

ElectroCap Project Proposal

Automatic inventory checking

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TÉCNICO LISBOA

1. Advisors and Mentor

- Scientific Advisor: Prof. Luís M. Correia;
- Coordinator: Prof. Luís M. Correia;
- Co-coordinator: Prof. João Felício

2. Problem definition

Nowadays, people who use mobile inventories (such as plumbers or electricians) face the problem of equipment loss. Many of these workers carry items on their vans and have little way of knowing if, where and when they get lost. As such, we propose a device to be placed inside these vehicles, which would check whether all predefined objects of interest are present inside the vehicle.

3. Solution beneficiaries

Ultimately, this solution can be beneficial to all jobs that require the transportation of equipment between places, like shipping companies or storage facilities. More specifically, we think this will benefit professionals such as: vets, musicians, service installers and maintenance technicians.

4. Technological solution (I)

Technologies:

- UHF RAIN RFID
- Bluetooth

4. Technological solution (II)

Imagine the following situation:

- A plumber carries their tools around as they go from place to place.
- By placing a tag (RFID) on each of their tools, and adding them to a virtual inventory, when placing the items in the van, they will be recognized by a reader previously installed in the vehicle, allowing the user to know if all the tools in the inventory are present.



4. Technological solution (III)

Item to use	Price
THINGMAGIC EL6e(PLT-RFID-ANT-EL6E-EU , includes an antenna and sample tags)	281,84€
Raspberry Pi 3 Model B	31,99€
Other possible cables and resistors	5€
TOTAL	322,46€

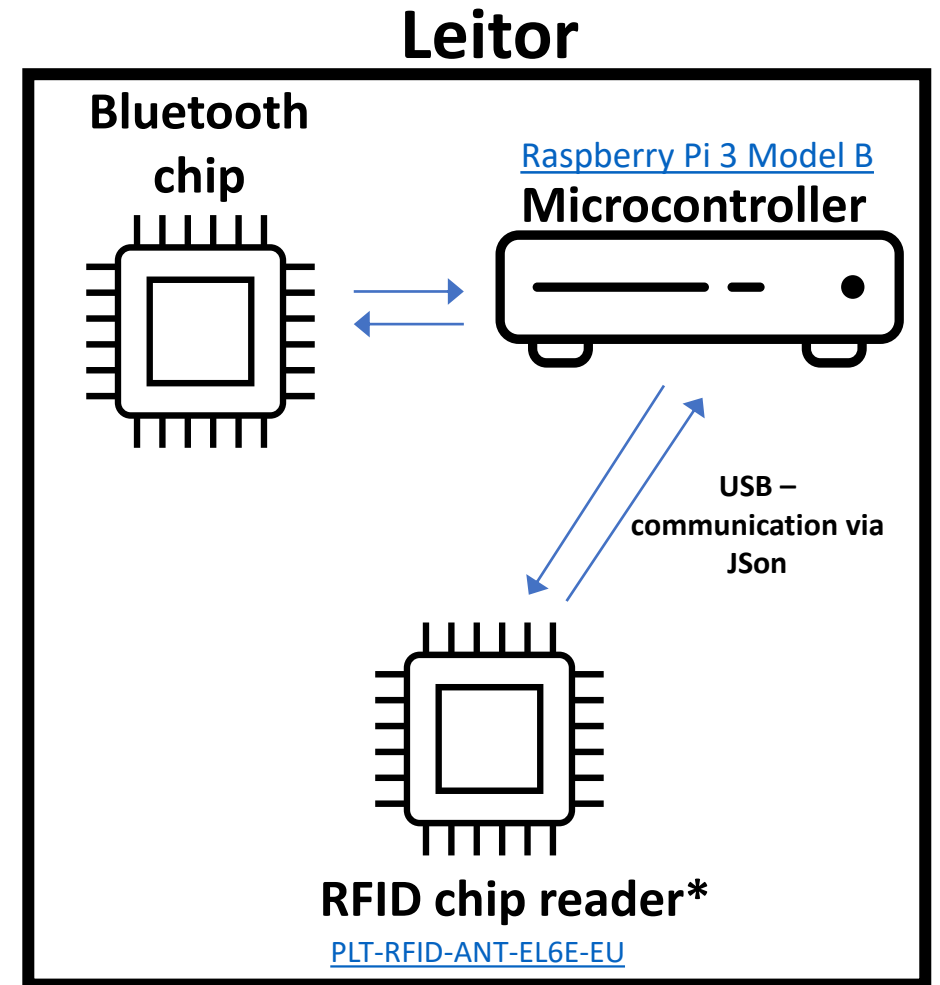
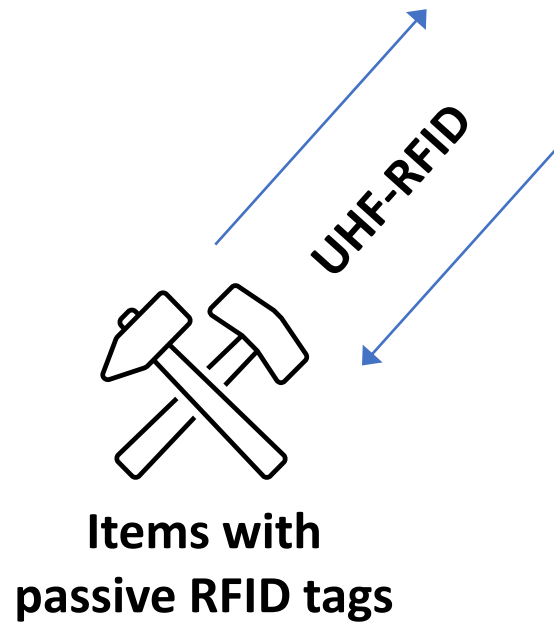
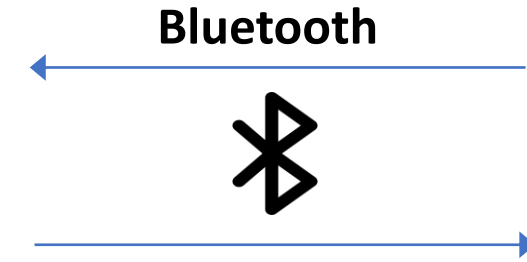
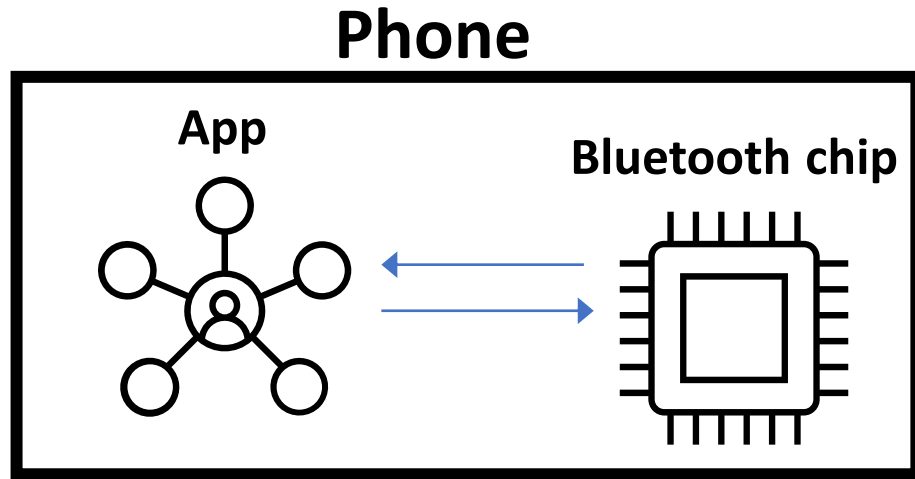
4. Technological solution (IV)

Our solution consists of using passive UHF RFID technology to establish communication between the tags (that are attached to the items) and the reader. This reader (a microcontroller with a Bluetooth [1] connected through SPI to a RFID reader module [2]) will emit an omnidirectional signal in a medium range (up to 2 meters) and communicate with a smartphone via Bluetooth, to allow the verification of all items. When the signal hits a tag, the tag “responds”, allowing the item to be detected. The resulting information would be saved in an app, where the user could associate tags to specific named items, as well as check and identify the missing items in real-time.

[1] - [Raspberry Pi 3 Model B](#)

[2] - [PLT-RFID-ANT-EL6E-EU](#)

4. Technological solution (V)



*Antenna is embedded in the reader

5. Competitors and previous work (I)

- Most implementations use fixed sensors, and the main technologies already used are:
 - **Short- and Long-Range RFID:** short range RFID is used in applications such as card readers, and long-range RFID is used in warehouses, but for fixed spaces and without any inventory or management apps associated;
 - **BLE-based solutions:** With BLE beacon devices, no scanning of the individual inventory items or assets is required. However, a battery is required in each device;
 - **[SmartVan](#):** an "app-based solution for van stock inventory management", based on NFC and BLE Technology. Using active tags and a handheld sensor it is possible to add items using NFC and BLE for tracking;

6. Solution requirements (I)

Our goal is to make a cheap (no batteries) and practical (no manual checking of each item) solution, by using a single reader placed inside the van and an included app that allows for easy introduction/removal of certain items. These are our main objectives in building this product, thus the usage of passive tags and wireless technologies at a distance.

As such, we impose ourselves the following requirements for this project:

- Reliable reading of tags in a 4-meter radius of the reader;
- Reliable reading of at least 100 tags concurrently;
- Reliable reading of tags behind different objects.

6. Solution requirements (II)

Existing solutions/products:

- [SmartVan](#)
- [Sortly](#)
- [Mobile Inventory Software For HVAC And Plumbing Contractors](#)
- [Zetes - RFID in Supply Chain](#)

7. Technical challenges

The main hurdle in our planning is how to integrate RFID technology. To allow for a large range of detection (i.e., larger than 1 meter), of tags placed in the objects, Ultra High Frequency RFID is needed[3], which requires more power, an increased risk of interference with our types of radio communications and a higher cost. Along with this, we need to implement a communication protocol between the reader and the smartphone. There are other challenges, like the functionalities related with live usage, such as allowing for multiple users to check the inventory at the same time.

[3] [What is the read range for a typical RFID tag?, RFID Journal](#)

8. Partners

Currently we have established a partnership with the artistic space [Lisboa Incomum](#), where we are going to conduct our later tests using a medium sized van. Due to the variety of equipment used (from electronic equipments, to cables, to metal tools, etc...), we find this to be an optimal place for testing. We are also going to use this opportunity to ask for different kinds of input and suggestions to improve the product, not just from this institution but also from other possible users.

9. Testing and validation metrics

Our first step will be to test our equipment's operating range inside a van. At the same time, we will test the rate of successful tag detections, the reader's detection speed, the real usage range (between the reader and the tags), if tags placed on all kinds of items (metallic, wood, etc...) work, the reader's optimum placement and direction inside the van, and if there is any kind of interference while using the items.

In addition, we will ensure that our app is easy to use and that the reader and tags are well integrated.

10. Division of labor (I)

Francisco	Filipe	Duarte
Electronics + Coordination	UI + Website	Backend + Logic
Electronic Components Research	Project Presentation Page	BLE Interface
Testing the RFID communication in Windows	Blog and Weekly Update Report	Item List Editing in App
Task Management	Website	Real-time Inventory Display
Electronics Assembling	App Design Concept	Tag-Item Association in App
Change of protocol from Windows to Raspberry Pi (via commands Json)	App UI	App Performance Optimization
	Project Poster	Device-to-Phone Connection (Software Side)
	Demo Video	

10. Division of labor (II)

António	André	Miguel
Backend + Logic	UI + Website	Electronics
Item List Verification	Project Presentation Page	Electronic Components Research
App Navigation	Blog and Weekly Update Report	Bluetooth Protocol Integration
Accounts and Authentication	Website	Device-to-Phone Connection
App Performance Optimization	App Design Concept	Schematics and Prototype Design
Device-to-Phone Connection (Software Side)	App UI	Final Prototype Design
	Project Poster	
	Demo Video	

