# Computer lab processing: Low cost actuators and detectors for bio-imaging application experiments.

J. Ramirez – A. Villa – M. Toscani

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# Introduction

What Is this presentation about:

- Provide a general overview of detectors, actuators and it's importance applied to Bio-Imaging.

- Emphasizing on reliability, high sensitivity, low noise and low cost.

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# Introduction

In the broadest definition, a sensor is to detect events or changes in its environment, it converts real world data (Analog) into data that a computer can understand.

# Introduction

## What is an Actuator?

- It is a device capable of performing a movement or a mechanical action over another hardware.

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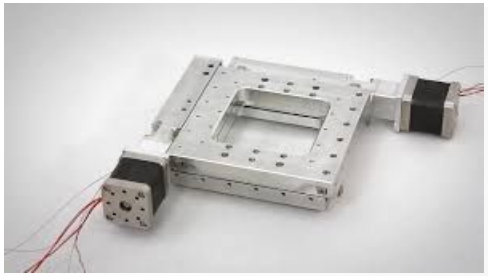
# Introduction

Detectors
Sensors

Actuators

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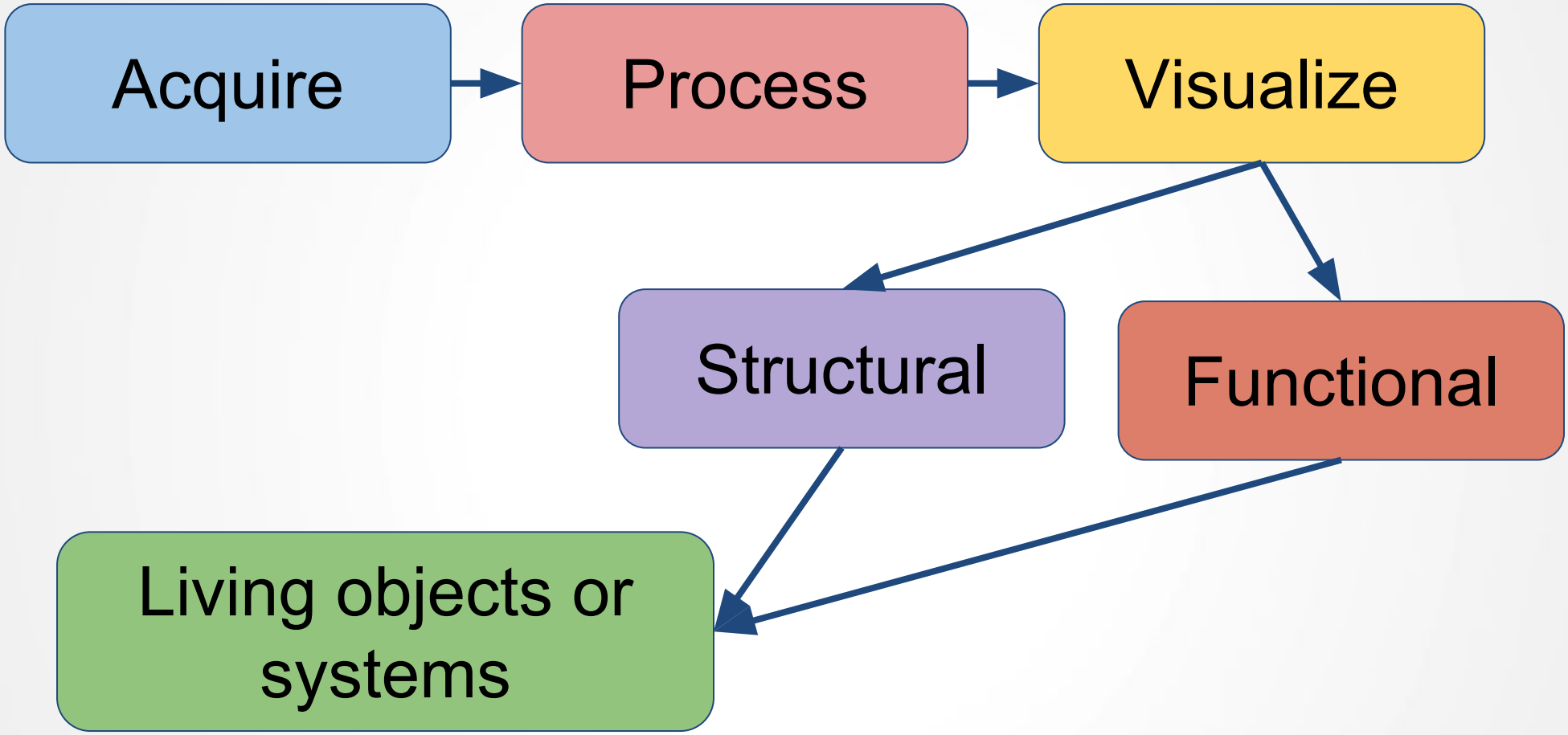
# Bio Imaging

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# Bio Imaging:

Reproducibility

Tissue

Time Lapse

MRI

Macro and Micro

Calcium

Isolated Cell

Gallium

Fluorescence

Isolated organ

Phosphorescence

Stimulated Emission

Field Stimulation

Ultrasound

High Durability

Molecular

Bio Lumniscence

Photo Acoustic

Thermography

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# The problem

What do I Need to make Low cost Bio Imaging?

High Sensitivity

High Durability

High Reproducibility

High Speed

Low Noise

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# The problem

## What do I Need?

Add functions or modify my existent setup

Build from Scratch

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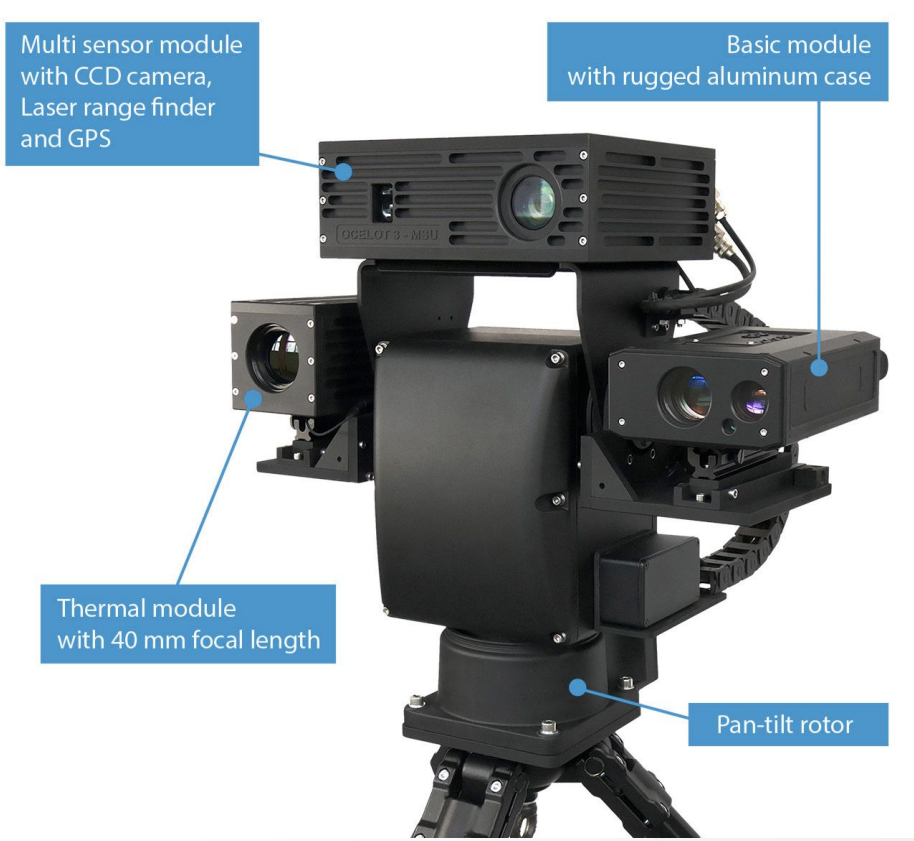
# The problem

## What do I Need?

- Synchronizations?
- Real time?
- High speed?
- Single detector?
- Small array?
- Camera?

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# The problem

Image means optics?
YES!!!

- Manufacturers and their “secrets”.
- Not easily adaptable nor modifiable.
- Firmware is closed source.
- Image quality or speed of acquisition?
- Apply KISS (Keep It Simple Straight).

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# The problem

## What is KISS principle?

- Design principle noted by the U.S. Navy in 1960.
- States that most systems work best if they are kept simple rather than made complicated.
- Simplicity should be a key goal in design and unnecessary complexity should be avoided.

# The solution: Sensor & Detectors

| | | | |
|---|---|---|---|
| PhotoMultiplier Tube | Complex | Expensive | Best In c |
| Charged Coupled Devices | Simple | Expensive | Best in c |
| CMOS Image Sensor | Simple | Low Cost | Noisy |
| Photodiode Array | Moderat | Low Cost | A/D Proc |
| Photocell Array | Moderat | Low Cost | A/D Proc |

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# The Solution: Sensor & Detectors

| | | | |
|---|---|---|---|
| Single big area Photo Diode | Moderat | Multiprice | A/D Proc |
| Single big area Photocell | Simple | Multiprice | Best IC |
| IR Pyrometers | Various | Low Cost | Noisy |
| Fiber Optics | Moderat | Low Cost | Detector |

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# The solution: Actuators

## Our Worst Enemy: Vibration

- Damping

- High Tech Control

- High Tech Actuator

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# The Solution: Actuators

| | | | |
|---|---|---|---|
| DC Motor Based | Easy | Low Cost | Elec. Noi |
| Stepper Based | Easy | Low Cost | Vibration |
| Piezo Motors | Various | Expensive | Best IC |
| Linear Non-Movin | Moderat | Expensive | V. Good |

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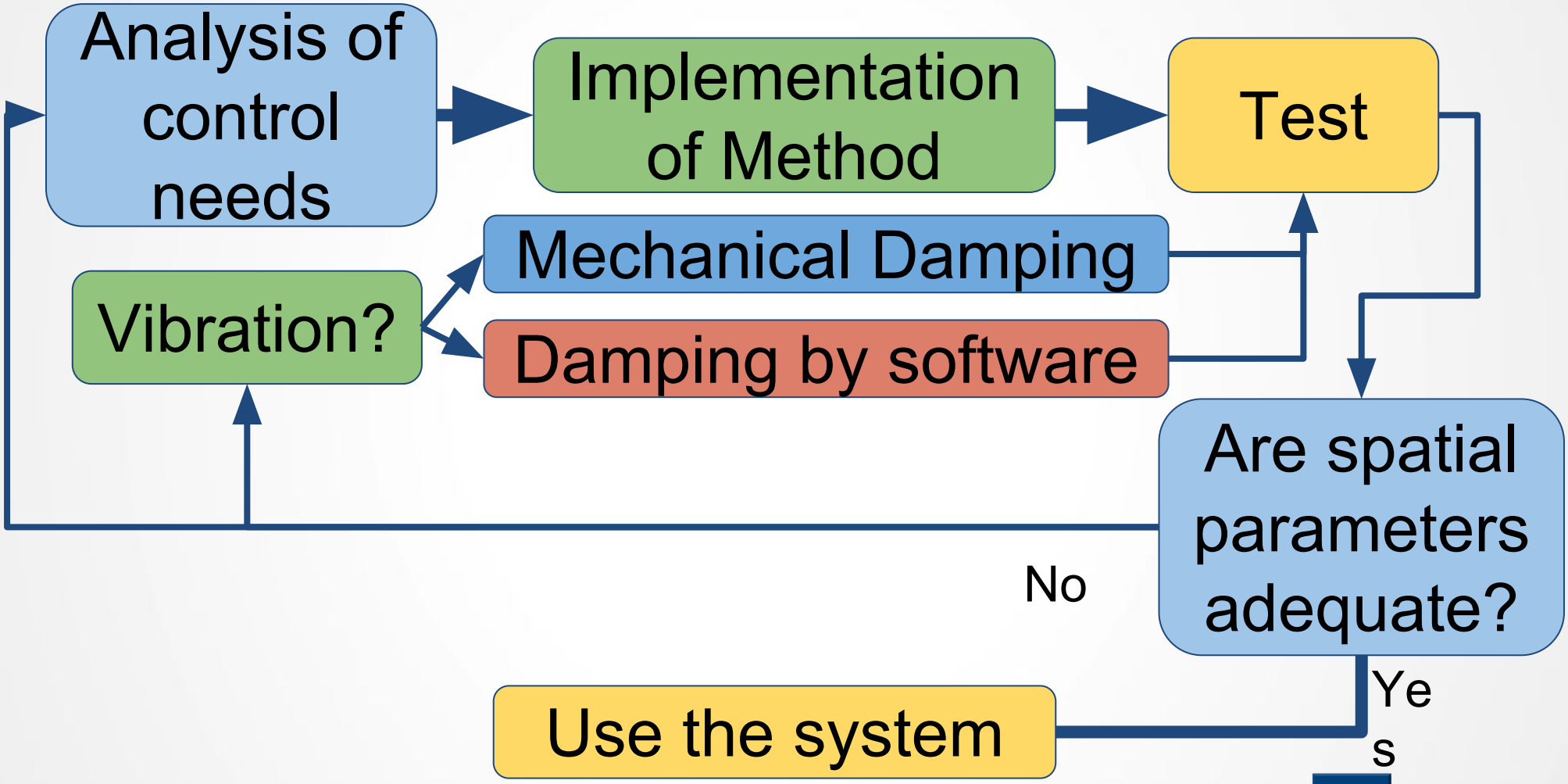
# The Solution: Damping

- Passive damping: Affordable and effective, but has easy to reach limits.

- Active damping: Difficult to implement and expensive. Highly durable and trustable.

# The Solution: Control Methods

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# The Solution: Control Methods

| | | | |
|---|---|---|---|
| DC H bridge | Easy | Low Cost | Elec. Noi |
| Stepper Half H | Easy | Multiprice | Vibration |
| AC Variator | Various | Expensive | Best IC |
| Linear Non-Movin | Moderat | Expensive | V. Good |

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# Programmable logic controller

Allows us to:

- Data acquisition.
- Motor Control.
- Displacement sensing.
- Safety measures.
- In one device.


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# Low cost signaling

Easy built-in hardware:

- Pulse Width Modulation.
- TImers.
- A/D converters.
- Some has D/A.
- All integrated in the microcontroller.


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# Data Acquisition

Microcontrollers:

- Can do DAQ.
- Limited Speeds.
- Only recommended for slow signals or phenomena.
- Is advised to use a separate DAQ system.

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# Synchronization

Microcontrollers:

- Camera synchronization is possible, with an input or output from the camera.
- Field stimulation needs special isolation.

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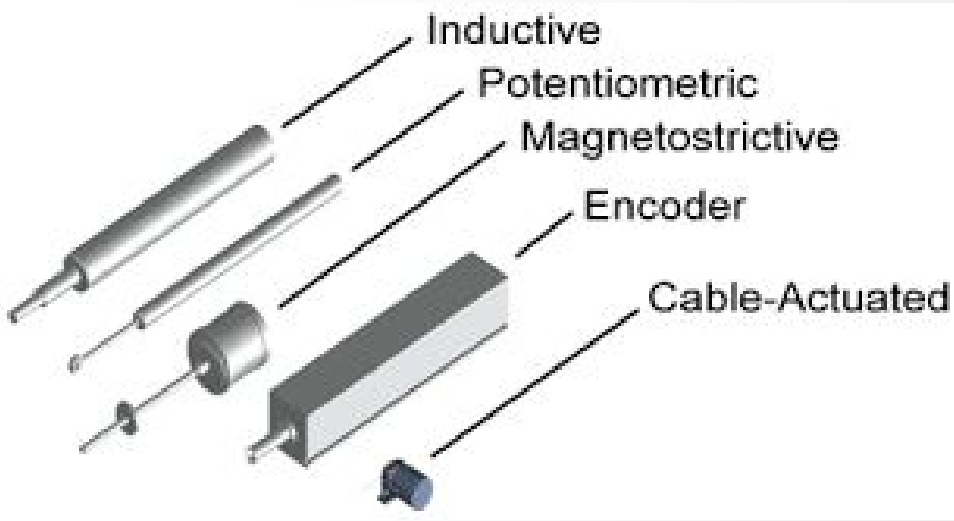
# Displacement sensors

Allows us to:

- Have feedback of the movement of motors and actuators.
- Implement a coordinate system.
- Know or determine the position of an element.



# Disadvantages

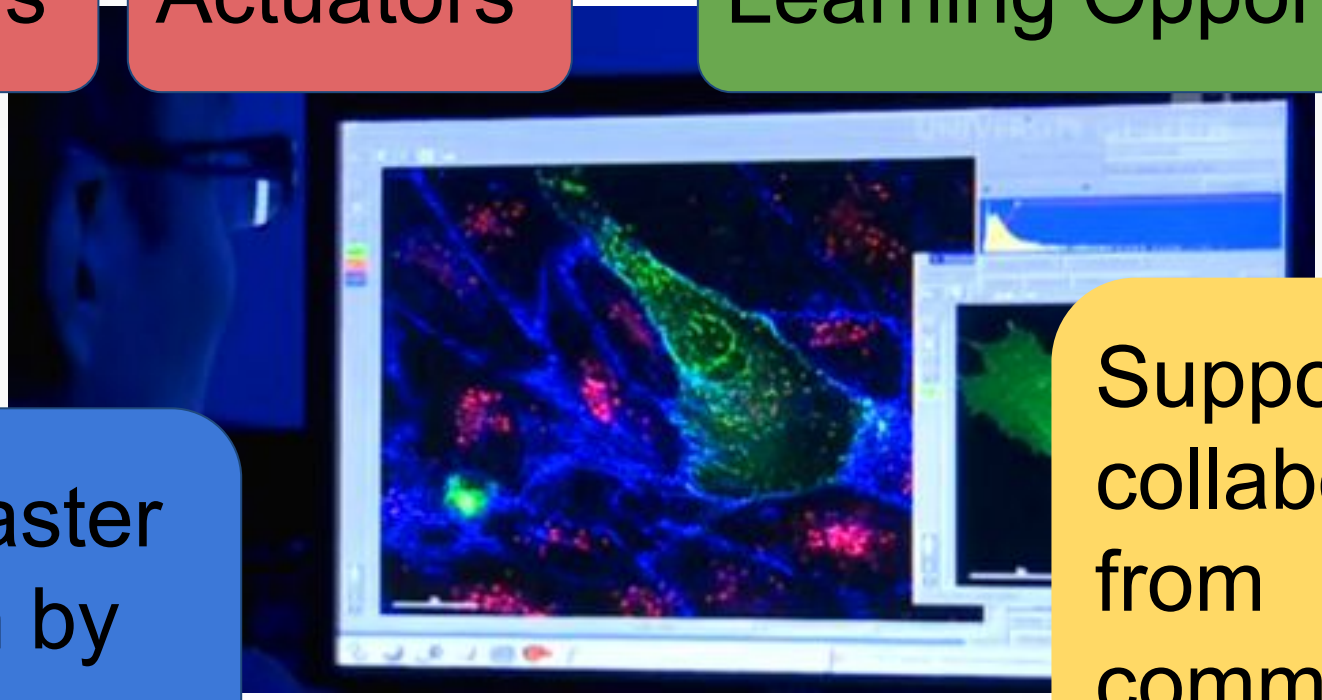
- Sensitivity of movement and detection can be easily underestimated.
- Problems in firmware and control methods are the predominant malfunctions, and take long time to solve by inexperienced programmers.
- To a successful implementation, is desirable to have some experience in instrumentation.

# Conclusions

Detectors

Actuators

Learning Opportunities



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Support and collaboration from communities

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# Useful Resources

- Sensor manufacturers: Hammamatsu, Kyocera, Analog Devices, Sharp.
- Cameras: Cohu 4900, RasPiCam, Elphel cameras, Playstation Eye, Photonis
- Motors: Buehler, Seiko, Mabuchi.
- Gearboxes: 4D robotics, Tamiya.
- Encoder Sensors: Agilent, Hohner.
- Microcontrollers: Microchip, Atmel.

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# Thank you for your attention.

Questions

javierramirezbenavides@gmail.com
jaramirez@ivic.gob.ve

"The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable man." -George Bernard Shaw.

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