Study and design of UWB antennas that can meet integration constraints in electronic systems such as mobile phones

Introduction :

Ultra Wide Band (UWB) technology, which has been around for decades, is a radio frequency communication system characterized by the emission of a low-amplitude signal (close to the noise level) over a very wide frequency spectrum. It allows for the precise localization of objects as well as people. UWB communication is based on the emission of short pulses (typically 2ns). Its technological characteristics and low integration along with operating costs make this technology of interest to many fields (automotive, medical, mobile telephony, ...), and a wide deployment in numerous consumer applications is more and more progressing. One of the major elements of this technology is the antenna part, and we can detail the criteria as follows :

- Antenna quality
- Antenna overall size
- Cost of the antenna
- Performances of the antenna

PhD Project

Study a directive antenna structure that can be integrated into a mobile phone system.

For certain UWB applications, it is advantageous to have a directional antenna. In the context of UWB, particularly for radar applications, it is necessary to have a directional antenna so that the transmission and reception of the RF signal can only occur in one direction (typically the front of the antenna). If the antenna is omnidirectional, there is ambiguity because the system cannot determine whether the target is located in front of or behind the antenna. That's why patch antenna structures are preferred.

On the other hand, some applications require that the beam width be limited, in order to allow the detection of targets only present within an angle of typically +/-35°. The problem is that a patch radiates widely over an aperture of approximately +/-80°, ensuring phase linearity over an aperture of +/-60°.

Thesis objectifs

The main objectives of the thesis are :

- Understanding the different UWB antenna structures through a bibliographic study categorized by antenna type
- Deduce the different structures (e.g., patch, PIFA, monopole, monopole with reflector...) that are most appropriate for our needs.
- Define the levers for optimizing the main characteristics of antennas: resonance frequency, bandwidth, gain, radiation pattern, phase linearity...
- Simulation of phase difference between 2 receiving antennas
- Setting up a simulation bench under HFSS including the import of layout
- Prototyping and verification on a test bench
- Writing a comprehensive report

Organization and provisional planning of proposed research work
The following roadmap has been initiated (this may, however, evolve depending on the progress and/or directions induced by the project) to fully achieve the objectives of the thesis.

T0 -> T0 + 6 months :
Immersion, understanding of the subject, bibliography

T0 + 6 months -> T0 + 12 months :
Simulation Set up

T0 + 12 months -> T0 + 22 months :
Antenna design study

T0 + 22 months -> T0 + 30 months :
The importance of the iterative nature of the study should be emphasized here, because while the first step is to define a structure(s) that meets the specified requirements while minimizing space constraints, the second step will be to reduce the size of the antenna so that the structure can be integrated into a mobile phone.

T0 + 30 months -> T0 + 36 months
The final phase of this thesis work will be devoted to writing the thesis manuscript as well as preparing for the defense.

Methods of research direction and exchanges between partners

During these 3 years of the CIFRE thesis, the student will spend 80% (≈29 months) of their working time at the NXP company and 20% (≈7 months) at the XLIM academic laboratory. The following distribution over the duration of the thesis has been initiated and remains flexible:

1st period:
The student will begin their thesis at the NXP, which will allow to him to get being familiarized with the environment and the issues of this study.
2nd period: After this first stay at NXP, the student will come to XLIM to complete and finalize the bibliography section, which is a crucial element in understanding and advancing the topic.

3rd period:
At the end of the bibliography, the student will return to NXP to initiate the design of the chosen architecture.

4th period:
At the end of the antenna design, the student will be able to return to XLIM to use the equipment of the "Platinom" platform to finalize the experimental part of the developed circuit(s). In parallel, the student will obviously have to write its manuscript, and he will have access to all the laboratory's computer resources to do so.

This distribution remains provisional and may nevertheless evolve depending on the progress and/or directions induced by the project.

For the smooth progress of this research project as well as the proper supervision of the student, weekly meetings between NXP and XLIM will be scheduled. These meetings can be held at the NXP or XLIM or via Viso using NXP or XLIM's video conferencing tools. At the request of the student and/or one of their supervisors, other meetings can be held to address and/or respond to specific issues.

Tools and equipment provided by each partner
NXP:
The student will be based at NXP and will have their own office and computer equipment provided. He will have all the necessary tools for the smooth conduct of his research, namely, mainly:

- License for HFSS simulations
- Measurement equipment such as network analyzer, spectrum analyzer, mini anechoic chamber, ...

XLIM:
The student will also have an office at the XLIM laboratory on the Angoulême site. This office will be equipped with the computer equipment that the student will need to progress in their work. As within the NXP company, he will have all the necessary tools for the smooth progress of his research, namely, primarily:

- HFSS,
- CST,
- ADS,
- Cadence,
- Matlab,

He will also have the opportunity to access the “Platinom” platform in order to carry out the necessary measurements for the validation of the prototype(s). This platform has, among other things, the following:

- Network analyzers,
- Spectrum analyzers,
- Sub-point measurement station,
- Anechoic chamber,

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