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Abstract

This is the abstract blablabla...
Keywords: Ultrawide Band, ...

Acknowledgements

I thank ...

Contents

Chapter 1

Introduction

Blablabla... [4]

Chapter 2

State of the art

This sections has the purpose to explain the state of the art.

2.1 Ultra-Wideband Technology

Ultra-Wideand (UWB) is a communication technology using, as the name states, a large bandwidth. This is not a new technology as it is the one used by Guglielmo Marconi for the first transatlantic communication using radio waves [5]. As define by the International Telecommunication Union Radiocommunication Sector (ITU-R) to be considered as UWB, the bandwidth of communication must be at least 20 % of the arithmetic center frequency [6].

One interesting feature of UWB is the possible coexistence with other radio waves already present in the environment such as Wireless Fidelity (Wi-Fi). As it can be seen on Fig. 2.1, the extension of the UWB in the spectral domain is quite huge.

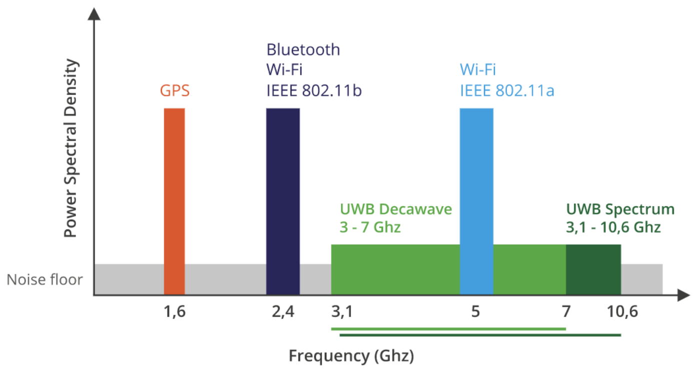

Figure 2.1: UWB spectrum compared to Wi-Fi and other wireless technology. Taken from [6]

Knowing this and based on the time-frequency duality reminded in eq. 2.1, one can see that the extension in the time domain will be quite small.

$$x(at) \longleftrightarrow \frac{1}{|a|} * X(\frac{f}{a}) \tag{2.1}$$

HERE - ADD THE IMAGE FOR TIME EXTENSION OF UWB

The Fig. 2.2 shows the theoretical duration of an impulse of the UWB.

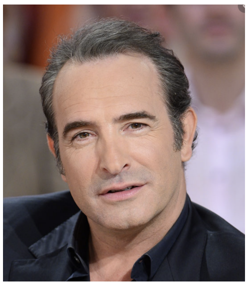

Figure 2.2: Theoritical duration of an UWB pulse

An advantage of the UWB is its robustness in regard of the Multipath Channels (MPC). This can be understood by looking at Fig. 2.3, where several peaks can be distinguished, each corresponding either to a different path travelled by the wave. Indeed, the probability to have a collision depends on the size of the pulse sent. From this, the interest of the UWB in confined area appears as a lot of MPC are present due to the reflections to all the wall of a room.

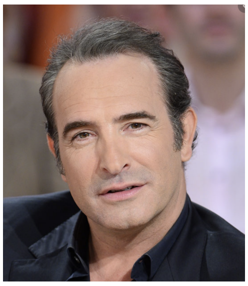

Figure 2.3: Example of an MPC

2.2 Real Time Locating Systems

Real-time locating systems (RTLS) are systems used to track and identify the location of objects in real time. This is a rather vague definition since nothing is specified concerning the means employed to achieve the localization. The RTLS that will be presented in this section will all have in common the use of wireless communications, between devices being called in this paper "anchor" and "tag". The tag being associated with the object to locate while the anchor is at a fixed and known location.

Those RTLS can be separated in two categories : "Relative localization" and "Absolute localization". The relative localization algorithm presented in 2.2.1 is the Time of Flight (ToF) method that is used in this project to compute the distance between an anchor and a tag. This choice has been made and explained in [2], [3] alongside a presentation of several approach to determine the relative position of a tag relatively to an anchor.

2.2.1 Symmetric double sided two-way ranging

Symmetric double-sided two-way ranging (SDS-TWR) consists in an exchange of three messages between two devices, respectively $RDEV_1$ initiating the communication and '$RDEV_2$. Each device need to save the Time of Emission (ToE) or Time of Arrival (ToA) of every message. Those time being respectively t_0, t_1 for the first message, t_2, t_3 for the second message and t_4, t_5 for the last message.

Each message contains the different timestamps previously computed, meaning that at the end of this exchange $RDEV_2$ possess all the informations about the timestamps, while $RDEV_1$ misses the last one. If one wants $RDEV_1$ to be able to compute the ToF then a last message with that t_5 in it should be exchanged.

A schematic of the exchanges between $RDEV_1$ and $RDEV_2$ that occurs in SDS-TWR is shown on Fig. 2.4.

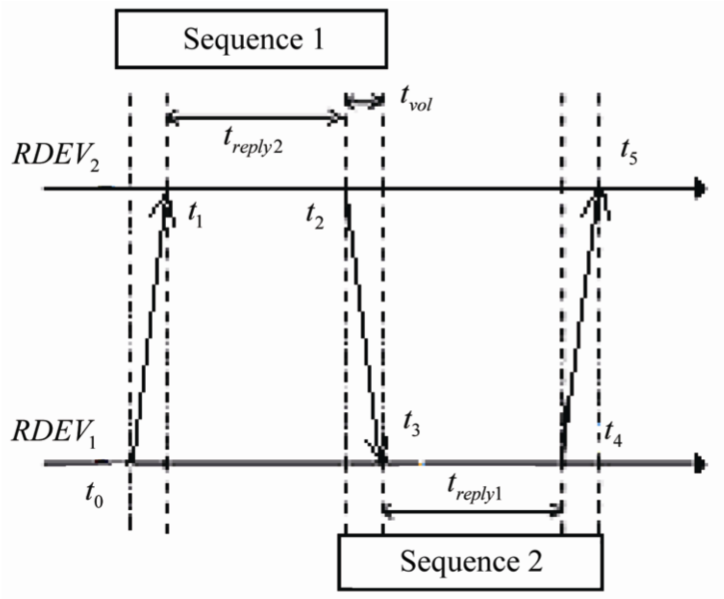

Figure 2.4: Symmetric double-sided two-way ranging. Taken from [1]

Based on those timestamps, the computation of the ToF can be observed in eq. 2.2.

$$t_{est} = \frac{((t_3 - t_0) - (t_2 - t_1)) + ((t_5 - t_2) - (t_4 - t_3))}{4} \tag{2.2}$$

Since that ToF computed remains an estimation, it is important to know the magnitude of the error as well as its evolution in parallel of the true value of the ToF.

$$t_{true} - t_{est} = \frac{1}{4} * (t_{reply2} - t_{reply_1}) * (e_1 - e_2) \tag{2.3}$$

The term $e_1 - e_2$ being the difference between the internal clocks of both devices. [1]

2.2.2 Trilateration

Based on the relative localization performed using SDS-TWR, a ToF can be computed. If the relative distance between a tag and three different anchors is known, it is possible to compute the intersection of three circle having as center the position of the anchor and radius the ToF associated to this anchor. A scheme displaying that solution can be seen on Fig. 2.5.

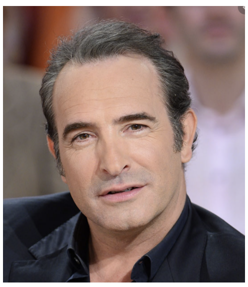

Figure 2.5: Triangulation -> Ajouter photo

As one can deduce, in a two dimensional plan, three anchors are need to have an intersection of one point. In a three dimensional plan, four anchors would be needed.

2.3 Project advancement

Using the technology briefly presented in sections 2.1 and 2.2 a locating system has been developed by ... INDIQUER LE NOM DES ETUDIANTS PRECEDENTS (Cedric, Quentin ?) ... [AJOUTER LES REFERENCES].

2.4 Virtual Anchor

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