Pannel: SIGNAL 2018

Advances on Sensing Techniques and Signal Processing

Moderator : Pr. Wilfried Uhring – University of Strasbourg and CNRS

Pannel List :

Özgür Tamer, Dokuz Eylül Üniversitesi, Turkey

Laurent Fesquet, Grenoble INP/TIMA Laboratory, France

Mohammad Mehdi Saberioon, University of South Bohemia in České Budějovice, Czech Republic

May 23 2018 – Nice, France

Introduction

- Sensing and Signal Processing has to be seen in this wide sense
  - Acquisition
    - Sensor
    - Low level driver
  - Pre processing
    - Analog
    - Signal conditioning
  - High level processing
    - Image processing , Microprocessor, FPGA, GPU, neuromorphic, …

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Sensing is everywhere

- Currently **60 – 100** sensor on board
- Smarter car → **200** expected number of sensor in a car in 2020
- → **22 billions** sensor per year for automotive industry

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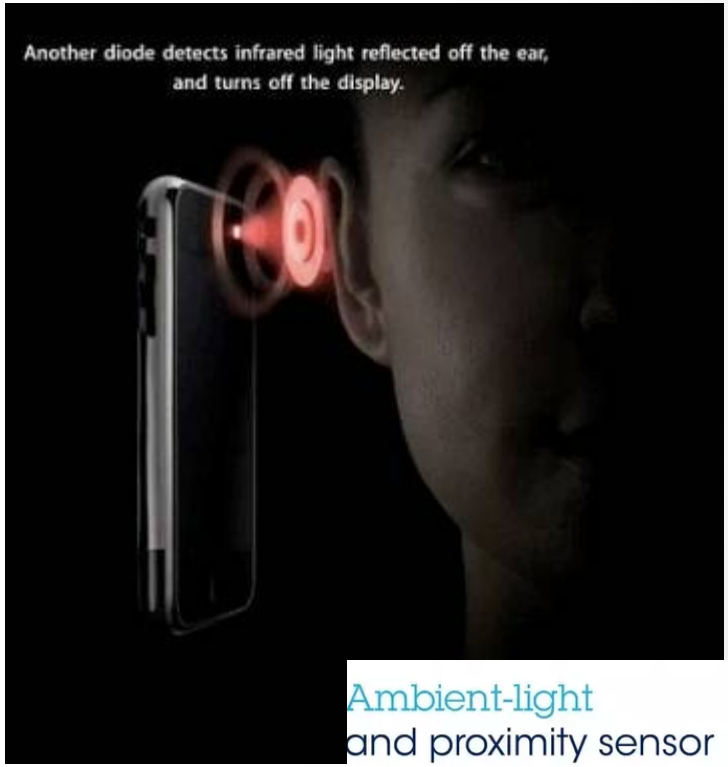
Sensing in mobile phone

- Proximity Sensor ➔
- Ambient Light sensor
  - Screen brightness
- Barometer



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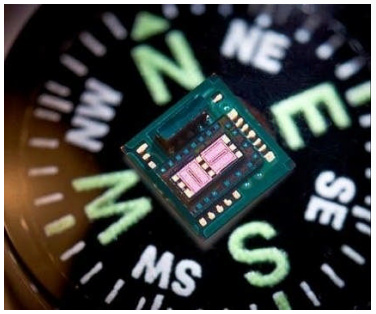
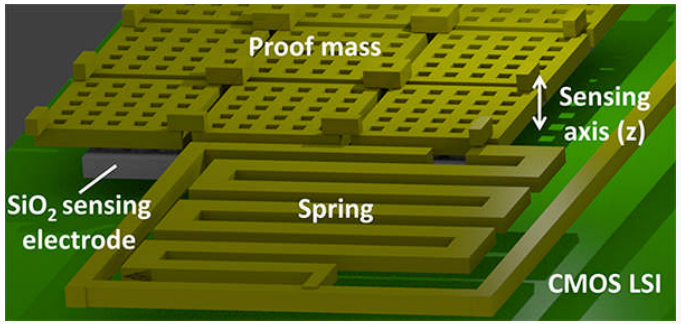
Sensing in Mobil phone

- Magnetometer
- Accelerometer
- Gyroscope
- Thermometer





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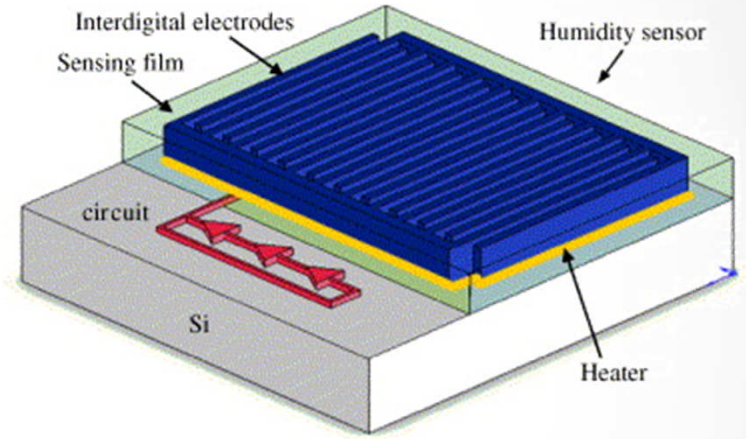
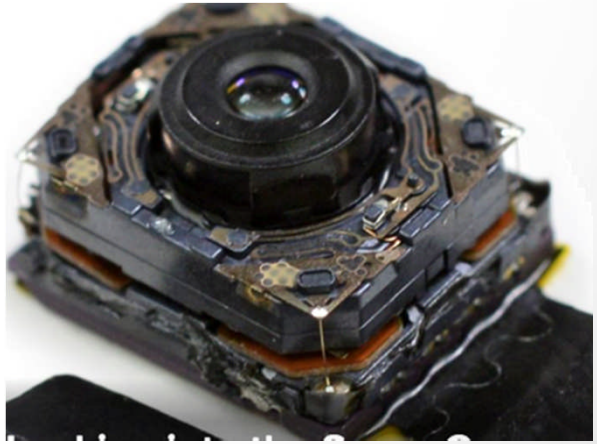
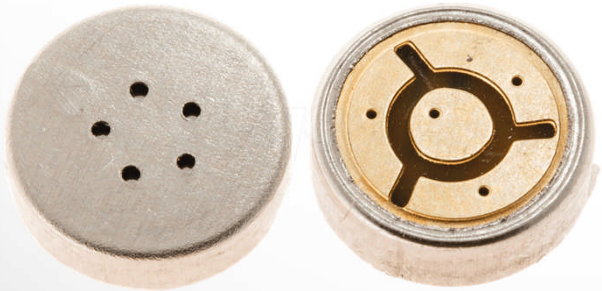
Sensing in mobile phone

- Humidity
- Camera
- Microphone







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Sensing, allways sensing, …

- Radar Sensor
- Optical Sensor
- Not visible wavelength camera (IR, THz, …)
- Biosensors
- Touch Sensor
- Image Sensor
- Proximity Sensor and Displacement Sensor
- Level Sensor
- Motion and Position Sensor
- Humidity Sensor
- Accelerometer and Speed Sensor
- Chemical Sensor
- Force Sensor
- Electric & Magnetic Sensor
- Gesture Sensor
- Photoelectric Sensor
- Ultrasonic Sensor)
- …

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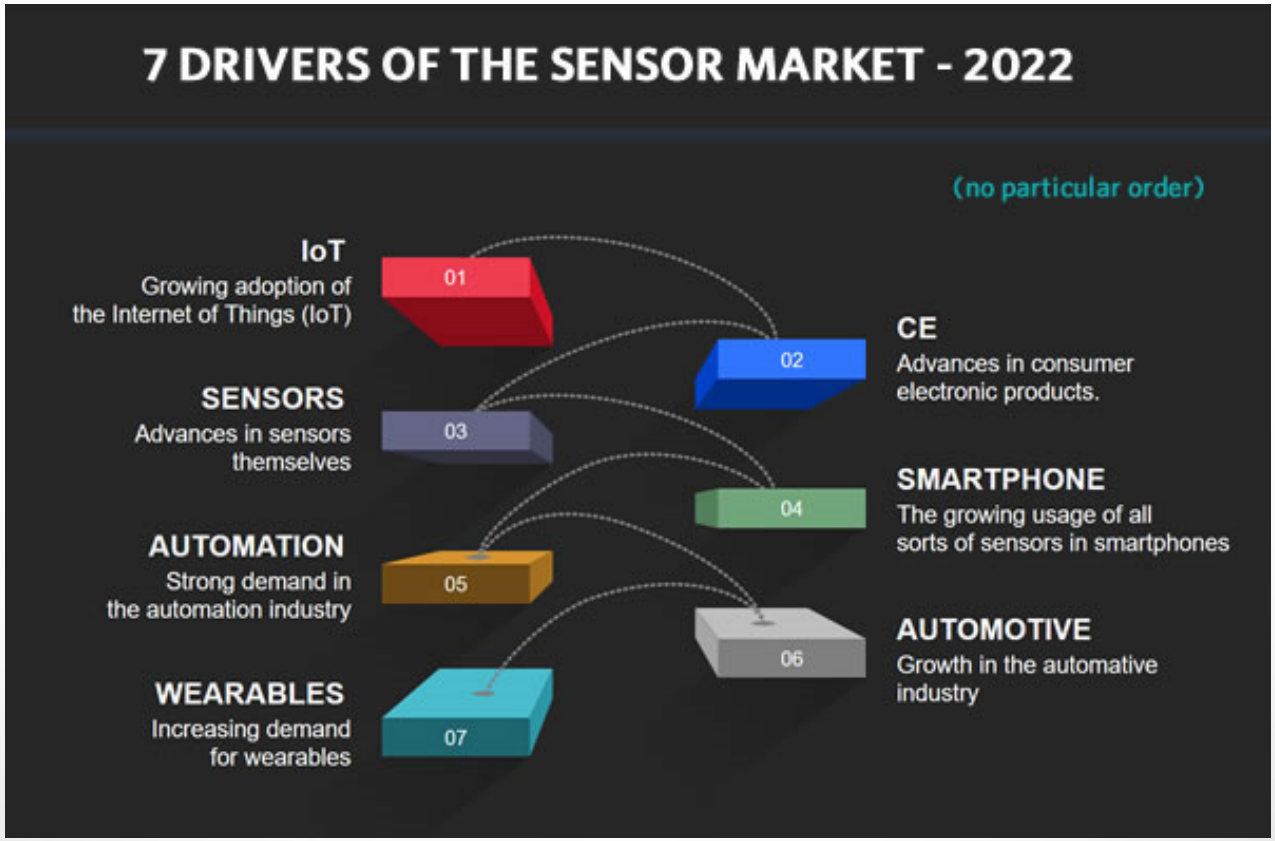
Sensor market

- According to Allied Market Research (AMR), global market sensors ➔**$241 billions by 2022**



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outline

- Sensor in IOT context
- Uncertainty in sensing information
- Sensor Fusion
- Trends
  - Compressed sensing
  - Signal processing
  - sustainability

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Sensing in IOT Context

- Laurent Fesquet
  - Event driven sensor
  - Low power
- Big Data ?

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Uncertainty in sensing information

- Unpredictive behavior from objects
  - Mohammad Mehdi Saberioon

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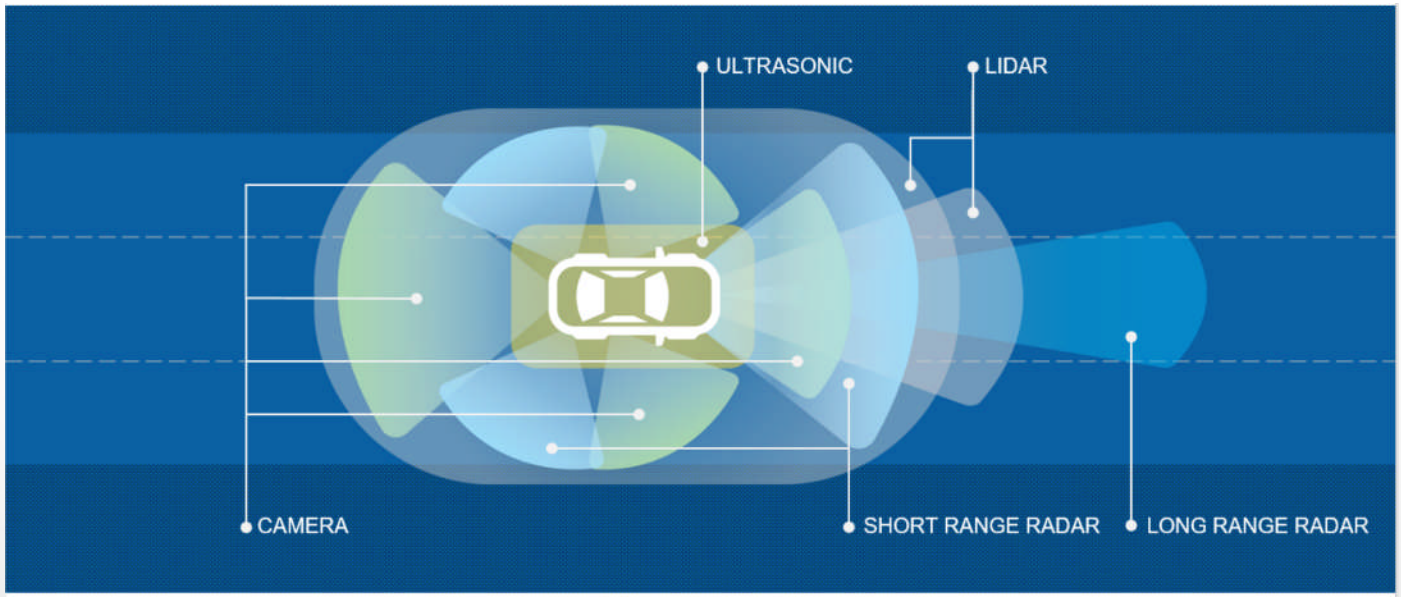
Sensor Fusion

- Combining all the available information

Özgür Tamer



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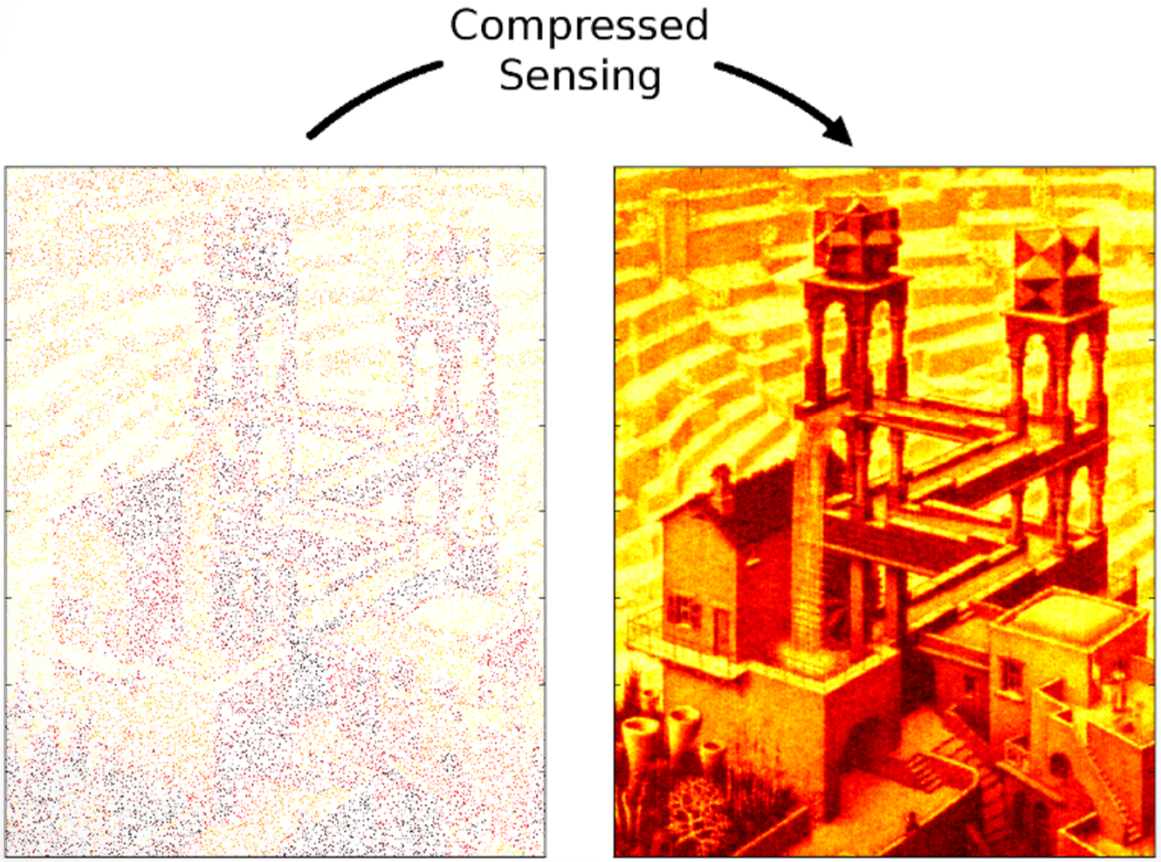
Compressive sensing



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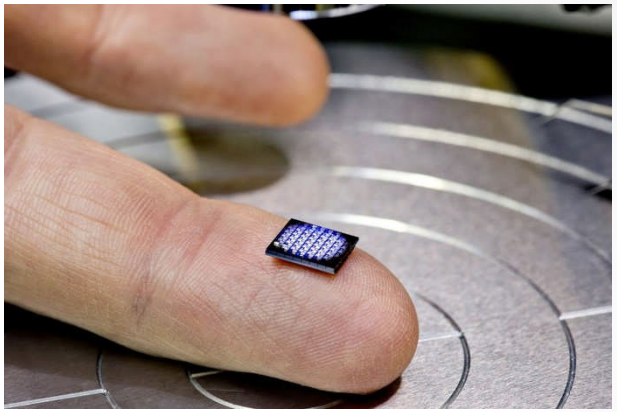
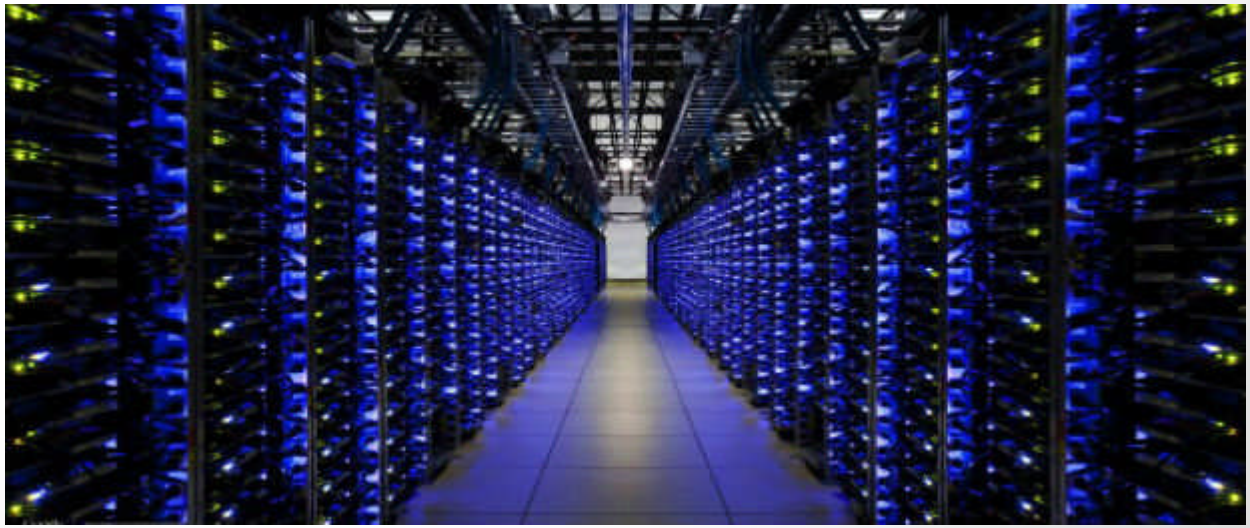
Signal processing

- Embedded processing
- Cloud processing





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Sustainability

- Sensing for sustainability
  - Air metric
- Sustainable sensing
  - Low power, recyclable sensor
  - New technology
    - Organic electronic

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Uncertainty in sensing information

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Challenges !!

- Unpredictive behavior from objects (usually living organisms); artificial and unnatural objects in environment
- High cost of sensors, limited availability and the complexity involved in processing the raw data

How to overcome?!

- Standardization of the rules for assessing the accuracy and precision of predictions is a prerequisite for the comparison of different optical sensors and their applications across different studies

For instance

- To develop the specific image processing protocols for more accurate results
- To develop algorithms and techniques for automating the measurement process with the possibility of robust feature matching and verification, under variable conditions of lighting and perspective, to avoid delays in data processing. [Can Deep learning be useful?]

The Third International Conference on Advances in Signal, Image and Video Processing
SIGNAL 2018
May 20, 2018 to May 24, 2018 - Nice, France

Advances on Sensing Techniques and Signal Processing

Panel

Laurent Fesquet

***University Grenoble Alpes** / **CNRS – TIMA** – Grenoble, France*

***EPFL – ICLab** – Neuchâtel, Switzerland*

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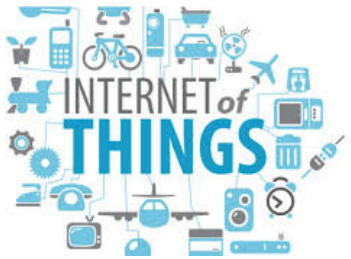
Internet of Things Challenges

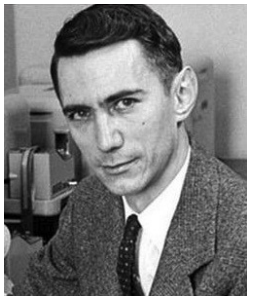
+ more data
+ more storage
+ more computation
+ more communications
+ more consumption
+ more autonomy

Nyquist-Shannon Theorem



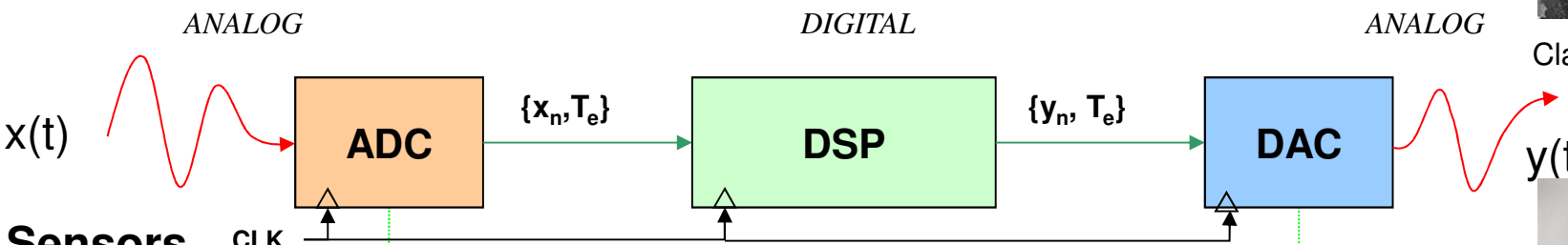
A new paradigm for signal applications

How to reduce the activity and the number of samples?



Claude Shannon

Uniform and Synchronous



Frederick J. Beutler

Non Uniform and Event-driven

Events Events

Event-driven electronics

$$P = \alpha C V^2 f$$

- Power consumption is sensitive to V^2, f and C

→ Reduce **V, f and C**

… **but you will loose performances**

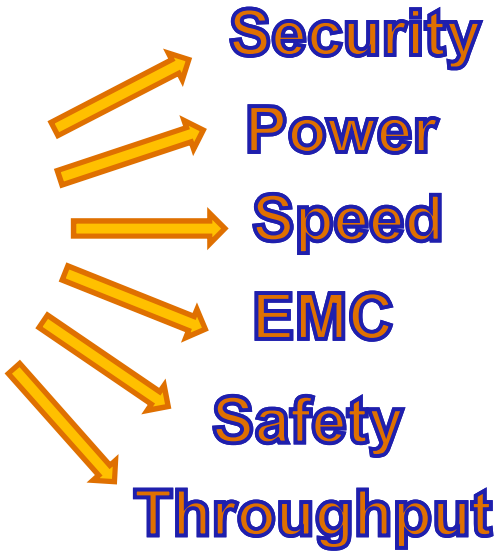
- Other option:

→ **Reduce the activity α**

→ **Design Event-driven circuits**

Event-Driven Signal Applications

- Sampling should be **specific to signals and applications**
- Only compute **few events**
- Use **Event-driven electronics**



New freedom degree for app-designers

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Sensing and Sampling for Low-Power Applications

Laurent Fesquet

***University Grenoble Alpes** / **CNRS – TIMA** – Grenoble, France*

***EPFL – ICLab** – Neuchâtel, Switzerland*

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Thursday, May 24, 9:15

Thanks for your attention

SENSOR FUSION

Dr. Özgür TAMER

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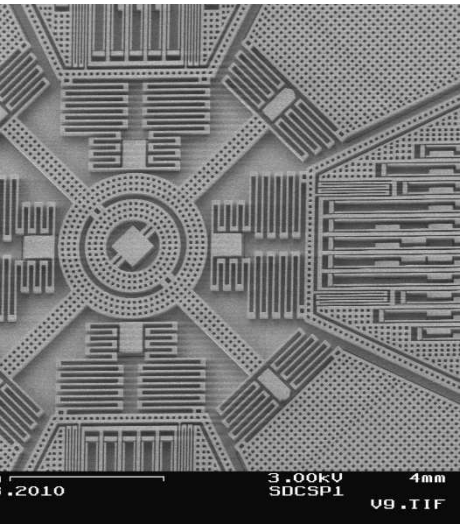
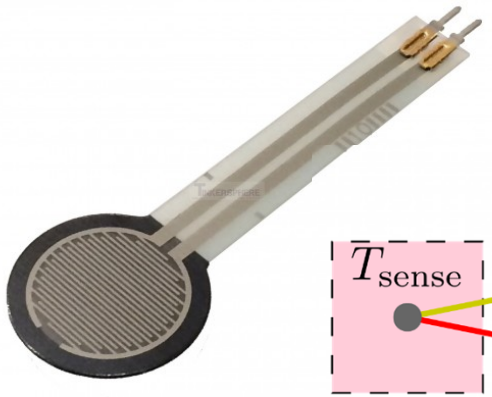
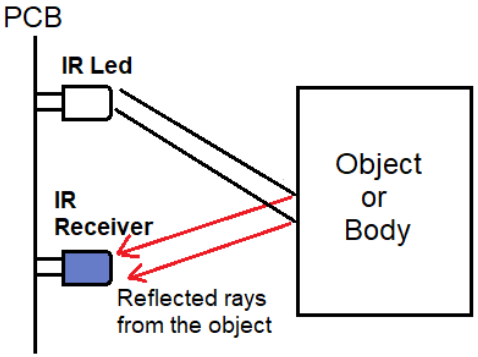
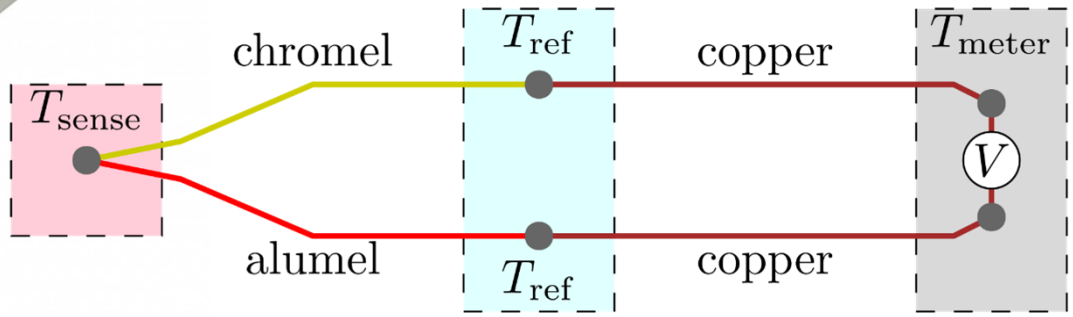
SENSOR FUSION

- Sensors









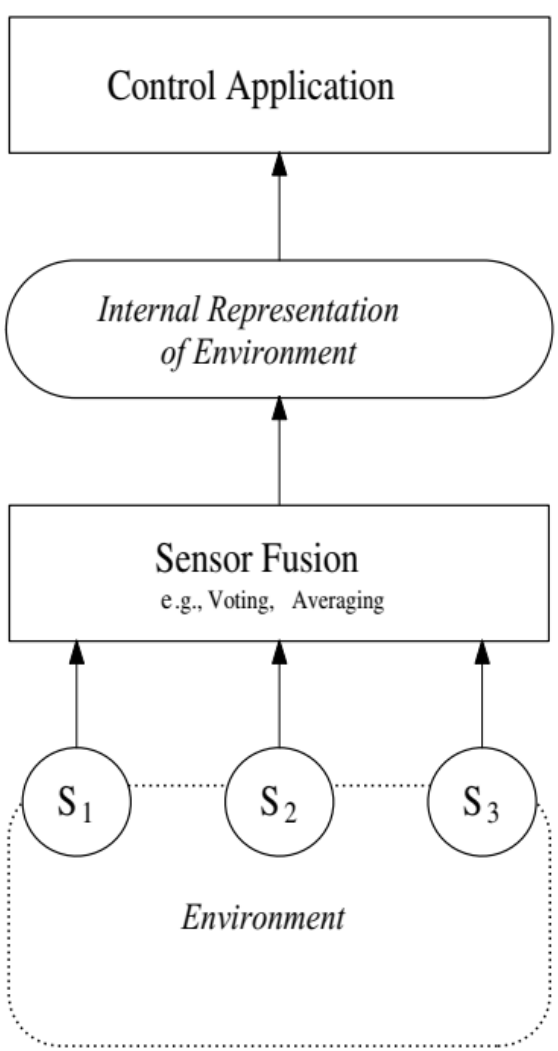
SENSOR FUSION

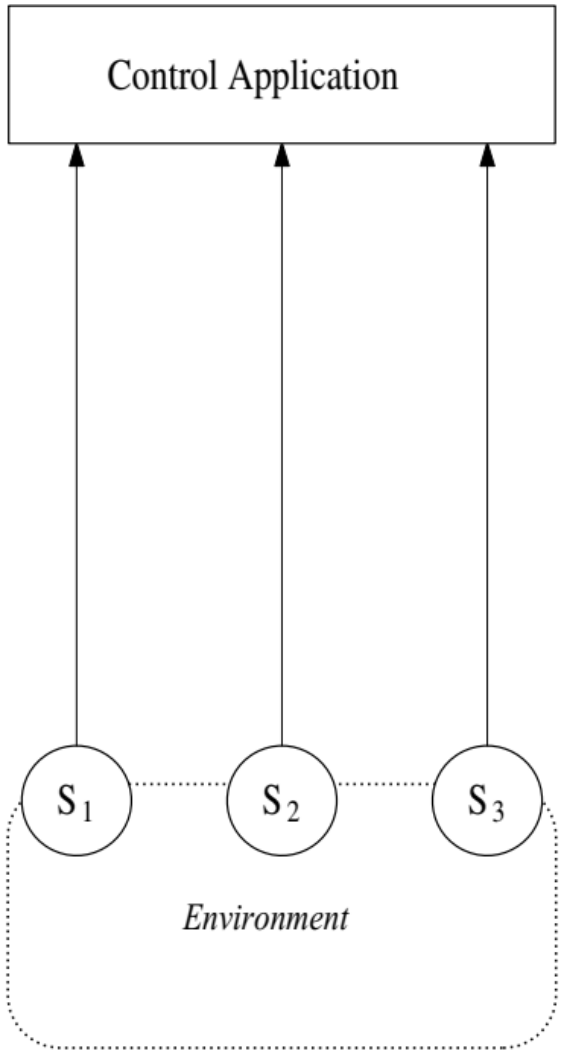
- Sensors are far from perfect devices.
- Each has limitations based on their physical sructures
- General Limitations
  - Sensor Deprivation
  - Limited spatial coverage due to region restrictions
  - Limited temporal coverage due to set up time before measurements
  - Imprecision
  - Uncertainty due to limited observation of the object

SENSOR FUSION

- How do we cope with imperfect sensors?
- Sensor fusion is the art of combining multiple physical sensors to produce more accurate than any of the sensor alone can give.
- Combining data from multiple sensors corrects for the deficiencies of the individual sensors

SENSOR FUSION





SENSOR FUSION

- Fusion processes are often categorized in a three-level model distinguishing low, intermediate, and high level fusion
  - Low-level fusion: combines several sources of raw data to produce new data that is expected to be more informative than the inputs
  - Intermediate-level fusion: Combines various features processed from raw data to be used for further processing
  - High-level fusion: Combines decisions from several methods

SENSOR FUSION

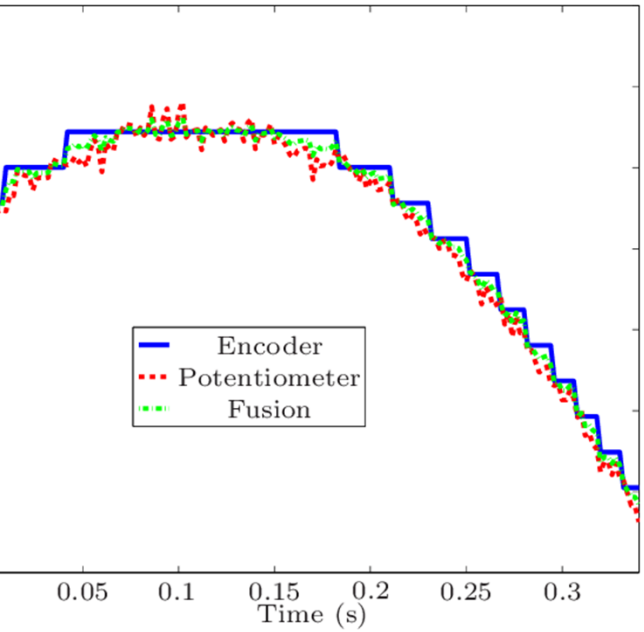
- What do we gain
  - Robustness and reliability
  - Extended spatial and temporal coverage
  - Increased confidence
  - Reduced ambiguity and uncertainty
  - Robustness against interference
  - Improved resolution

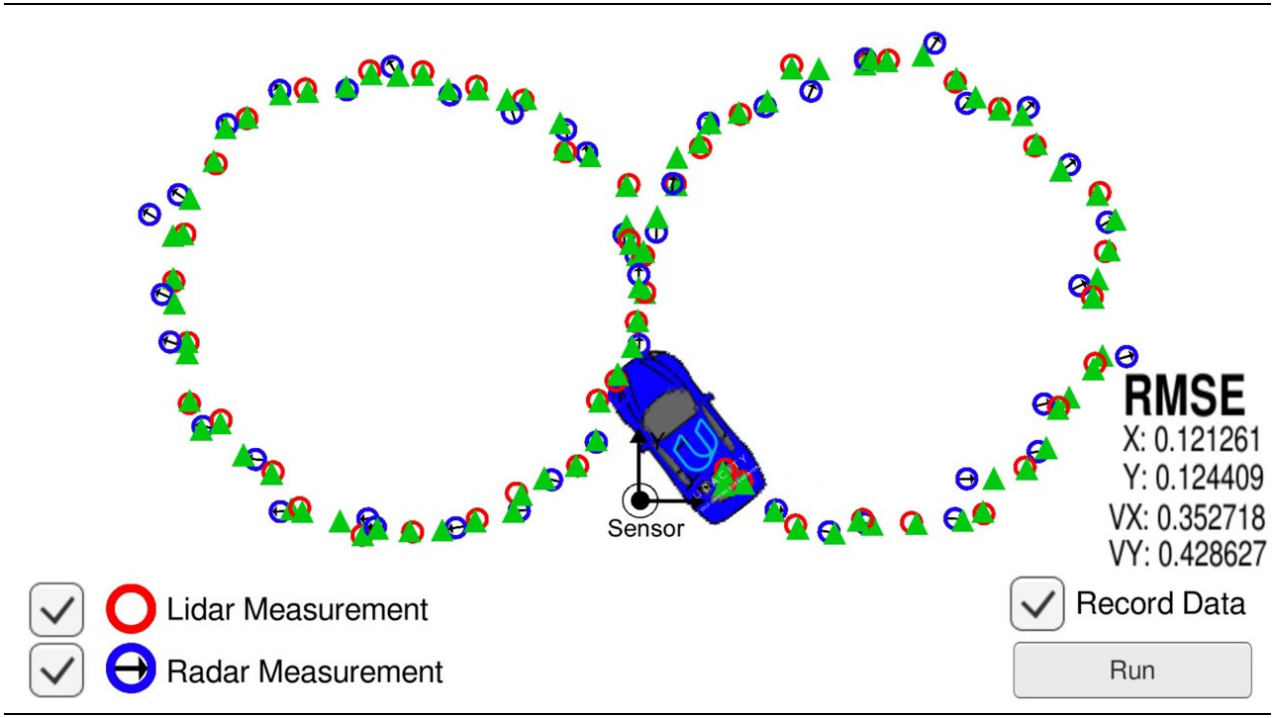
SENSOR FUSION

- Determining the weights
  - Kalman Filter: uses Markov Chains and Bayesian Inference to iteratively refine its guesses for weights using prior observations.
  - PID (Proportional–Integral–Derivative) Filters are like primitive Kalman filters with all the iterative tuning are replaced with three fixed values.
  - Real systems are often hybrids, somewhere between the two.

SENSOR FUSION

- Some examples





- Ref:

- An articulated assistive robot for intuitive hands-on-payload manipulation Alexandre Campeau-LecoursPierre-Luc BelzileThierry Laliberté Clément Gosselin
- Junsheng Fu youtube video