20MECH5131/6031 Intro to Robotics
Homework#5 – Sensors in Robotics (90 pts)

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Answer the following questions and submit your work online in a SINGLE file.

Please use single space, 12 font size, and standard margin for formatting your submission.

1. Answer to question 1:

1) True
2) True
3) True
4) False
5) True
6) True

2. Answer to question 2:

1) Properties: It means what physical properties does the transducer sense. For example, if the senser is used to test color, then color mark sensor should be adopted. If temperature needs to be sensed, then temperature sensor should be used.

2) Environment: For example, the distance between the sensor and the object or the temperature of the environment. If the distance is more than 300m, then Laser Radar would not be very effective, while millimeter-wave radar still works well.

3) Desired other features: For example, the speed of response and operation range of sensors. It depends on use. If people use the transducer to detect high precision data, then the sensor has higher big should be adopted and therefore it is also definitely more expensive

3. Answer to question 3:

Photoelectric reflection sensors detect visible light with wavelengths from 400nm to 780nm. In contrast, pyroelectric infrared sensors can sense infrared light with wavelengths exceeding 780 nm. Therefore, the range of light detection is the most important difference between the two sensors.

4. Answer to question 4:

This is because capacitors are sensitive to temperature and humidity. Capacitance varies with temperature depending on the relationship between dielectric constant and temperature.
In addition, humidity also affects the capacitance size. Water vapor condenses on the surface of the capacitor and is absorbed, causing the insulation resistance of the capacitor to drop and generating leakage and flying arcs. The dielectric constant increases and the dielectric loss increases.
Capacitive sensors have two main advantages. First, it has a relatively simple structure, which means it is easy to produce and quite economical. In addition, it has a very high intrinsic frequency and a very short response time. Therefore, it is suitable for measuring high speed and high frequency motion.

5. Answer to question 5:

Radar emits electromagnetic waves. It does not require a transmission medium. Ultrasound is an acoustic wave, a mechanical wave. It is emitted by the vibration of a piezoelectric substance and therefore cannot be used in high pressure or negative pressure environments. It is generally used only in atmospheric pressure environments.

6. Answer to question 6:

Capacitive sensors can be divided into variable pitch, variable area and variable media types. In general, they can be used for a wider range of materials to be measured. Inductive sensors can only be used for metallic objects. But on the other hand, capacitive sensors need to ensure that the measured environment is free from contamination, such as dust, oil and water, because these factors can change the dielectric constant and thus change the measurement results.

7. Answer to question 7:

a) Thru-beam sensor. This is because thru-beam sensors are the most reliable sensing mode, and it is relatively economical.

b) Ultrasonic sensor. This application is more dependent on determining the shape of the object. Ultrasonic sensors perform exactly this function by emitting ultrasonic waves.

8. Answer to question 8:

Color-coded sensors should be used because their most distinctive feature is the color, which is different from the environment. Therefore, color-coded sensors can be used for effective identification of the presence of black trim

9. Answer to question 9

Capacitive sensors. It uses electrostatic field to detect the variation of capacitance between the sensor and the object. When the milk of the carton is not as the same level as others, it would detect it, so this is suitable for such application.

10. Answer to question 10:

a) Laser sensors. It is suitable for precision position and detecting tiny objects. Other sensors do not have comparable competence.

b) Thru-beam sensor. It is often used for sense object presence and absence. For example, when it reaches a specific height which is designated, the sensor will detect and report it to user.

11. Answer to question 11:

Thru-beam sensor. It would be quite easy for user achieve this by thru-beam senso. After designating a specific height and when the stack reaches the heigh, the thru-beam sensor would detect it and report to user.

12. Answer to question 12:

Capacitive sensor should be adopted, since it uses electrostatic field to detect the variation of capacitance between the sensor and the object. It is suitable for detecting the fluid level or solid level, for example, in this case.

13. Answer to question 13:

Fiber-optic sensor and laser sensor. Laser sensor is used to emit laser and fiber-optic sensor is used to sense the change of laser. When the laser is interrupted, the fiber optic sensor records the change in light and counts it.