

RFID based People-Object Interaction Detection

Author: Raúl Parada Medina

Ph.D advisors: Rafael Pous Andrés and Joan Melià Seguí

5th July, 2016

SIGNET group. Department of Information Engineering



**Universitat
Pompeu Fabra**
Barcelona

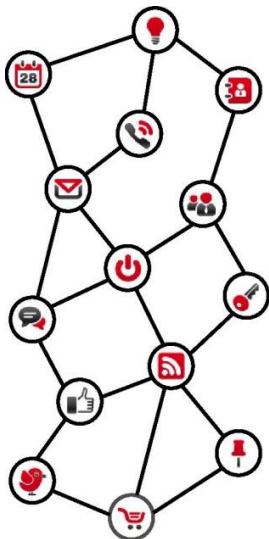
Department
of Information and Communication
Technologies



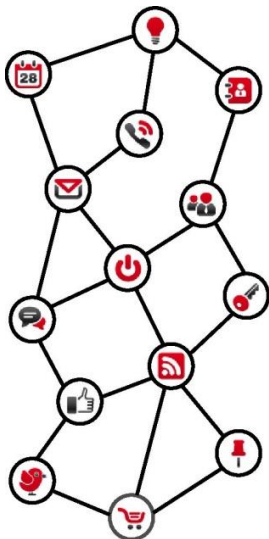
**UNIVERSITÀ
DEGLI STUDI
DI PADOVA**

Motivation

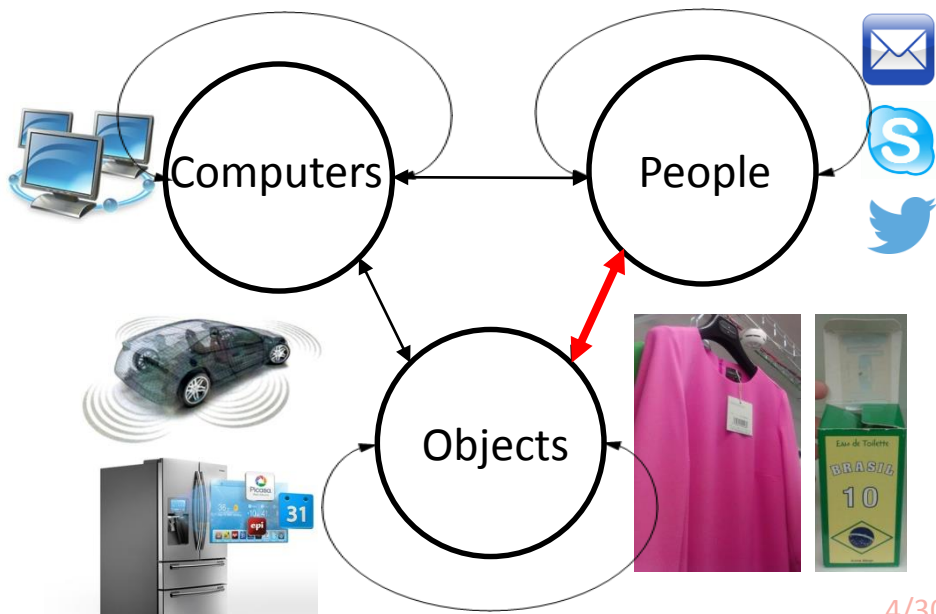




- Introduction
- Special Hardware
- People-Object Interaction



- Introduction
- Special Hardware
- People-Object Interaction



The development of systems to detect the **interactions** between **people** and **simple objects** using **RFID technology**.



In a smart shelf

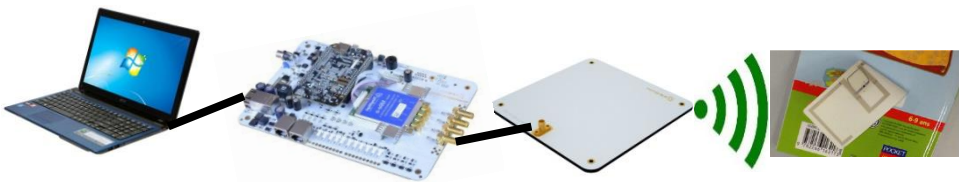


At the entrance



From the ceiling

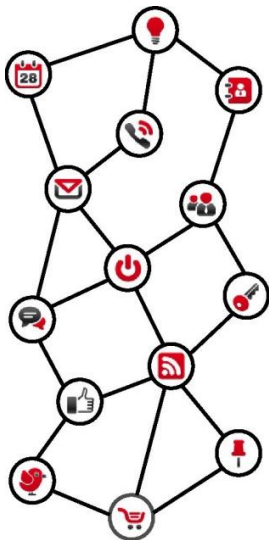
Radio-Frequency Identification (RFID)



Frequency band: ETSI (865-868 MHz) FCC (902-923 MHz)

- Semantic indicators
 - Identification code (96-bit typically)
 - Antenna port
 - Timestamp
- Additional indicators
 - Received signal strength indicator (RSSI)
 - Radio frequency phase (PHASE)
 - Read count

Index



- Introduction
- **Special Hardware**
- People-Object Interaction



Helix antenna



Monopulse system



Phased array system

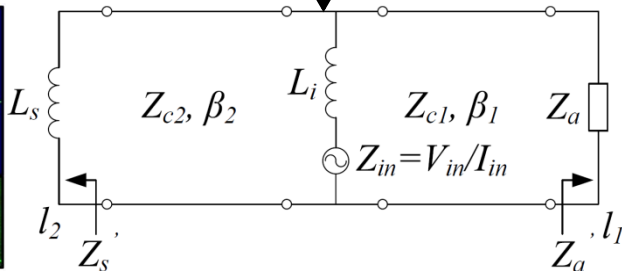
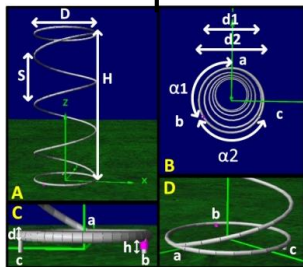
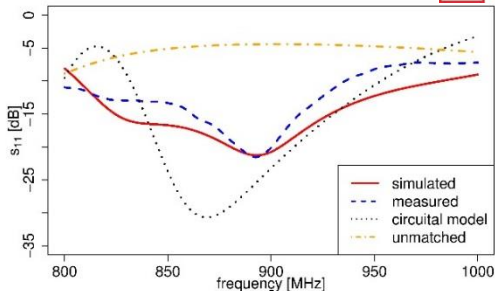
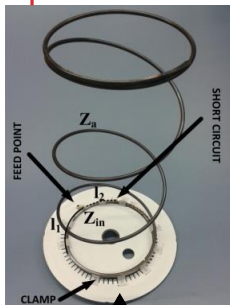


Smart shelf

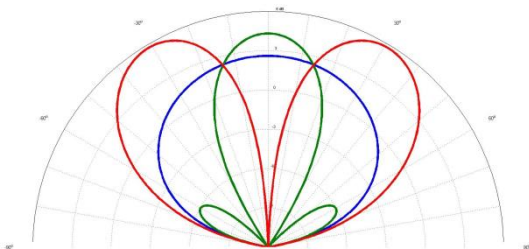
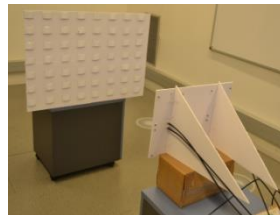
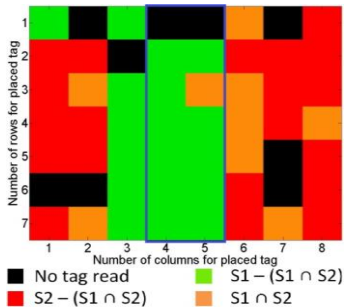
☐ Our contributions

☐ Others' contributions 8/30

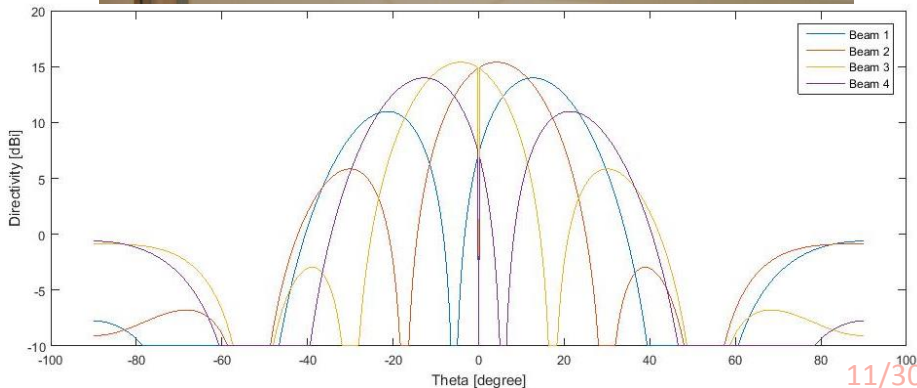
Special hardware – Helix antenna



Special Hardware – Monopulse system

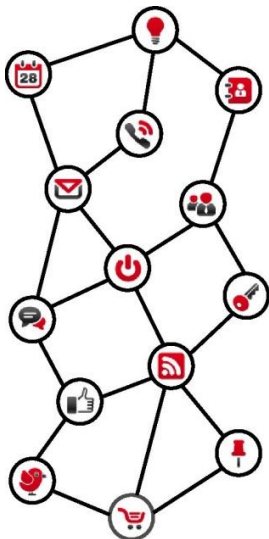


Special hardware – Phased array system



Special hardware – Smart shelf



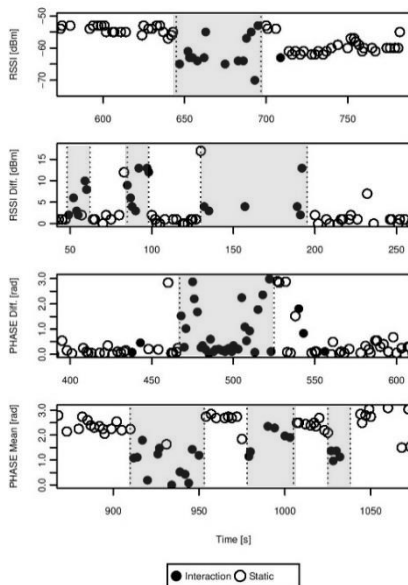


- Introduction
- Special Hardware
- **People-Object Interaction**

Interaction in a smart shelf



Interaction in a smart shelf

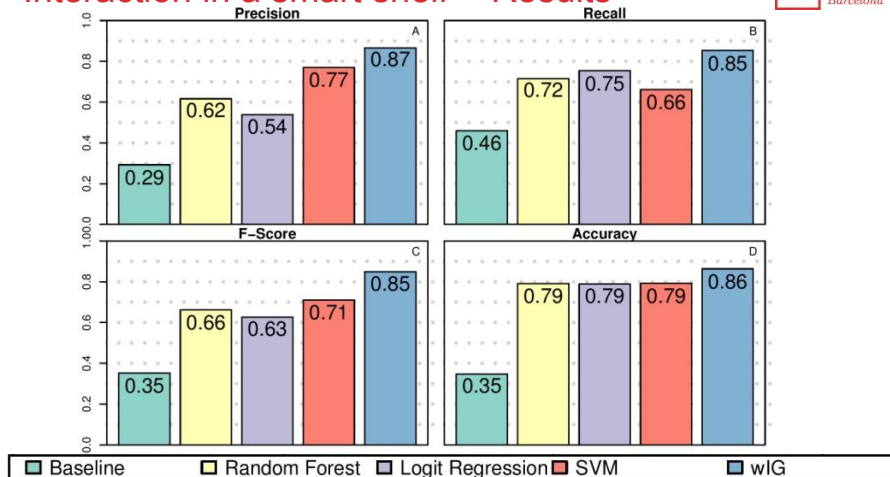


- Two type events are specified: **static** and **interaction**

- Features' values remain constant when the tag is static

- Otherwise, during an interaction event the features' values vary

Interaction in a smart shelf - Results

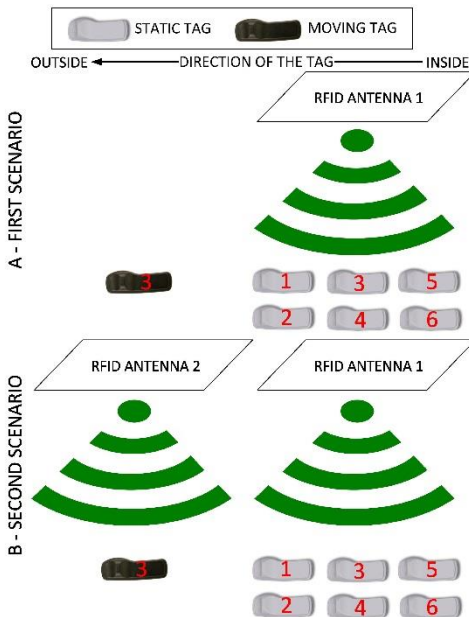


F-Score metric of wLG higher (85%) than standard Machine learning algorithms Support Vector Machine (71%), Random Forest (66%), Logistic Regression (63%) and Baseline (35%).

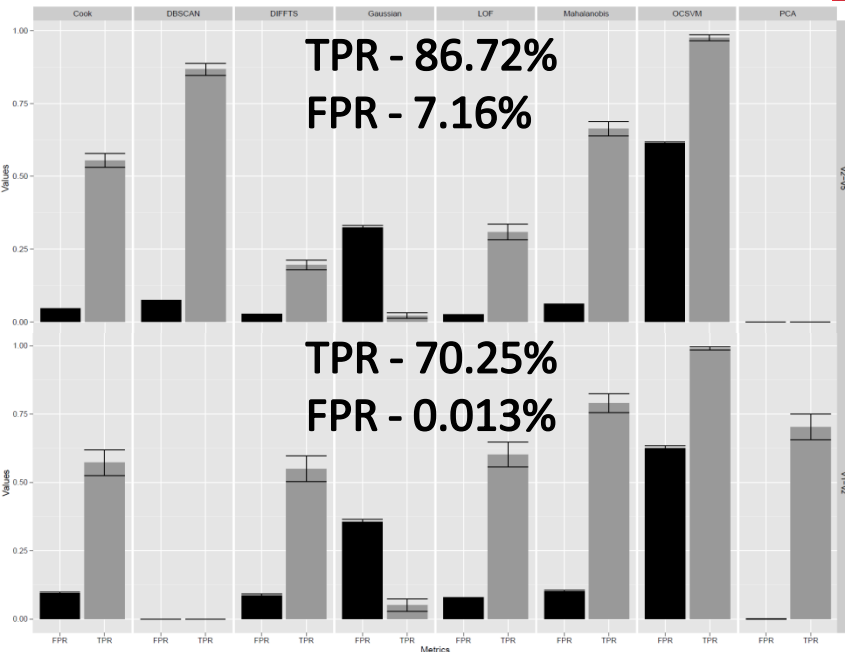
Interaction at the entrance (Outliers)



Interaction at the entrance – Our proposal



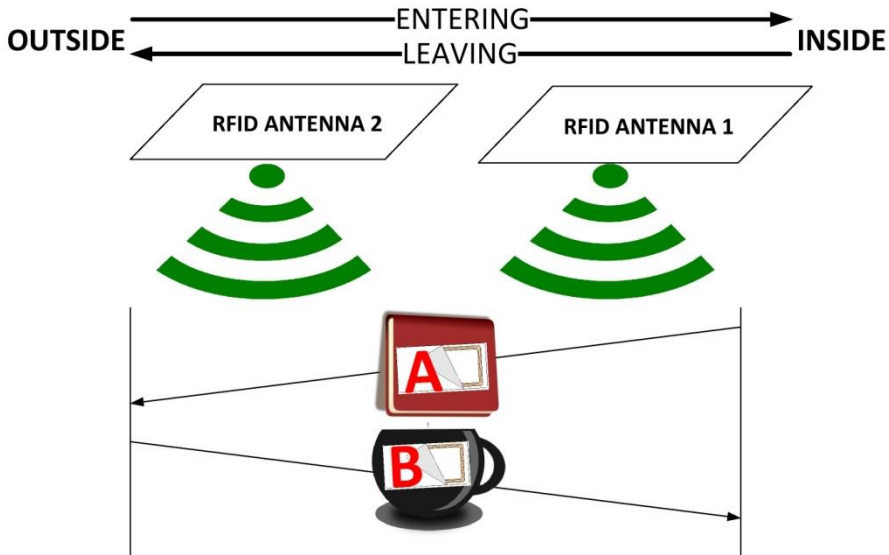
Interaction at the entrance – Results



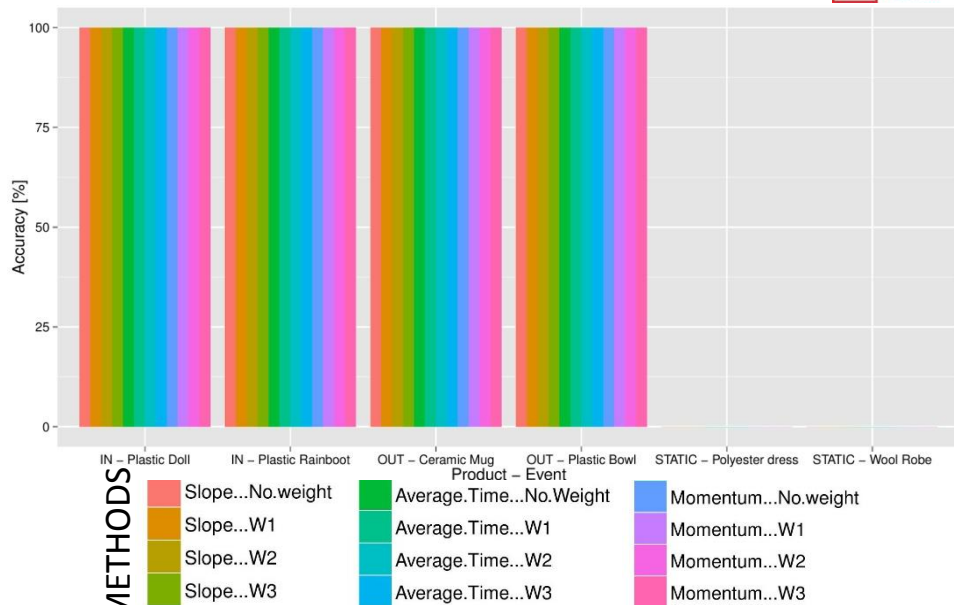
Interaction at the entrance (Direction of pass)



Interaction at the entrance – Our proposal

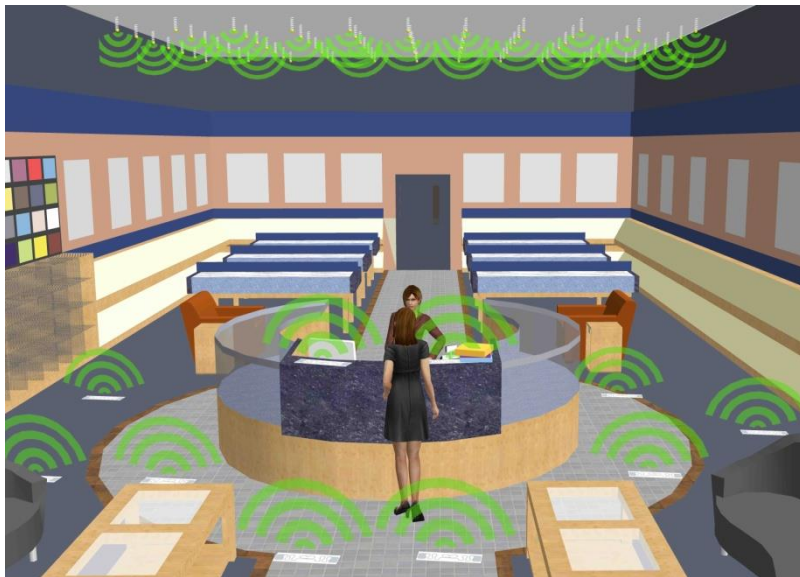


Interaction at the entrance – Results



100% accuracy detection and no false alarms.

Interaction from the ceiling

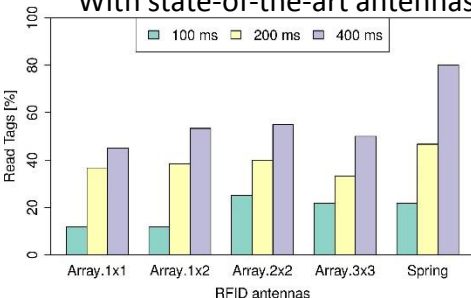


Interaction from the ceiling – Clothing store



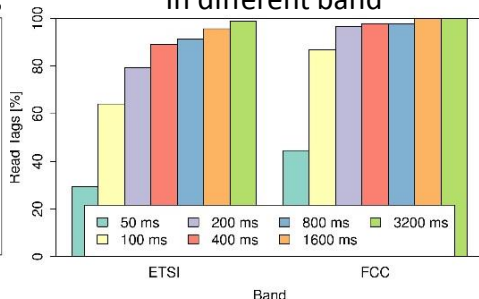
Comparing our spring-based helical antenna:

With state-of-the-art antennas



Where our spring-based helical antenna performs better.

In different band



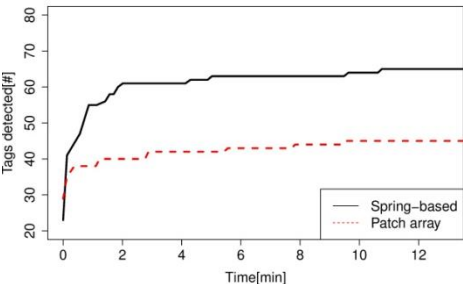
Achieved 99 and 100% accuracy in both ETSI and FCC band.



- Antenna held at 4 meters from the floor
- Distance antenna-tag over 2 meters
- Space where customers seek products

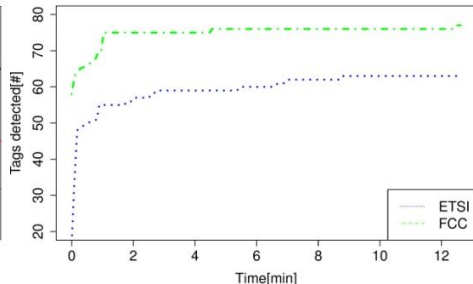
Comparing our spring-based helical antenna:

With an state-of-the-art antenna



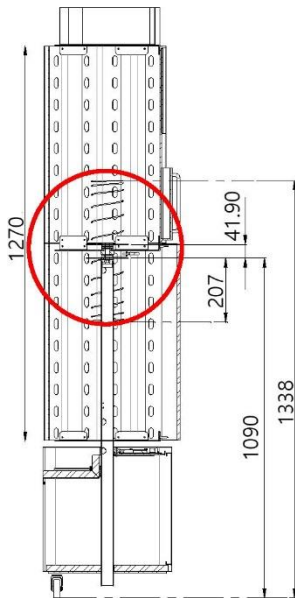
Our spring-based helical antenna performs better.

In different band



In the FCC band our approach returns better inventory accuracy.

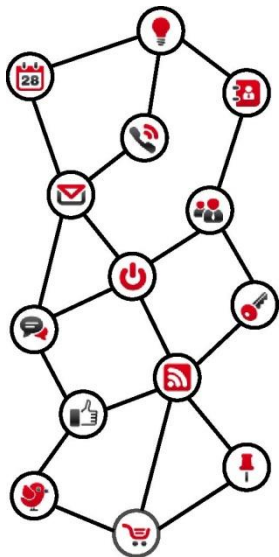
Interaction from the ceiling – Sunglasses Rack



Tag Type	Tags for each test	Avg. Tags detected	Avg % detection
High-Kick (G2iL)	36	35.9	99.72
Smartrac MiniWeb (G2iL)	36	35.8	99.44
Checkpoint Vortex (UCODE-7)	36	36	100

Achieved a 100% accuracy.

RFID based People-Object Interaction Detection



Raúl Parada Medina
rparada@dei.unipd.it
www.rparada.com
SIGNET