Daniele Gatti
Tutor: Prof. Arpaia Pasquale

XXXII Cycle - I year presentation

Low-cost transducer networks for real-time movement tracking and modelling in life-size immersive serious games

Università degli Studi di Napoli
Federico II

Outline

- ✓ My Background
- ✓ Fellowship
- ✓ Problem
- ✓ Proposal
- ✓ Orientation estimation
- ✓ Products
- ✓ Next Year

My background

- I received the MSc degree in Electronic Engineering (cum laude) from University of Naples, “Federico II”.

- I work within “Electrical and Electronic Measurements” DIETI Group (building 3/A, 1st floor)

Fellowship

My fellowship is financed by European Social Fund (ESF).

Partners

SpinVector

Instrumentation & Measurement for Particle Accelerator Lab

IMPALA

life.augmented

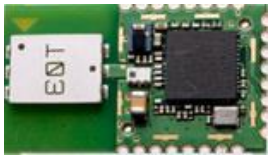
Which is the problem?

The research concerns the use of low-cost transducers based on microcontrollers to define the motion of humans or objects in an immersive environment of augmented reality for serious games.

State of the art

The common technologies in indoor localization are:

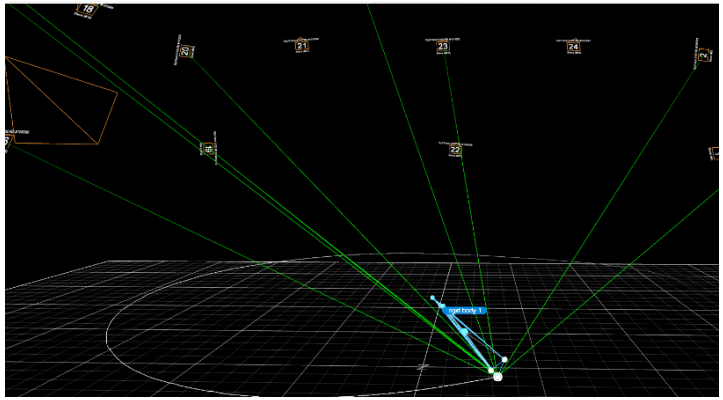
- Radio frequency
- Camera-based solution
- Infrared
- Ultrasonic



High performance solution

Optitrack 6DOF real time IR tracking system.

1. ± 1 cm uncertainty.
2. 1 kHz bandwidth.
3. 5 user localization
4. **High-cost $ 15000 ***



* 5 Ø × 2 meters, ≈ 4 users

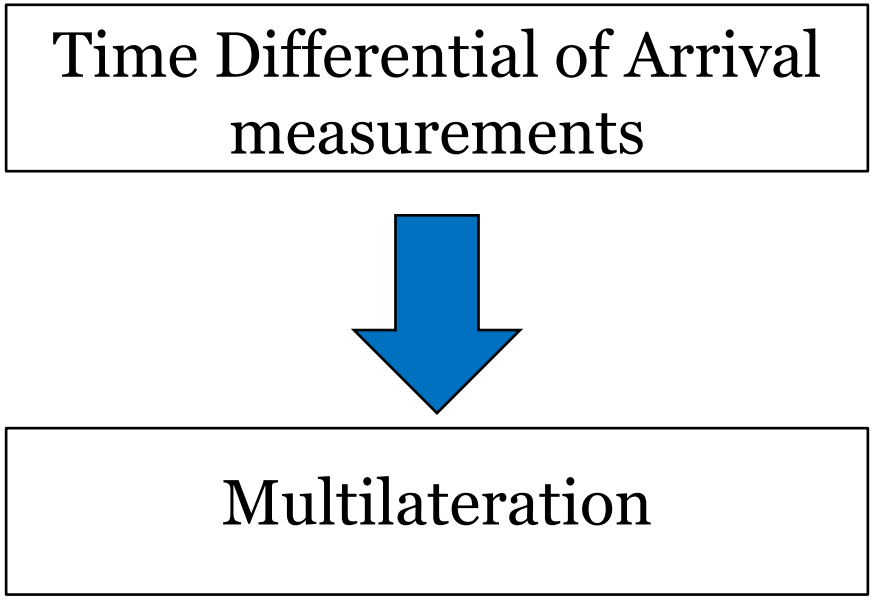
Solution

Ultrasonic systems are an attractive solution in low-cost indoor applications, owing to their low power consumption, the availability of low-cost transceivers, and their work bandwidth, allowing cheap hardware and simple processing.

For this reasons, the ultrasonic technology is considered as a convenient solution for a low-cost accurate indoor positioning.

Solution

The localization problem is faced through two main steps: a Beacon-Target distance measurement and a localization algorithm.

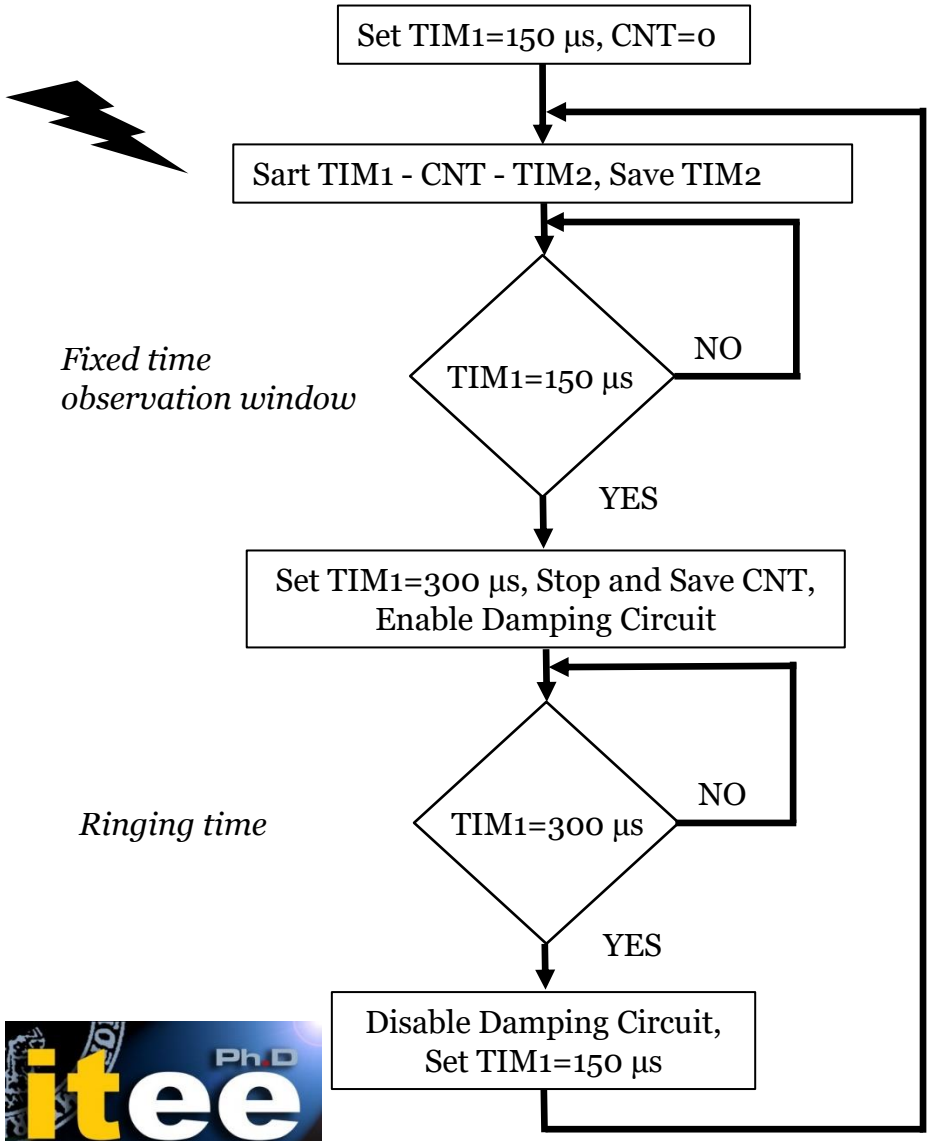


Proposal

Recognize different beacons by comparing the received signal with a threshold: when the signal is greater than the threshold, a counter is incremented. If the signal is observed in a fixed time window, the counter value (NTH) depends only on the time shape of the received signal in **transient phase**.

The beacons node are driven by a sinusoidal signal; thereby, if different signal frequencies are emitted by the beacons, the NTH counted at the receiving node is different.

Proposal



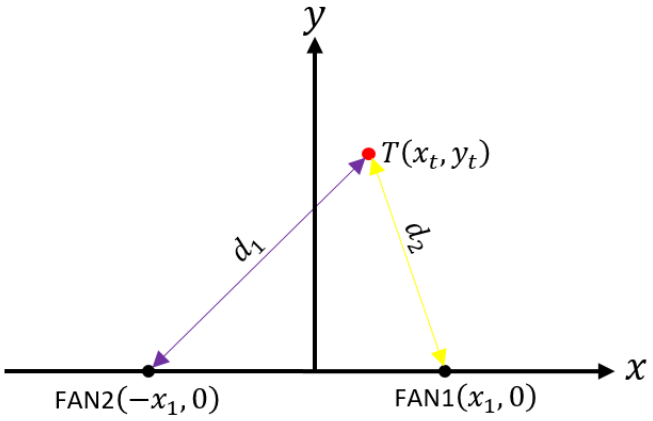
Beacons

Target

Daniele Gatti

Results

The prototype is tested in an area of 1.8 m x 2.0 m for four target different positions. Two synchronized emitting beacon nodes are positioned at the coordinate x1 = 0.5 m. The x RMS error is 1.90 cm, the y RMS error is 5.59 cm, the maximum of the error standard deviation is 0.4 cm.

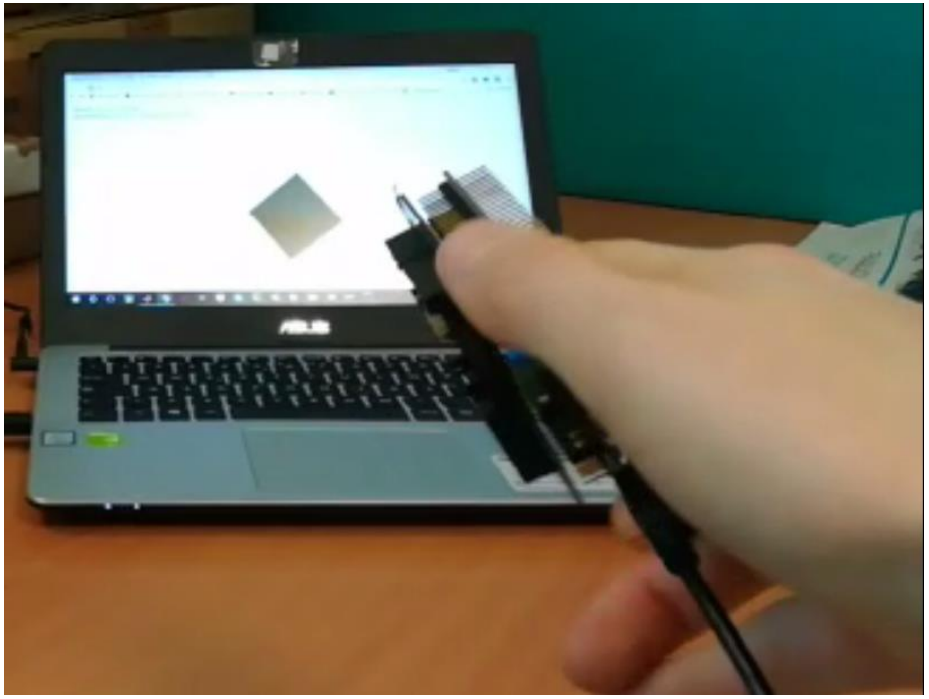


d_1 [m]	d_2 [m]	$\bar{x}_{error}$ [cm]	$\bar{y}_{error}$ [cm]	$\sigma\bar{x}_{error}$ [cm]	$\sigma\bar{y}_{error}$ [cm]
2.22	1.82	2.80	-6.9	0.05	0.1
2.28	2.00	-2.3	7.9	0.1	0.4
2.00	1.64	-0.78	2.1	0.06	0.2
2.23	2.00	-0.80	3.4	0.09	0.4

Orientation estimation

In STMicroelectrnics I implemented an 9DOF attitude and heading reference system using Madgwick filter on NUCLEO STM32F401RE microcontroller and ISK01A sensor platform.

life.augmented



Products

Conference Paper

- Leopoldo Angrisani, Pasquale Arpaia, and Daniele Gatti. "Analysis of localization technologies for indoor environment." IEEE International Workshop on Measurement and Networking (M&N), 2017.

- Leopoldo Angrisani, Pasquale Arpaia, and Daniele Gatti. "Fast beacon recognition for accurate ultrasonic indoor positioning." IEEE International Workshop on Measurement and Networking (M&N), 2017.

Next years…

Research activity

1. Using augmented reality in harsh enviroments for human-robots cooperation at CERN.
2. Modeling of the motion and the synthesis of virtual agents to improve the human interaction in serious game.

Summary of credits

Student: Daniele Gatti	Tutor: Pasquale Arpaia	Cycle XXXII
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	Credits year 1								Credits year 2								Credits year 3									
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Total	Check
Modules	18			9	3		9	21	15							0								0	21	30-70
Seminars	13	1	7			0	0.6	8.6	5							0								0	8.6	10-30
Research	34	4.5	4.5	5.4	6.5	5.5	4	30	40							0								0	30	80-140
	65	5.5	12	14	9.5	5.5	14	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	180

Thanks for your attention!!!