Perception

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1.	**How can we classify different sensors?**	Using two axes of classifications: Proprioceptive/Exteroceptive and Passive/Active
2.	**What are proprioceptive sensors?**	They are sensors which measure values internal to the system.
3.	**What are exteroceptive sensors?**	They are sensors which acquire information from the robots environment. Hence, the measurements are interpreted by the robot to extract meaningful environmental features.
4.	**What are passive sensors?**	They are sensors which measure ambient environmental energy entering the sensor.
5.	**What are active sensors?**	Theya re sensors which emit energy into the environment, then measure the environmental reaction.
6.	**How do optical incremental encoders work?**	As the rotor moves, the amount of light striking the optical detectors vary. One illumination and detection pair is placed 90 degrees shifted with respect to the original in terms of the rotor disc. This allows us to get 2 square waves. The ordering of which square wave produces a rising edge first signifies the direction of rotation.
7.	**How do optical absolute encoders work?**	Each position of the disc is coded, so the quantities (theta, w, etc.) can be retrieved, even when power fails.
8.	**What are the pros and cons of optical incremental encoders?**	Pros: - Easy to make - Cheap - Determines speed and direction Cons:

		- Need to set reference point - Fails to find quantities after power failure
9.	**What are the pros and cons of optical absolute encoders?**	Pros: - Determines angular displacement - No need for reference point - Result remains after power loss Cons: - Complex - Expensive
10.	**What is the resolution of an encoder?**	It expresses the number of mechanical degrees the encoder turns between each pulse of a square wave.
11.	**How do MEMS accelerometers work?**	They work by measuring the change in capacitance. The mass is confined to springs, such that it moves in only one direction. When an acceleration in a particular direction is applied, the mass will move and the capacitance between the mass and the capacitance between the mass and the plates will change. This change in capacitance is used to measure its associated acceleration value.
12.	**How do gyroscopes work?**	They measure the angular rate using the Coriolis effect. When a mass is moving in a particular direction with a particular velocity, and when an external angular rate is applied, a force will occur. This force will cause perpendicular displacement of the mass. So similar to the MEMS accelerometer, this displacement will cause a change in capacitance, and is used to measure the associated angular rate.
13.	**What are inertial measurement units (IMU's)**	They are sensors that combine accelerometers and gyroscopes (6 DOF), and sometimes magnetometers (9 DOF).
14.		

	What are some limitations of IMU's?	- Extremely sensitive to measurement errors - Effect of gravity vector - Drift due to integration Reference to external measurement is required after long period of operation.
15.	**What are the types of active ranging sensors?**	Time of flight: - Ultrasonic - LiDAR Triangulation: - Optical triangulation - Structured light
16.	**What is a common technique for filtering sensors readings?**	Moving average