DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

COURSE OF MEASUREMENT ARCHITECTURES FOR CYBER-PHYSICAL SYSTEMS

MASTER DEGREE IN CONTROL SYSTEM ENGINEERING

MINI-PROJECTS

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OVERVIEW

The presentation is structured as a comparison between three different mini-projects in order to describe the main differences and give, at the same time, a brief but clear description of all the projects.

Projects :

A very simple real-time game

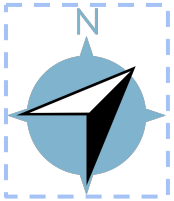
Measuring distances with a ultra sound sensor

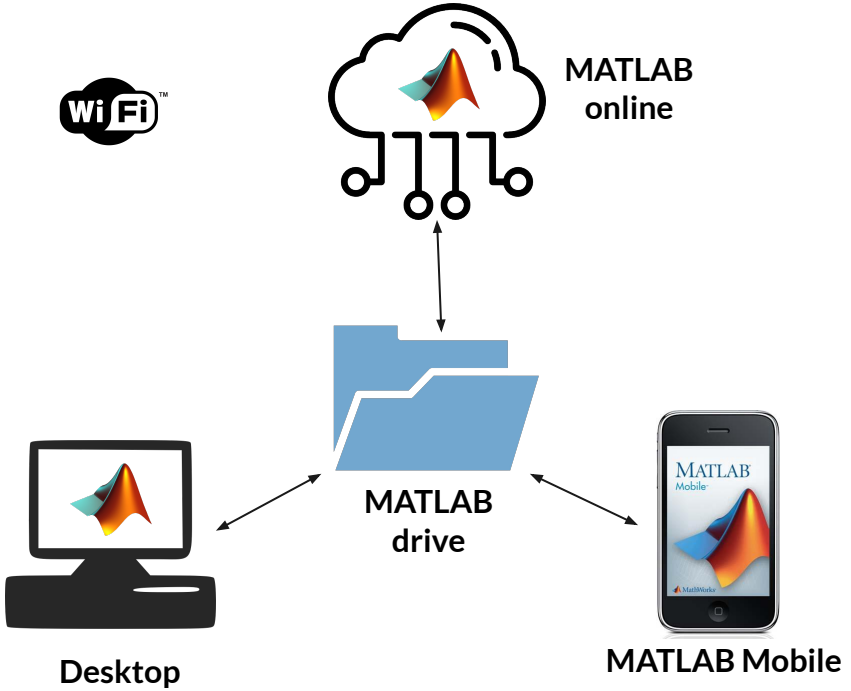
Electronic compass

SUMMARY

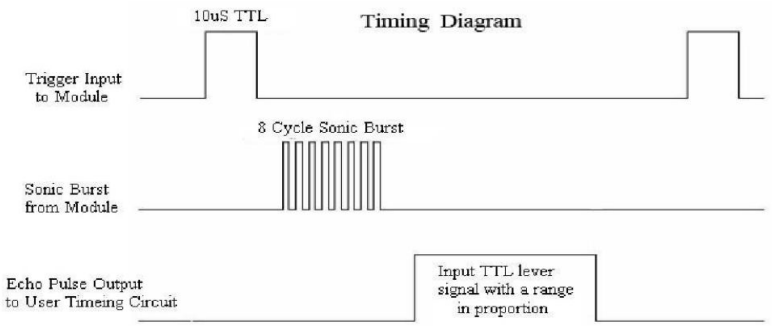
- ➔ Hardware set-up
- ➔ Flow charts
- ➔ Results
- ➔ Problems and improvements

HARDWARE SET-UP



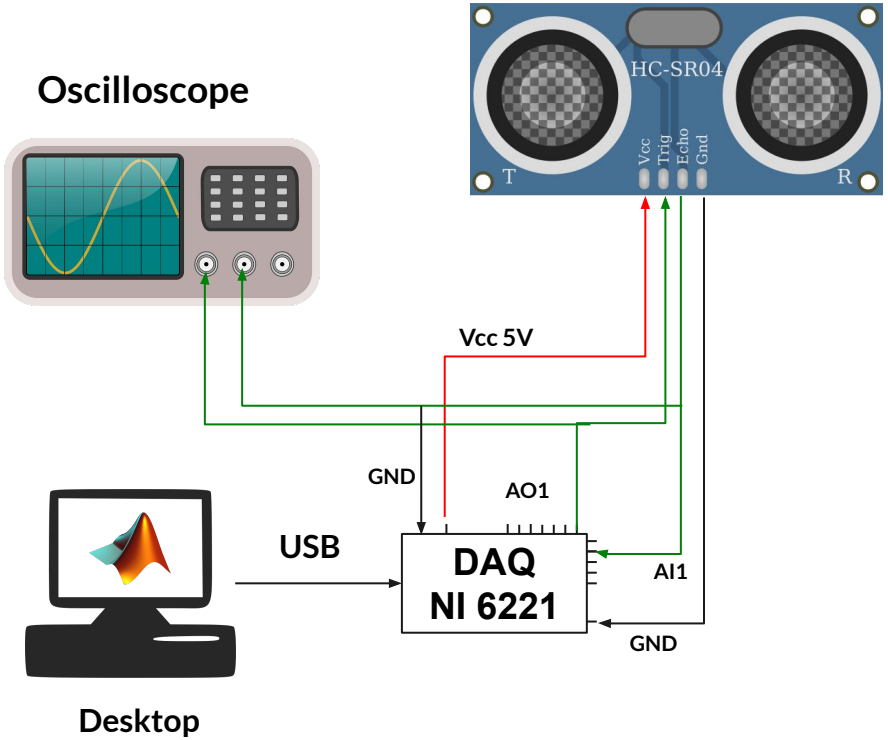


HARDWARE SET-UP



HS-SR04

Oscilloscope

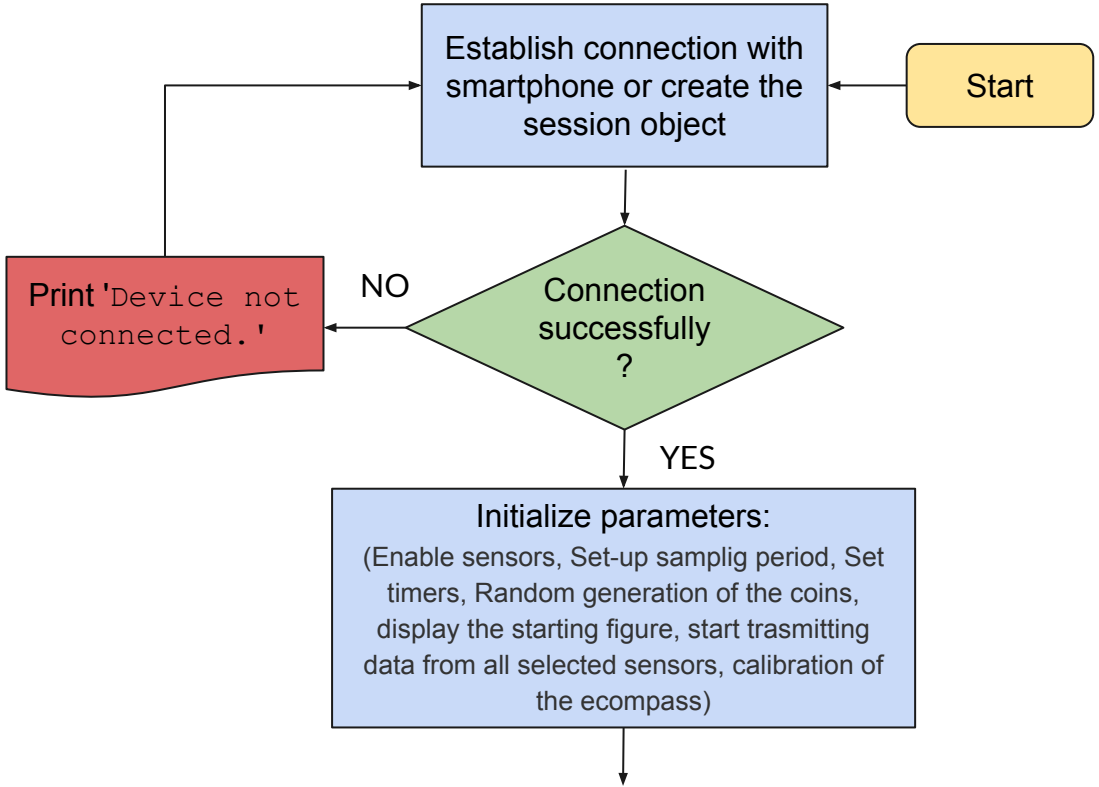


FLOW CHARTS

Establish connection

&

Initialization



FLOW CHARTS

```
session.NotifyWhenScansQueuedBelow = 100000;
session.NotifyWhenDataAvailableExceeds = 119999;
signal = [zeros(1,118998) 10*ones(1,2)
zeros(1,1000)];
```

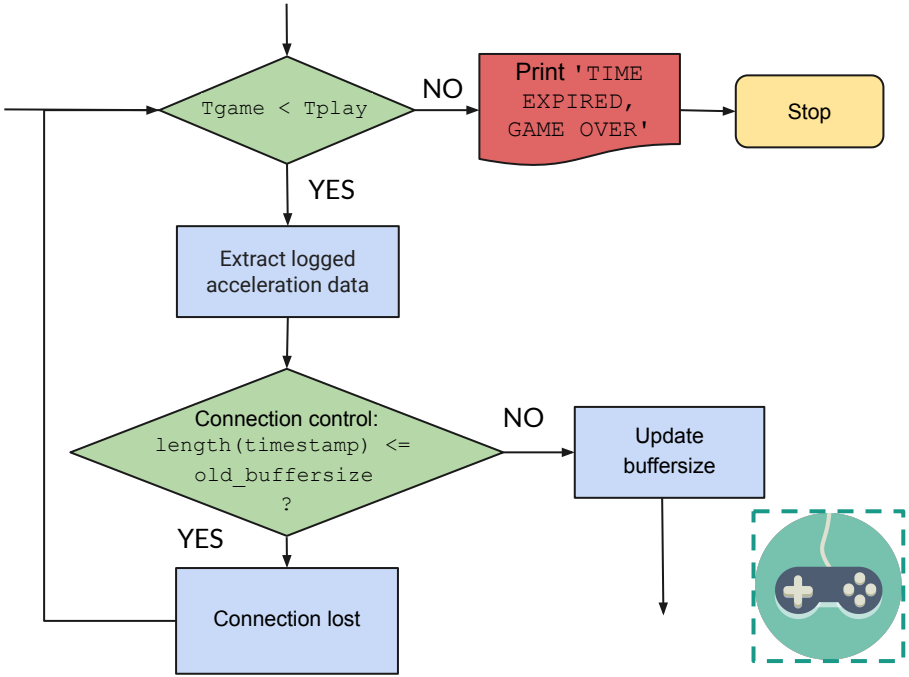
Initialization parameters:

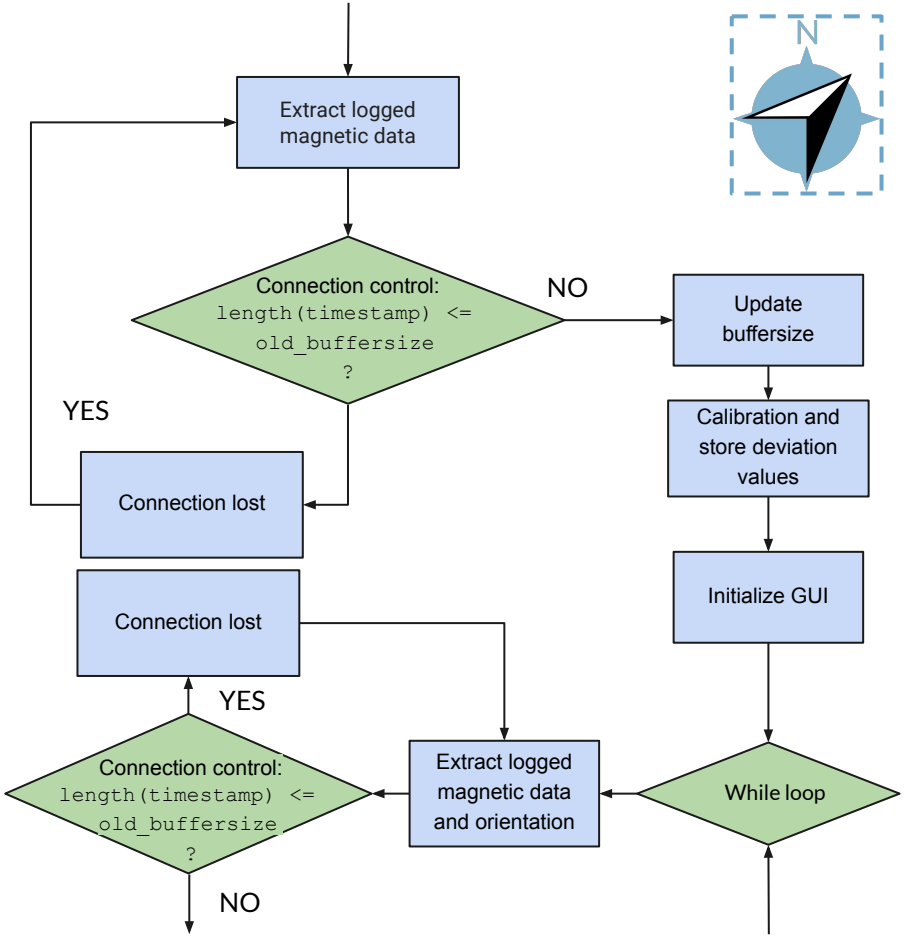
- ➔ Enable accelerometer
- ➔ **Set sampling rate = 10 [Scan/s]**
- ➔ Random generation of the coins
- ➔ Initialize figure with coins
- ➔ Set thresholds
- ➔ Begin transmitting data from selected sensors
- ➔ Start timer

- ➔ Create a session with DAQ
- ➔ **Set sampling period = 200000 [Scan/s]** (one scan every 5 μs)
- ➔ Set continuous acquisition mode
- ➔ Set trigger and echo channel
- ➔ Add two listener
- ➔ **Set threshold for generation of the trigger and acquisition**
- ➔ Define Callback functions

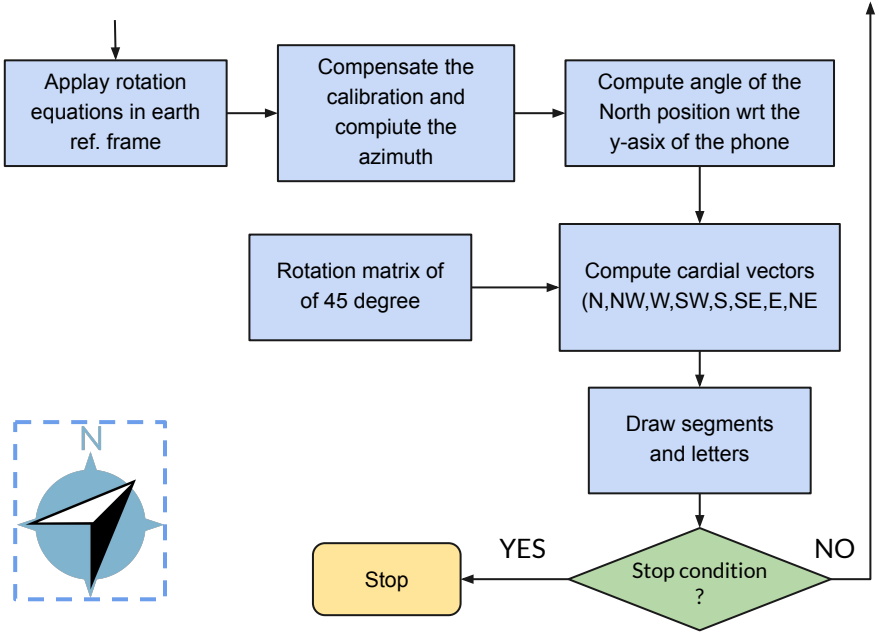
- ➔ Enable magnetic sensor and orientation sensor
- ➔ **Set sampling rate = 10 [Scan/s]**
- ➔ Begin transmitting data from selected sensors
- ➔ **Calibrate the ecompass**
- ➔ Store deviations

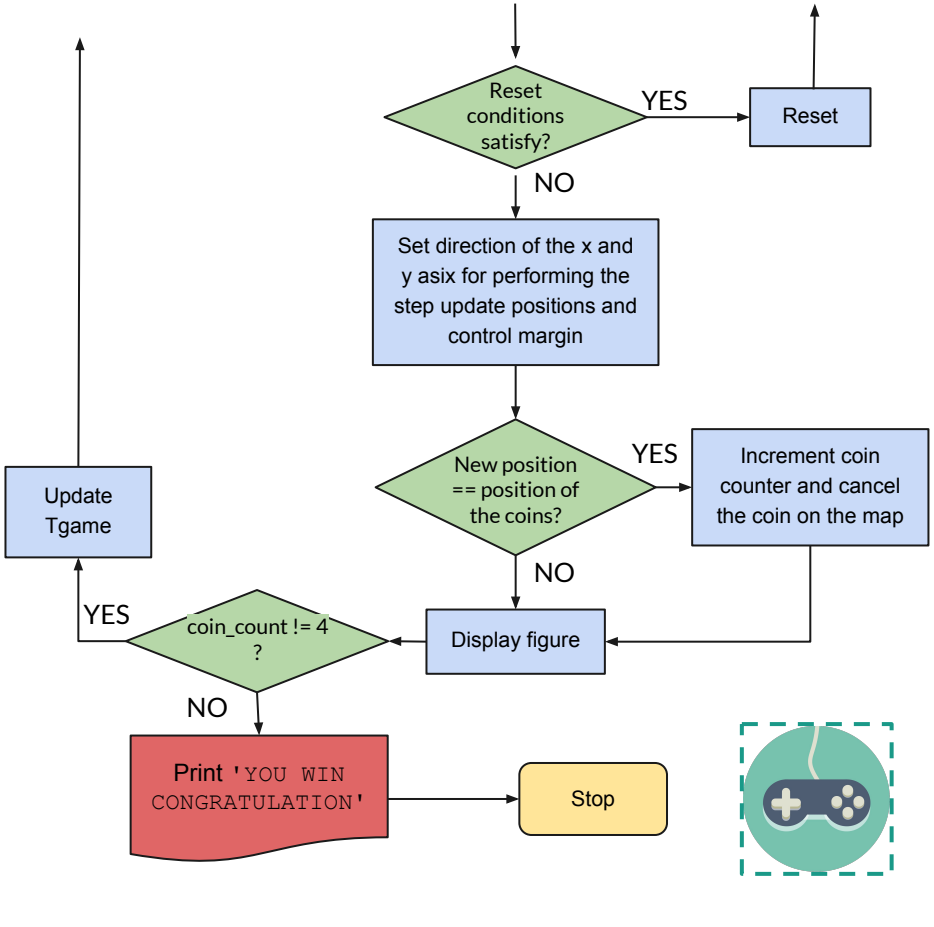
FLOW CHARTS - Real-Time system





FLOW CHARTS - Process





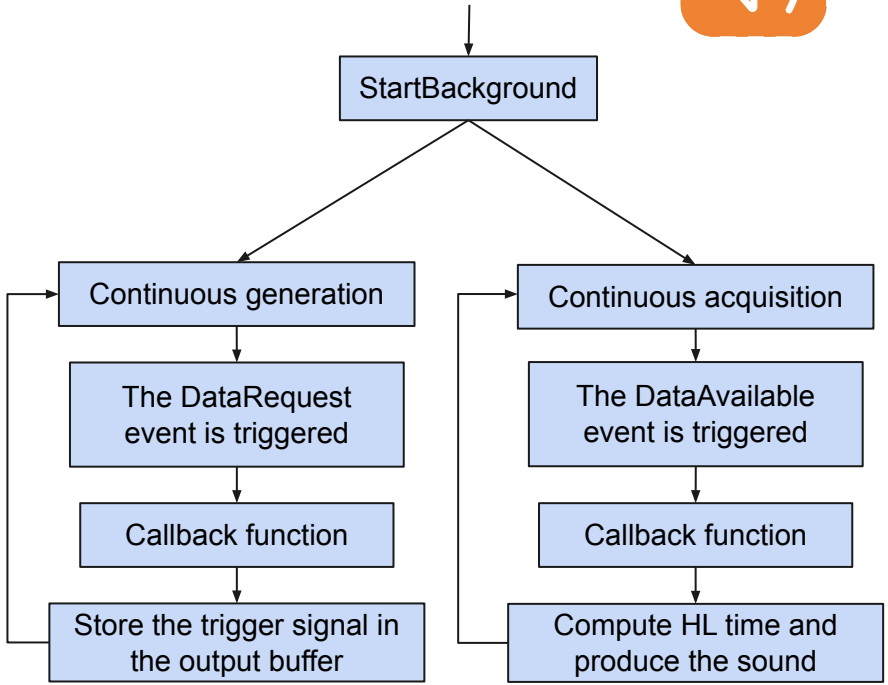
FLOW CHARTS

StartBackground: starts the operation of the session object, without blocking the MATLAB command line and other code.

The DataAvailable event is triggered if the number of samples stored in the circular buffer exceeds the number imposed in "NotifyWhenDataAvailableExceeds".

The DataRequired event is fired when you need to queue more data. This parameters can be impose by setting the “NotifyWhenScansQueuedBelow” parameter. (big enough for permits to queue the new signal)

```
session.NotifyWhenScansQueuedBelow = 100000;
session.NotifyWhenDataAvailableExceeds =
11999;
```



RESULTS

Real-time game:

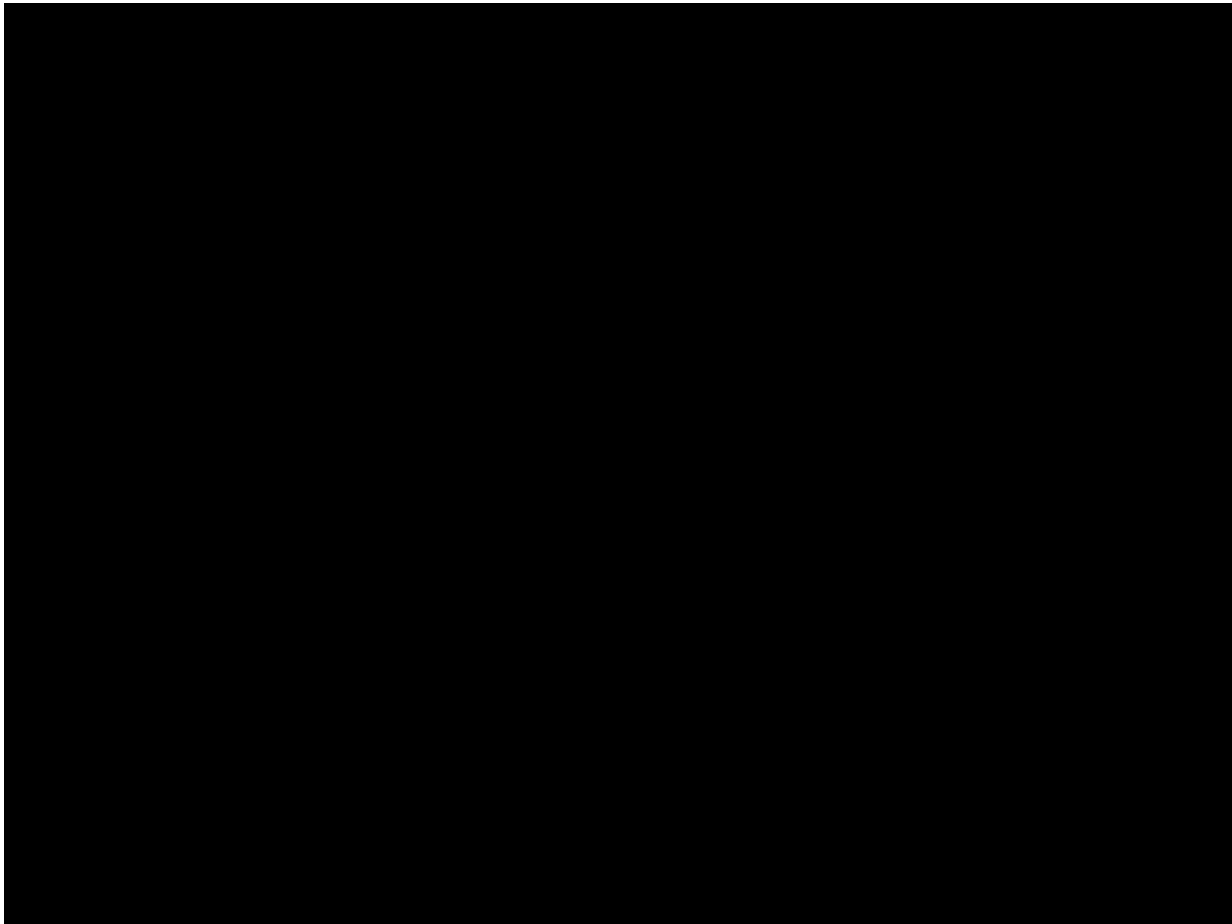
- Sampling time = 10 [Scan/s]
- Tcycle is about 1 s

Measuring distances:

- Sampling time = 200000 [Scan/s]
- $\Delta T = f_S * N.W.D.A.E = 0.6\ s > \Delta T_{ELAB}$ (Callback called almost 2 times for second)

Electronic compass:

- Sampling time = 10 [Scan/s]
- Tcycle is about 0.4 s



PROBLEMS AND IMPROVEMENTS

Problems:
- Need a faster response
- Not perfectly reliable connection

Improvements:
- Speed in communication
- Implement a step incremental speed

Problems:
- Not possible to implement a finite acquisition (time for full the buffer is not enough)
- 20x sec times problem for callback call
- High level phase of the echo signal not always in the same position

Improvements:
- Tuning of the parameters

Problems:
- Not perfectly accurate (1-5° inaccuracy)
- Not perfectly reliable connection
- Small delay in displaying the GUI

Improvements:
- Speed in communication