IROS 2009 Tutorial: Filtering and Planning in I-Spaces PART 2: PHYSICAL SENSORS

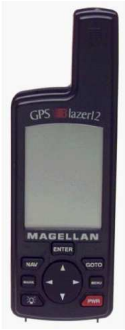
Steven M. LaValle

October 20, 2009

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

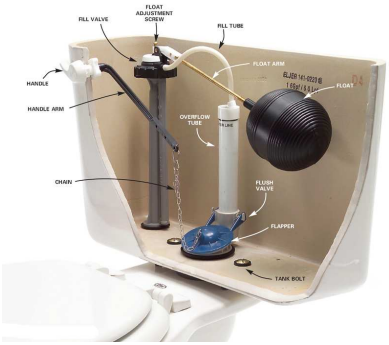
What Is a Sensor?

Light-dependent resistor



GPS unit

Wireless card



Toilet float mechanism

We know it when we see it, but will not try to formally classify.

Where Might We Want to Use Sensors?

Shopping mall

Control room

Assisted living

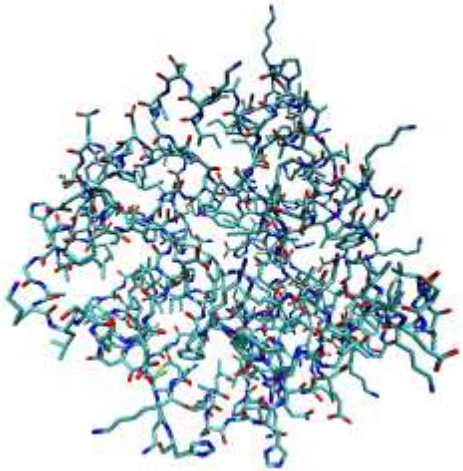
Coral reef

Where Might We Want to Use Sensors?

Roomba

CMU Boss

UAV



Protein

What Physical Quantities Are Sensable?

Spatial: displacement, velocity, acceleration, distance to something, proximity, position, attitude, area, volume, level/tilt, motion detection

Temporal: clock, chronometer (elapsed time), frequency.

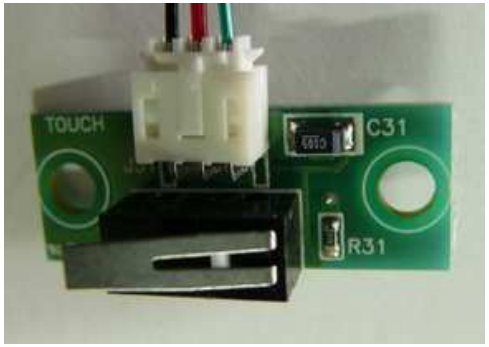
Electromagnetic: voltage, current, power, charge, capacitance, inductance, magnetic field, light intensity, color. These may operate within a circuit or within open space.

Mechanical: solid (mass, weight, density, force, strain, torque), fluid (acoustic, pressure, flow, viscosity), thermal (temperature), calories.

Other: chemical (composition, pH, humidity, pollution, ozone), radiation (nuclear), biomedical (blood flow, pressure).

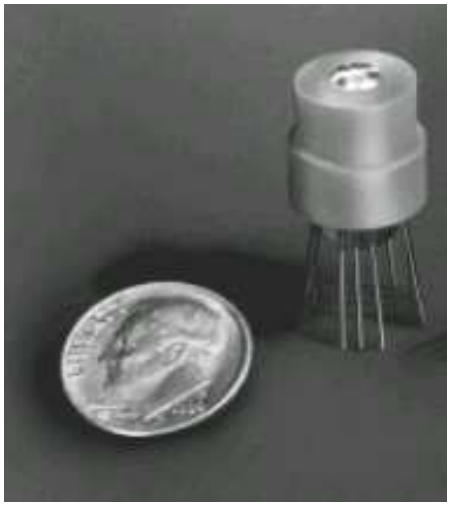
See *CRC Measurement, Instrumentation, and Sensors Handbook*

What Sensors Are Available?



Contact sensor

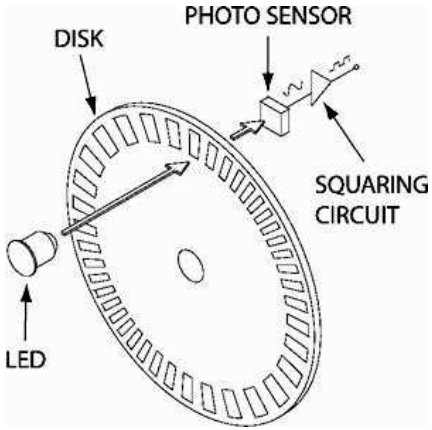
Sonar



Compass

Microphone

What Sensors Are Available?



Wheel encoder

Stopwatch/timer

Occupancy detector

Safety beam

What Sensors Are Available?

Camera

Wii remote

Pressure mat

SICK laser scanner

Common Sensor Characteristics

- *Transfer function* converts physical phenomenon to sensor reading:
$$g : \mathbb{R} \to \mathbb{R}.$$

- Domain of g may be *absolute* vs. *relative*.
- g itself may be *linear* or *nonlinear*.
- *Resolution* is given by set of possible $g(x)$.

- *Sensitivity* is set of stimuli that produce same reading.
- *Repeatability* is producing same readings under same phenomena.
- *Calibration* eliminates systematic errors.

You will find these notions in sensor handbooks.