping strategies and computational needs. Moreover [3] robot may also discriminate between different objects using haptic properties when vision is not available, or when it needs additional information example an unripe fruit feels different to a ripe fruit, though they may visually appear the same.

Every object has different stiffness, this can determined by sense of touch, force sensitivity resistor (FSR) sensor been used to performed this classification. FSR sensor is widely used for detect slippage of the object however not been used to classify the object. Challenging of using FSR sensor are because this sensor has high sensitivity. In this paper, we discussed about early stage of classification by investigating FSR sensor. Limitation if using KUKA Youbot gripper are 2cm (W) x 1cm (L).

2. METHODOLOGY

For experiment setup, KUKA Youbot gripper is been used as manipulator and the FSR sensor is attached to the gripper as shown in figure 1. The force sensor is read by the microcontroller while the KUKA Youbot's motion is programmed using Robot Operating System (ROS) via Ethercat connection.

Figure 1 KUKA Youbot.

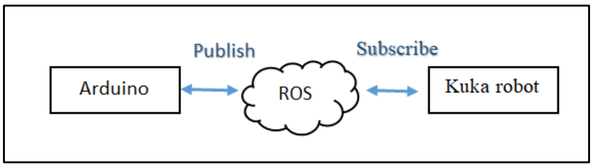
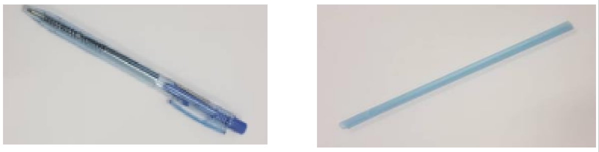


Figure 2 Interface between force sensor and KUKA Youbot.

In order to extract the value from FSR sensor, two different types of object were selected for the experiment to determine the different force readings to be used for classification. The first object is pen which is hard object while second object is straw which is soft object compare to the first although both is plastic material. The pen and straw has 0.8 cm diameter while the length of the straw.



(a) (b)

Figure 3 Object used for classification (a) pen and (b) straw.

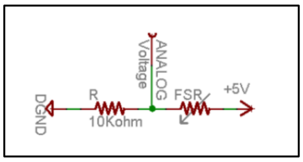


Figure 4 FSR sensor circuit diagram.

Figure 4 show the circuit diagram of FSR sensor and 10k ohm resistor. To obtain the value of the force from the sensor; voltage divider in Equation (1) to calculate resistance, R_{FSR} . Then the conductance, G is obtain as in Equation (2). Finally, force, F is obtained by Equation (3).

$$\frac{V_{OUT}}{V_{IN}} = \frac{R_1}{R_{FSR} + R_1} \quad (1)$$

$$G = \frac{1}{R} \quad (2)$$

$$F = \frac{G}{30} \quad (3)$$

Figure 5 show the block diagram to classify object, the classifier are from supervised learning.

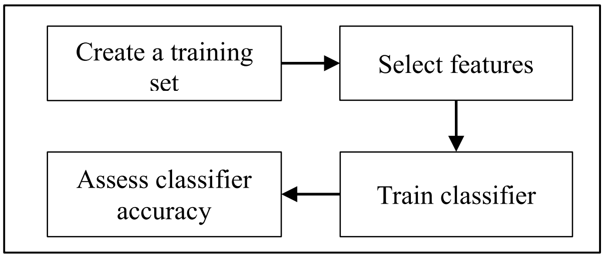


Figure 5 Flow of classification.

For the experiment, we move the gripper at a sample time of 1 seconds with a distance of 0.0001 mm until it grasps the object. In grasping the object, soft object will deform/compress while the hard object stays. The gripper will reach its maximum grip with respect to the object size.

3. RESULT AND DISCUSSION

This chapter will discuss on force measurement per second results, which collected from the experiments.

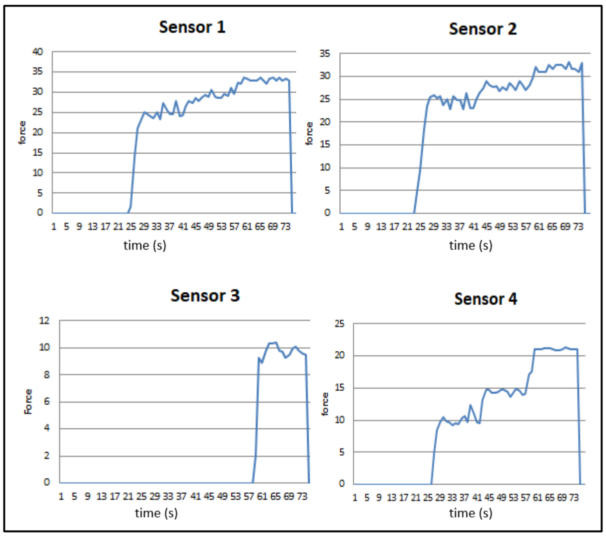


Figure 6 Force measurement for pen.

In Figure 6, force reading for the sensor 1 and 2 of the pen are fluctuating in the range of 25 to 35 newton. While sensor 3 and 4 has less force reading, compare sensor 1 and 2 because the pen did not contact with the sensor much.

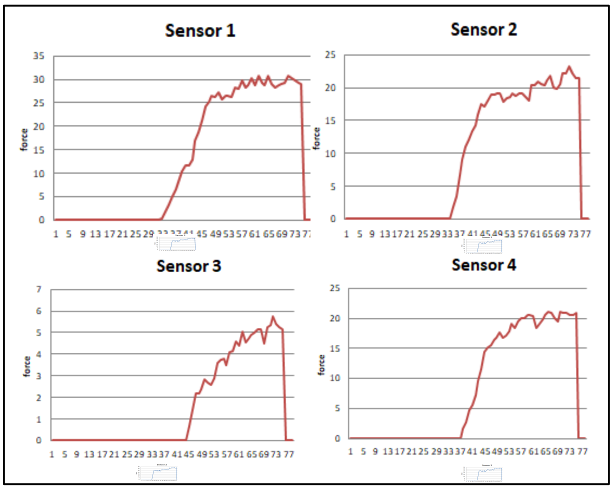


Figure 7 Force measurement for straw.

In Figure 7, forces reading for the sensors are increasing because the straw is been deflated and then constant in one range.

4. CONCLUSIONS

In this paper we formulated a primary methodology for performing object classification in an interactive manner, using two fingers KUKA Youbot gripper and force sensors. For doing so we grasped a range of objects with different stiffness positioned in front of the robot gripper. The force measurements are taken from four force sensor. The experiments were performed with an under actuated compliant robot hand which was controlled in an open-loop fashion. From the result we can conclude that the force measurement straw is smaller compare to force measurement of the pen.

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