Microwave Frontends for Dependable Wireless Communication and Localization Systems

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DEPENDABLE THINGS
Dependable Internet of Things in Adverse Environments

Introduction

Adaptable antenna systems and microwave frontends are key elements of modern wireless localization and communication systems as they affect the overall performance and reliability. Two of the factors that can be exploited to improve their reliability are the Polarization Diversity and scaling towards the mmWave frequency. To evaluate its effect, a two-step plan is in place, each of them comprises the study the state-of-the-art and the development of hardware prototypes for applications in the domain of the Internet of Things (IoT). As IoT devices for consumer use deeper integrate into our everyday life, it has become imperative to design more dependable systems since IoT failures may have disastrous consequences.

Problem formulation

Two of the characteristics that can be targeted to improve the performance of the afore-mentioned systems are:

- Diversity schemes use two or more communication channels with different characteristics, to reduce the effect of fading and co-channel interference. One of the parameters that can be used to implement this technique is the polarization of the antennas.

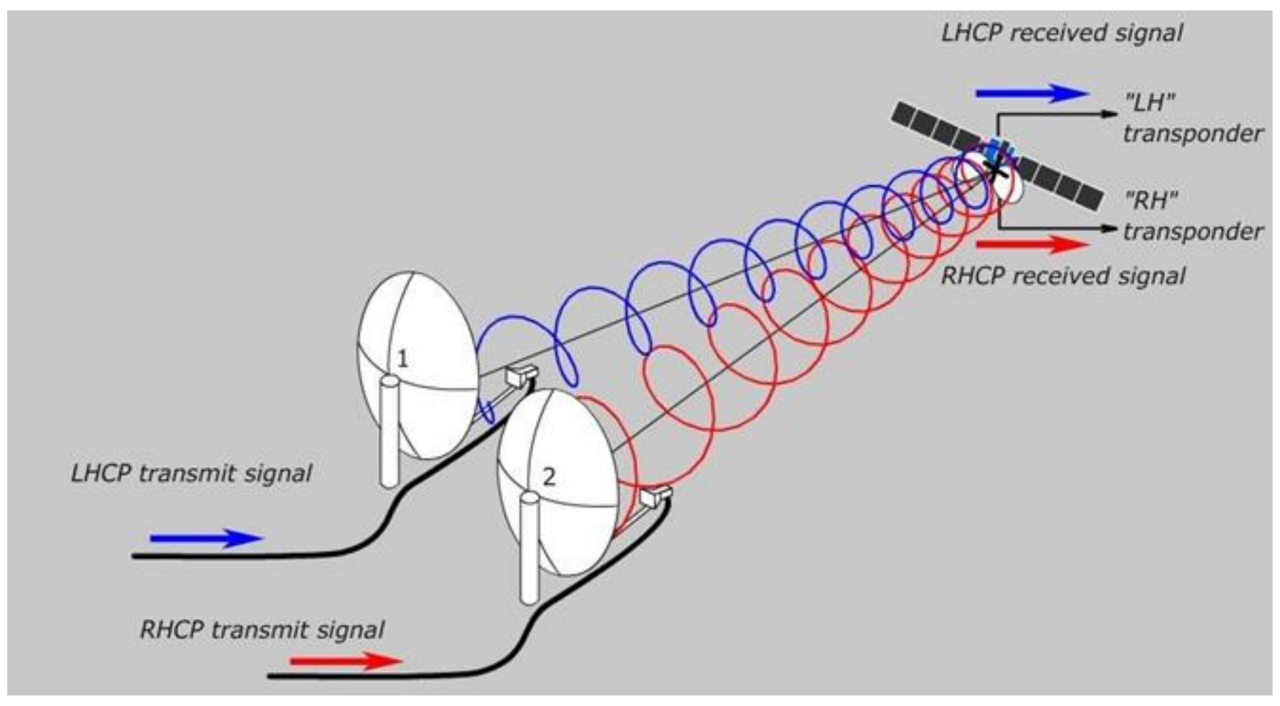

Figure 1. Example of a Communication System using Circularly Polarized Antennas [1].

- mmWave radio technology due to their potential advantages in the implementation of highly accurate positioning systems.

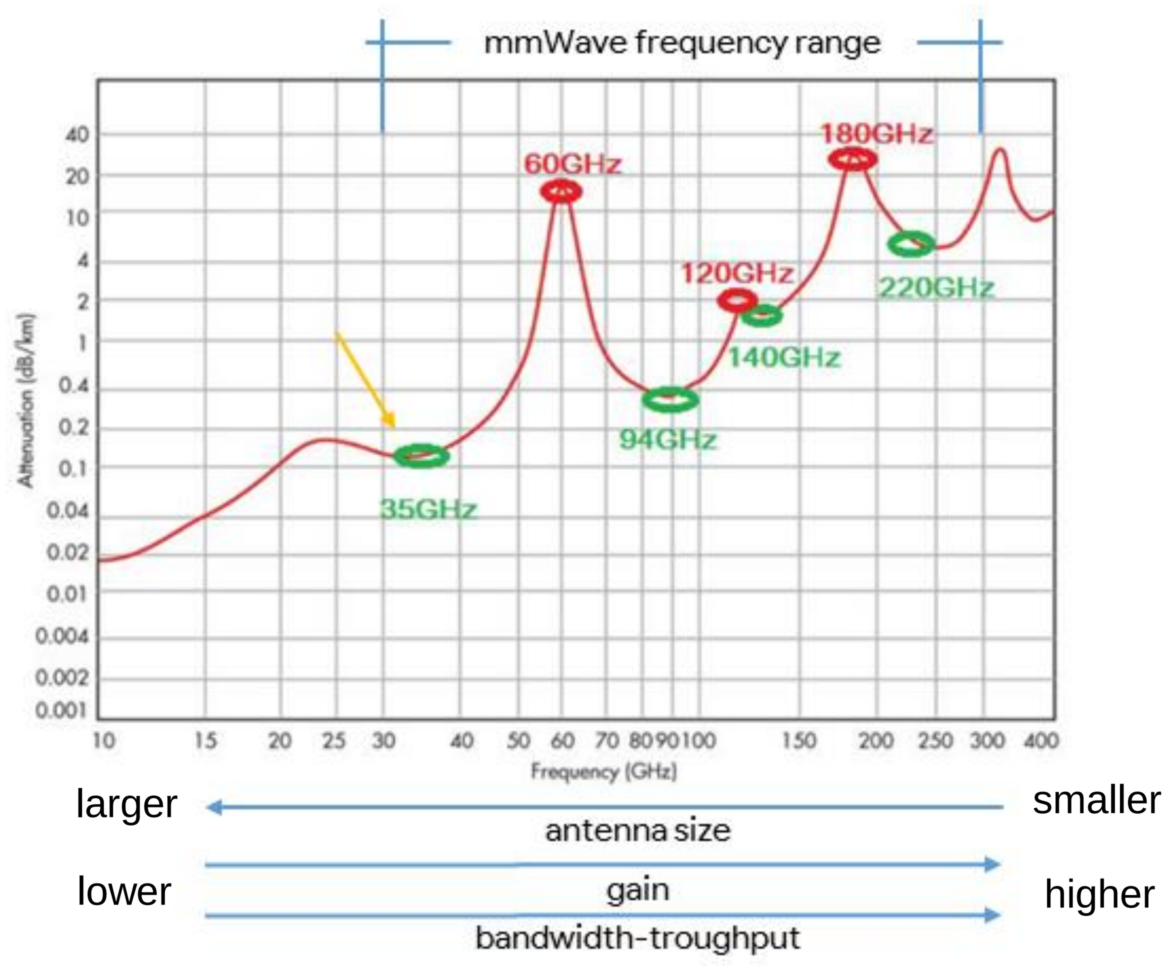

Figure 2. Attenuation vs frequency in the mmWave range (adapted from [2]).

Hardware implementation

To proof the concept of implementing the Polarization Diversity Scheme in a real-life scenario, an Archimedean Spiral Antenna (ASA) backed by a cavity was designed. Since the antenna will be paired with UWB radios, its parameters (gain, directivity, and axial ratio) should be stable in the frequency range between 3 and 7 GHz. Additionally, it is targeted to use four of them it in an already implemented Localization System [3] to achieve a 360° coverage, in consequence, the ASA was designed to present a Half Power Beamwidth (HPBW) of 90°.

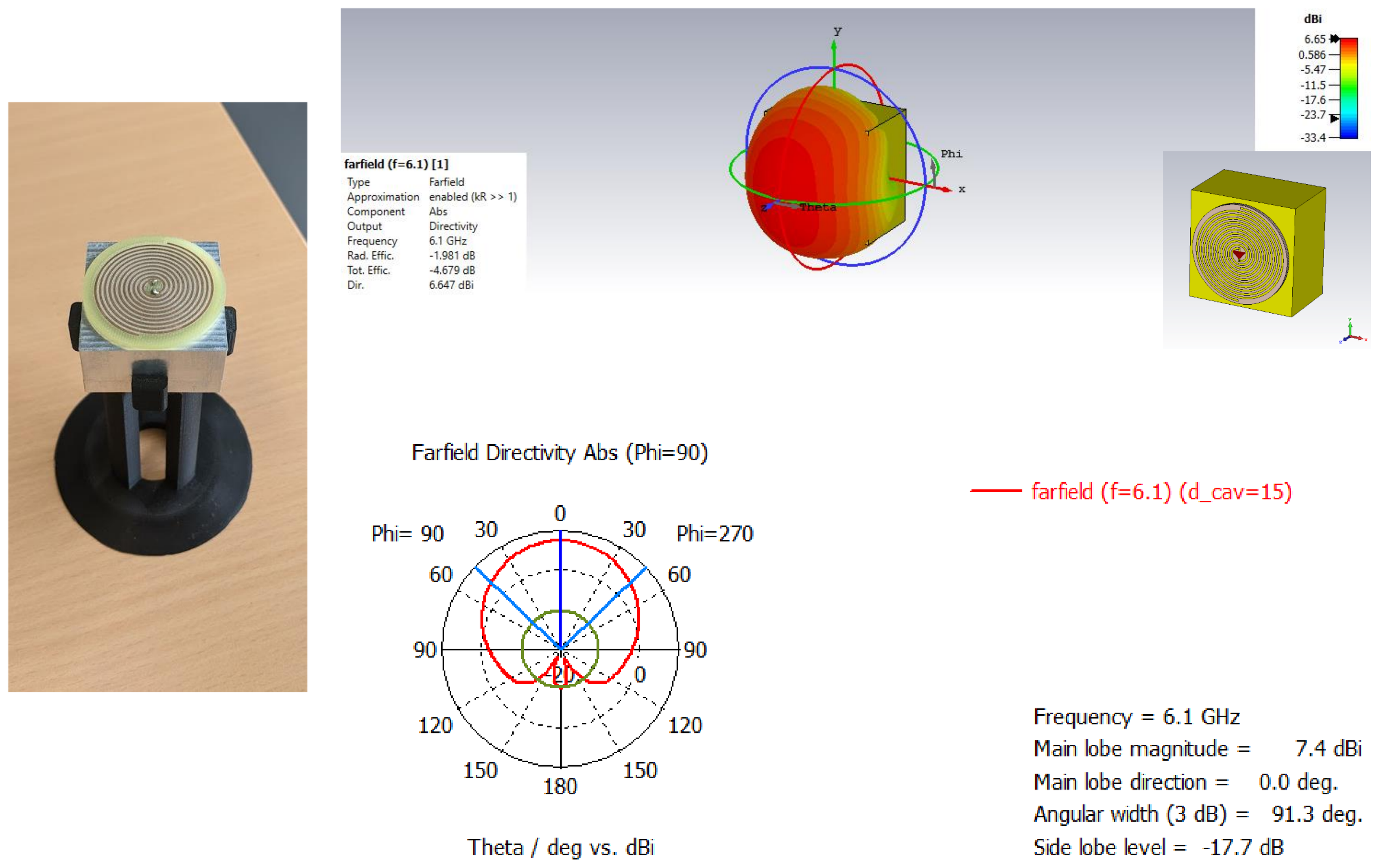

Figure 3. Simulated radiation pattern of the ASA with fabricated prototype.

The designed ASA fulfills the design goals and the measurement process in underway. Miniaturization techniques are being studied in order to make the antenna more suitable for mobile systems. On the other hand, for the scaling to mmWave ranges, the development of a reconfigurable reflectarray is targeted. This type of antenna is known for combining some of the advantages of aperture antennas and phased arrays.

Summary and outlook

The research in this project is concerned with the development of dependable systems for wireless localization and communication systems for applications in the domain of IoT. Two possible solutions have been identified and the goal is to develop hardware implementations to measure the impact in real life situations.

References

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[3] Großwindhager, B., Rath, M., Kulmer, J., Bakr, M. S., Boano, C. A., Witrisal, K., & Römer, K. (2018). SALMA: UWB-based single-anchor localization system using multipath assistance. SenSys 2018 - Proceedings of the 16th Conference on Embedded Networked Sensor Systems, 132–144.

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