Sensors are in most electronics products these days. They're driving a technology revolution called, "The Internet of Things."

There are 6 "types" of sensors:

PROCESS sensors are used in petrochemical, pharmaceutical and semiconductor industries to measure and control the chemical reactions needed to create these important raw materials.

POSITION sensors are found in vehicles and aircrafts.

MOTION sensors are used there as well as in smartphones and security systems. And by the way, turn your phone off.

ERGONOMIC sensors are found in tablets, PCs, and phones.

CHEMICAL sensors protect us from fire and toxic vapor hazards.

ELECTRICAL sensors are found in lab instruments and security systems.

Let's take a deeper look about how sensors are used in your smartphone:
- Have you ever wondered how this phone shuts down if you leave it sitting in the sun on a hot summer day? That's because the thermistor inside this phone senses that the internal circuits may overheat soon. It sends a signal to the microprocessor to shut down this phone before it's too late.
- Now, let's take a look at Google Maps. Google Maps. Google Maps. It keeps us from getting lost, doesn't it? It's that GPS sensor in our phones that enables this little app.
- Proximity sensors placed by the earpiece of your phone telling it when you're on a call. Hello, hello, hello.
- The phone saves battery power by turning off the screen.
- The gyroscope enables this compass app
- A capacitive sensor on the touchscreen senses when your finger is touching an icon.
- A light sensor adjusts the screen brightness here for ambient light levels.
- And there is a battery sensor in here to correlate the charge level in the battery to present of life left on a phone.

Dozens of sensors are used in modern automobiles:
- Temperature sensors monitor the combustion process in the engine, the cooling process in the radiator and your comfort level in the cabin.
- Pressure sensors make sure you have sufficient oil to lubricate those pistons and proper air levels in the tires to make those wheels go around and you drive safely.
- A flow sensor makes sure you have sufficient air intake to combust the gasoline, that's of course if it's a gasoline engine.
- Position sensors monitor engine throttle, crank and camshaft angles, and radar detectors are critical features of all autonomous vehicle software.
- Airbags know when a collision is imminent from the accelerometer inside.
- And dashboard touch screens, well, they have capacitive sensors too.
- An oxygen sensor monitors the intake to the combustion reaction in the engine. And the oxygen and hydrogen sensors are used in experimental fuel cells for battery operated cars.
- A battery sensor is an essential element of all cars whether gasoline or battery operated.

Four classes of actuators are used in your automobiles, production equipment, and appliances in your home:

- First, hydraulic actuators use pressure from highly compressed oil to push large cylinders inside construction equipment such as lifts, cranes, and excavators. They're characterized by slow speed of response due to the long time it takes to compressed oil and the high gear ratios in the mechanisms that deploy them.
- Pneumatic actuators give a faster speed of response due to a faster compression of air versus oil. They're most commonly found in production assembly equipment. The downside is they're really noisy and small leaks in these seals lead to large losses in compression.
- Electrical motors convert electrical energy to rotary motion. They are directly interfaced with sensors within hardware and will be used extensively in our course.
- Mechanical actuators such as gears, and belts, and lead screws, either they boost up the torque or they convert the rotary motion to linear motion.
- Electrical actuators come in three flavors:
    - A stepper motor has multiple coils organized in phases. Energizing the coils sequentially allows the stepper motor to rotate in very precise steps.
    - A brushed DC motor has a coil that generates a magnetic field around that armature. One side of that armature is repelled by the north pole of a magnet located in the motor casing while the other side is attracted to the south pole of that magnet. The opposing forces cause the armature to rotate in one direction. As the armature rotates in that direction, the torque eventually goes to zero and the magnetic field of the armature attracts to the north and south poles. Reversing current to the armature causes that side to be repelled by the south pole, but attracted to the north pole and reversing current exactly on that half cycle creates your continuous rotation. The brushes in the brushed DC motors wear rapidly and must be replaced at frequent intervals.
    - Brushless DC motors resolved this issue by using permanent magnets rotating around a fixed armature. An electronic controller switches the phase to the windings allowing rotation within the motor.

Let's recap here. We discussed the major categories of sensors and actuators that we will feature in this specialization. Now in the next video, Jim, will give you an overview of the analog and digital interfaces that allow you to integrate sensors and actuators into embedded systems.