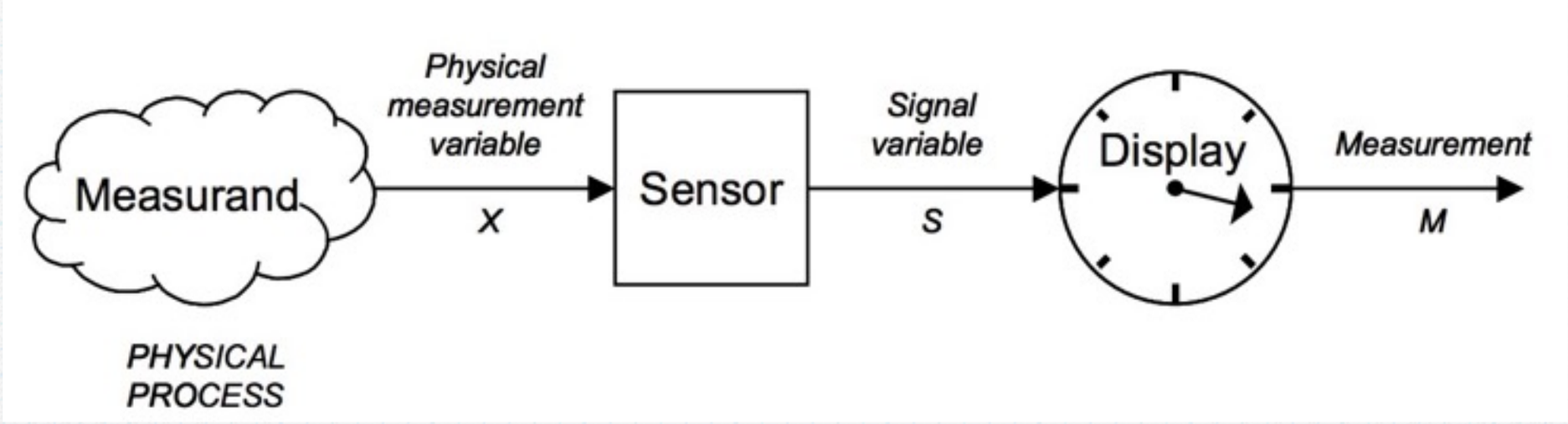
Ch 05: World of Sensors

by Dr. Sethavidh Gertphol

Outline

* characteristics of sensors
* sensor calibration
* show several types of sensors

sensors characteristics



Ricardo Gutierrez-Osuna, Lecture Notes on Intelligent Sensor Systems

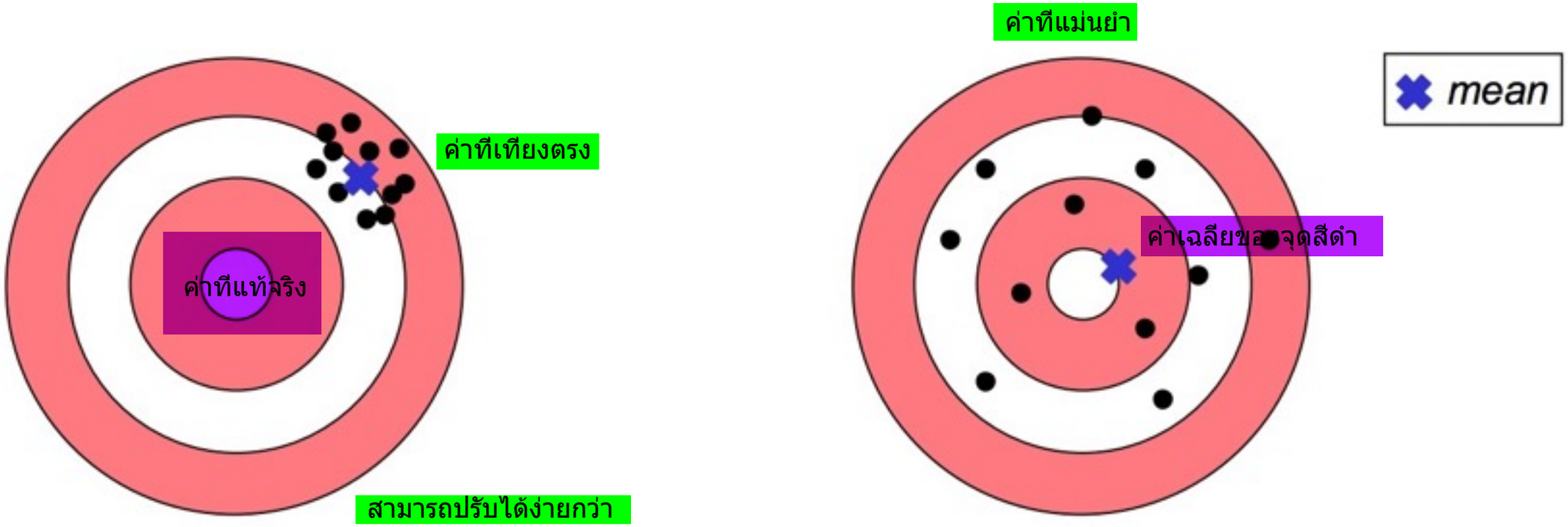
* range
  * minimum and maximum measured value that sensor can detect
  * usually designed that way
  * try to measure value outside of range can damage sensor

sensors characteristics

* **accuracy**:
  * how close the sensor output is to the true (actual) value
  * usually reported as relative errors (±%)
* **precision**:
  * how close are successive output when measure the same value
  * also called **repeatability**

accuracy v.s. precision

- Which shooter is more accurate?
- Which shooter is more precise?



Ricardo Gutierrez-Osuna, Lecture Notes on Intelligent Sensor Systems

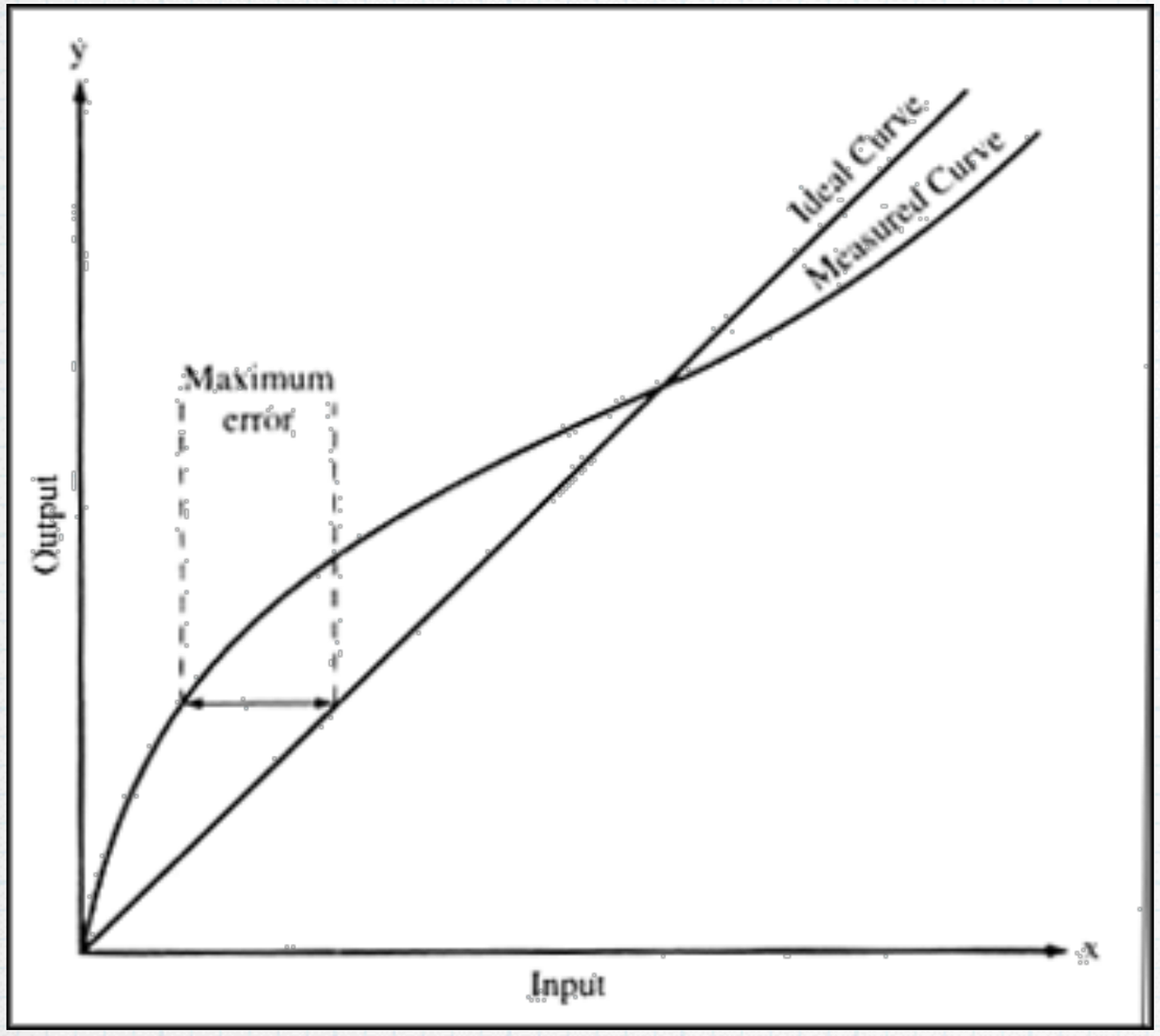
sensors characteristics

* resolution ค่าน้อยสุดทีมันตรวจจับได้
  * smallest change in value that is detectable by that sensor
* response time เวลาที output ออกมาแบบเสถียร
  * how long the sensor will reach its stable output
* sensitivity เป็นกราฟ input-output เป็นความชันของกราฟ
  * how large does the output change compared to measured value
  * slope of sensor response graph

sensor characteristics

* linearity ความเป็นเส้นตรงของกราฟ เป็นเส้นตรงคือดี
  * is the relationship between measured value and output linear across its range

* hysteresis ค่าทีเราวัดจากน้อย-มาก กับ มาก-น้อย จะได้ผลไม่เหมือนกัน
  * how different the outputs are when measuring one way compared with the other



http://www.ni.com/white-paper/14860/en/

http://www.mfg.mtu.edu/cyberman/machtool/machtool/sensors/fundamental.html

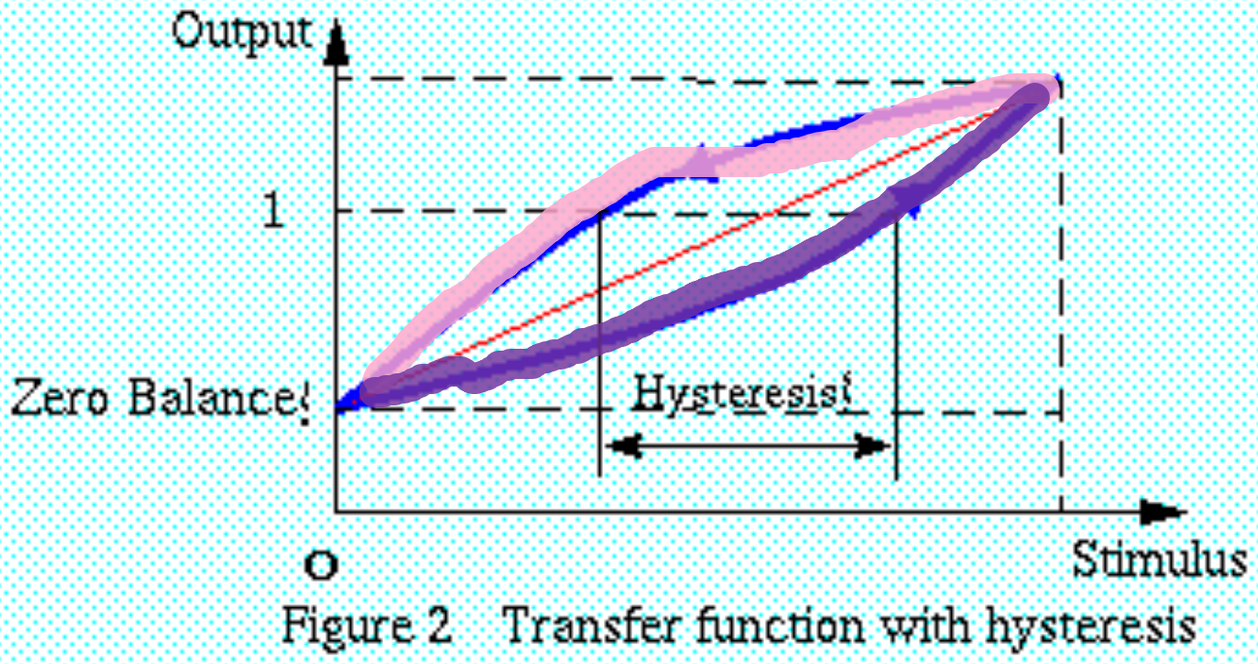


Figure 2 Transfer function with hysteresis

sensor calibration

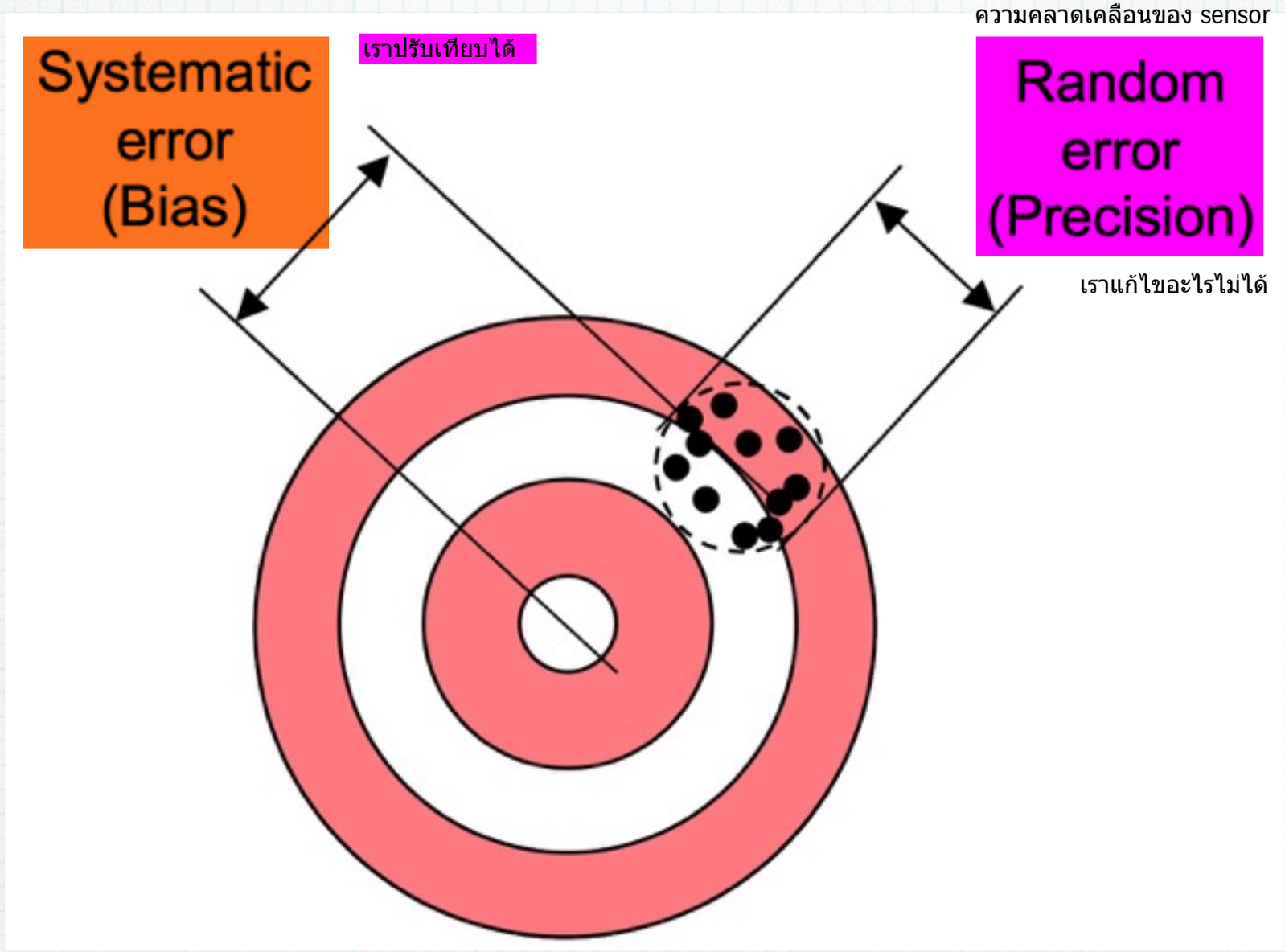
* out-of-the-box sensor may have errors in its reading

การปรับเทียบว่า sensor อ่านมาได้ตรงกับความเป็นจริงแค่ไหน

* need to calibrate before use
* must have standard reference or trusted readings to calibrate against
  * temperature: boiling water ice
  * rangefinder: rulers, measuring tape

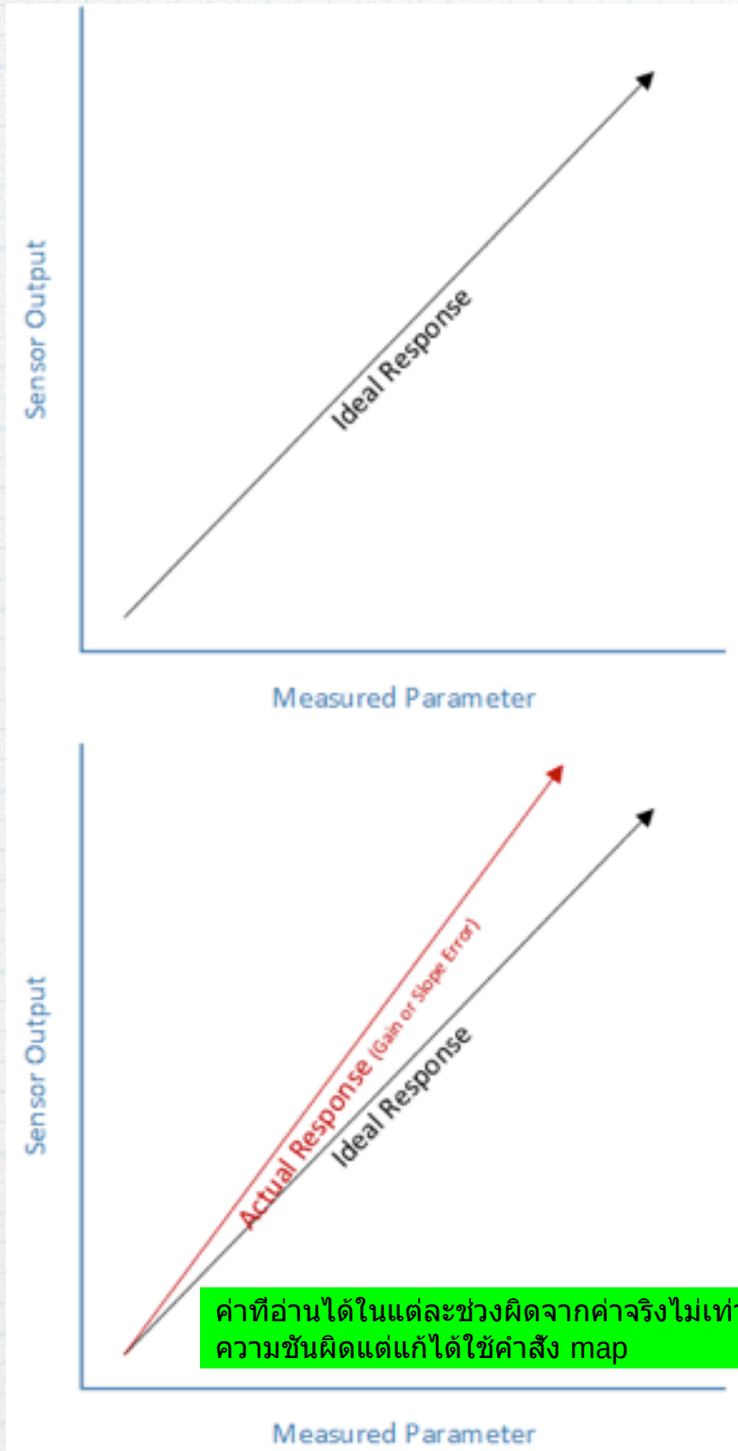
type of errors

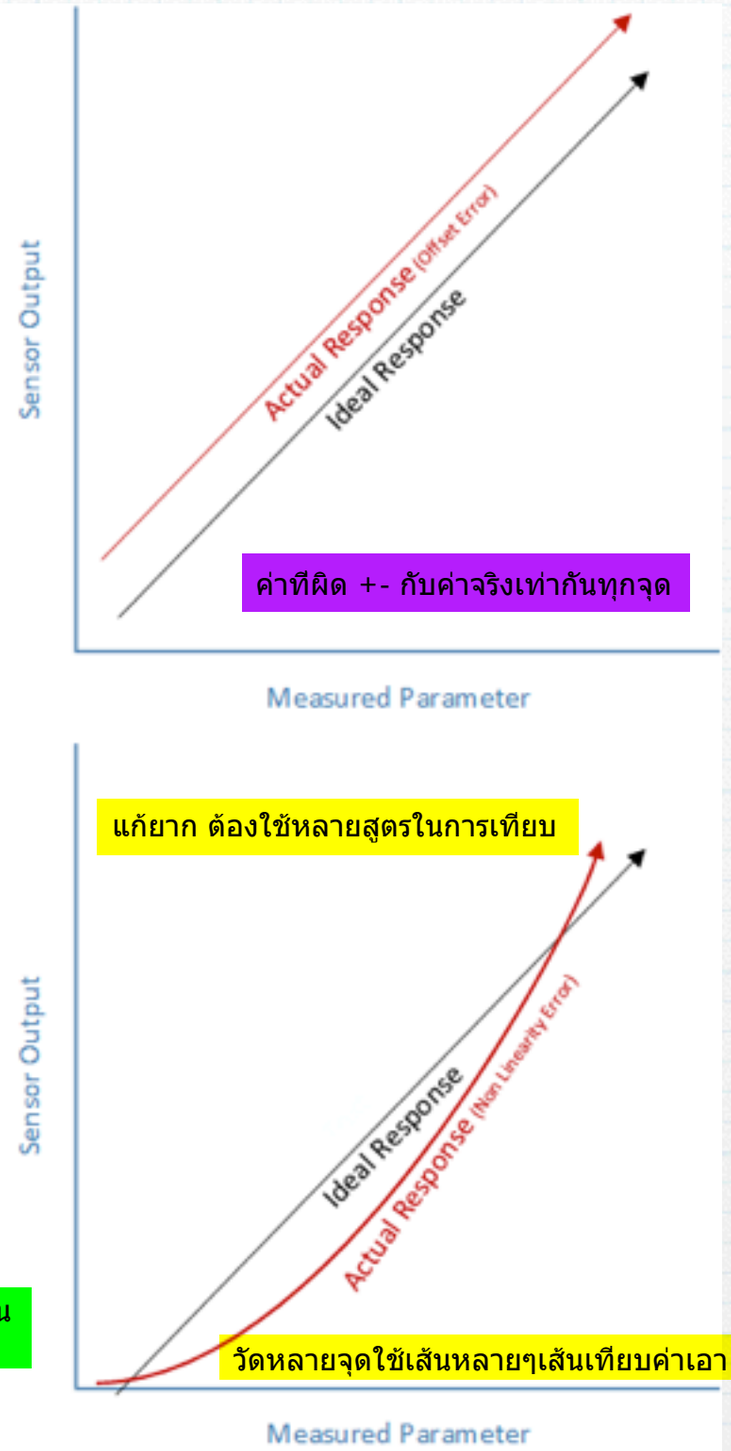
ค่าที่วัดได้คลาดกับความเป็นจริงเท่าไหร่



Ricardo Gutierrez-Osuna, Lecture Notes on Intelligent Sensor Systems

type of errors





ค่าทีผิด +- กับค่าจริงเท่ากันทุกจุด

ค่าทีอ่านได้ในแต่ละช่วงผิดจากค่าจริงไม่เท่ากัน
ความชันผิดแต่แก้ได้ใช้คำสั่ง map

แก้ยาก ต้องใช้หลายสูตรในการเทียบ

วัดหลายจุดใช้เส้นหลายๆเส้นเทียบค่าเอา

type of calibration

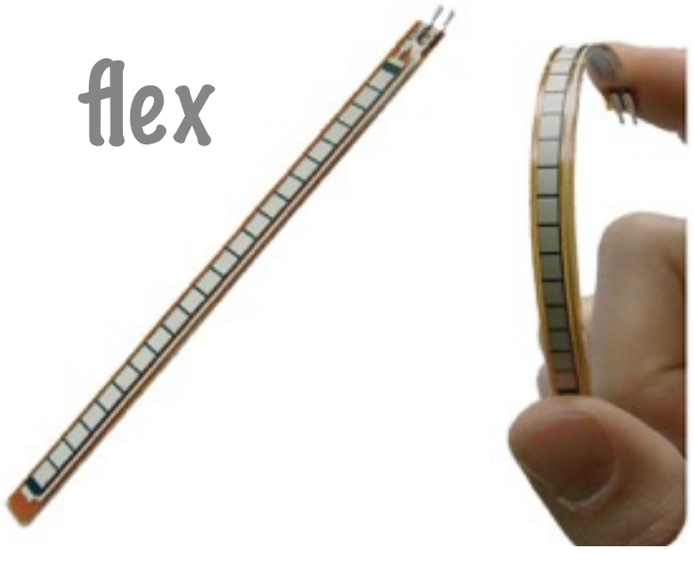
* one-point calibration
  * can fix offset error
* two-point calibration
  * fix gain and offset error
  * can use map() function
* multipoint calibration
  * fix non-linear error

There is a sensor for that

* several types of sensors created for industrial applications
* many are now very cheap
* there is a sensor to detect almost anything

Force-based sensor

flex



force

soft pot

vibration

load

tilt

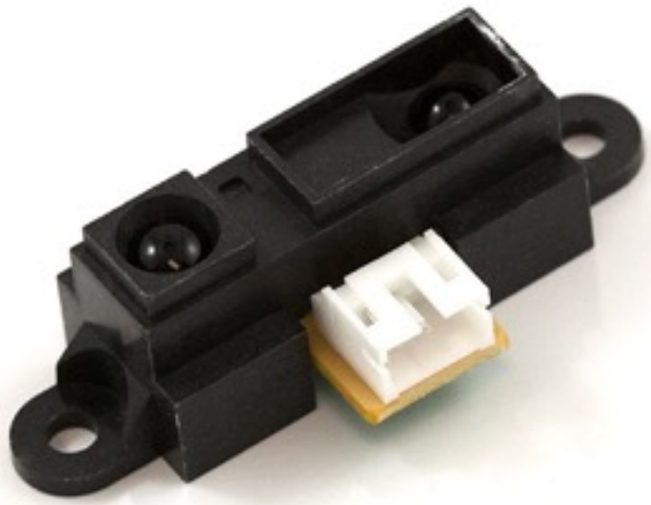
images from www.sparkfun.com

light, sound, color, range

light

sound

ir range finder



color

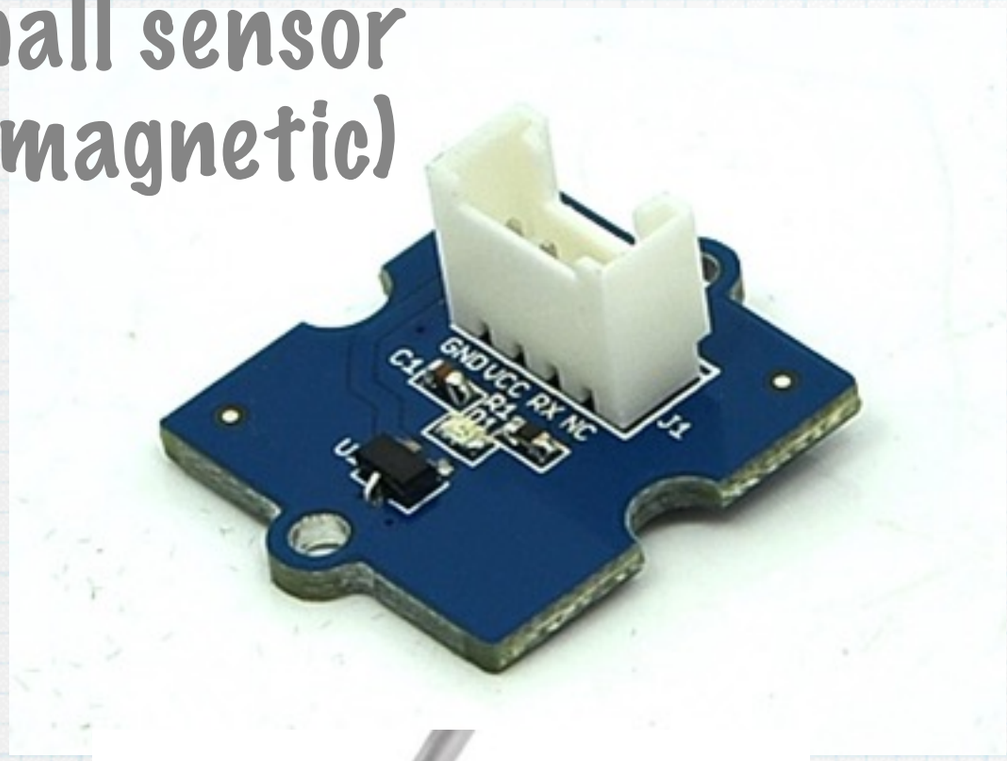
ultrasonic range finder

passive ir

images from www.sparkfun.com

field, current, temperature

hall sensor
(magnetic)



temperature
(water-proof)

current
clamp

accelerometer and gyro

images from www.sparkfun.com

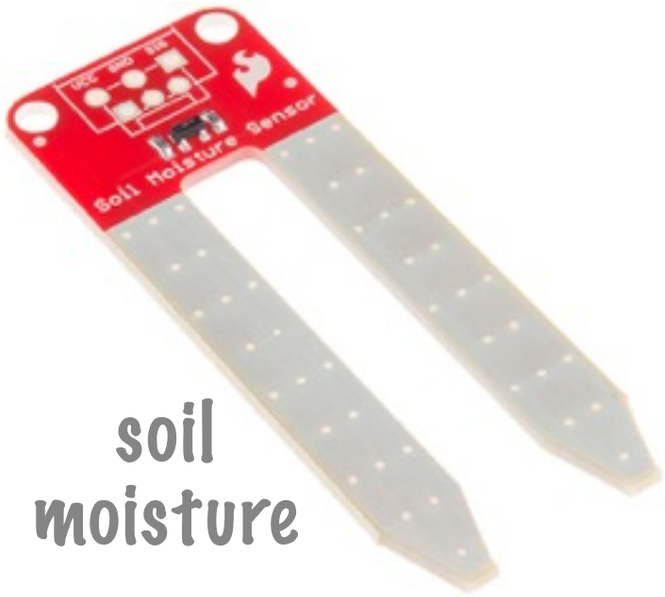
earth, air, water

LPG/Methane/Hydrogen

dust sensor

pH sensor

algohol/carbon monoxide



soil moisture

geophone

water conductance

images from www.sparkfun.com

biometric

muscle sensor

fingerprint scanner

mind wave sensor

pulse sensor

heart rate sensor

images from www.sparkfun.com

References

1. Sensor Fundamentals, retrieved from http://www.mfg.mtu.edu/cyberman/machtool/machtool/sensors/fundamental.html

2. Ricardo Gutierrez-Osuna, Lecture Notes on Intelligent Sensor Systems, retrieved from, http://research.cs.tamu.edu/prism/lectures/iss/iss_l2.pdf

3. National Instruments, Sensor Terminology, retrieved from http://www.ni.com/white-paper/14860/en/

4. Bill Earl, Why Calibrate?, adafruit, retrieved from https://learn.adafruit.com/calibrating-sensors?view=all