Radiovision: Implementation of a Smart Antenna Array for the Localization of Mobile Phones

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1. Motivation

A system capable of locating microwave sources can be useful for many applications, among which stand

- Locating people in disaster situations (earthquakes and avalanches).
- Confiscate phones in prohibited situations (jails).

In this context, Radiovision was born, a portable camera integrated with a 4×4 smart antenna array.

Fig. 1: Proposals for the use of Radiovision.

2. Proposed Antenna

An antenna that works over the entire mobile phone range is required to locate phones.

- The proposed antenna for the array (Fig. 2) is composed of a miniaturized spiral and a metamaterial reflector.
- This antenna works in all UMTS and LTE bands tendered in Chile (700-2600 MHz), and its small size (75 mm) prevents the generation of grating lobes.

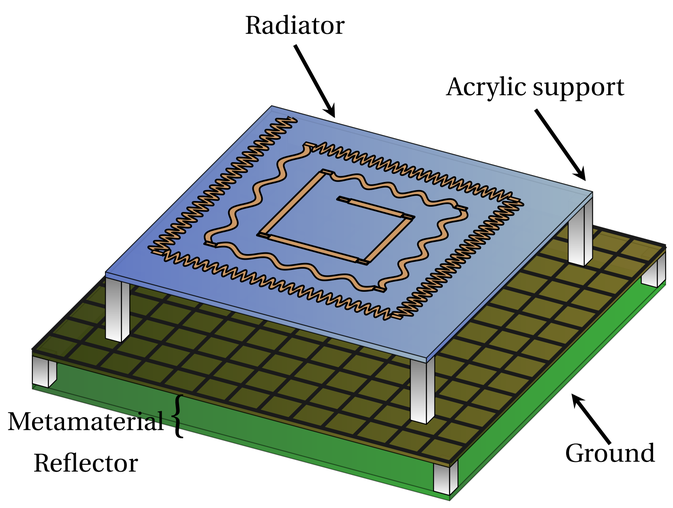

Fig. 2: Proposed design.

3. Antenna Measurements

Both the spiral antenna and its integration with the metamaterial reflector were simulated in HFSS, and subsequently fabricated and measured.

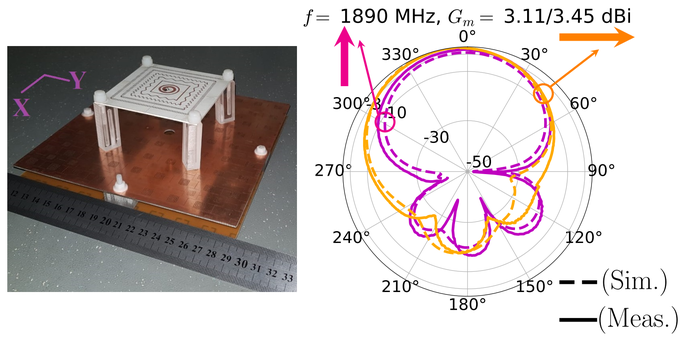

Fig. 3: Fabricated antenna and its measured and simulated radiation patterns for both polarizations.

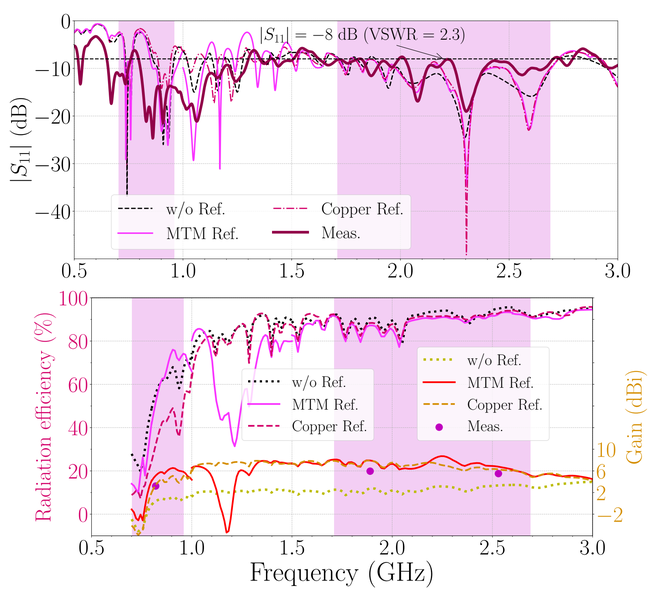

Fig. 4: Measured and simulated S_{11} parameter considering different reflectors. The total simulated and measured gain are also displayed.

4. Receiver and Digital System

The signals captured by the array are amplified and converted to baseband (0-70 MHz) by a heterodyne receiver. Subsequently, the signals are digitalized and processed by a Virtex 6 FPGA.

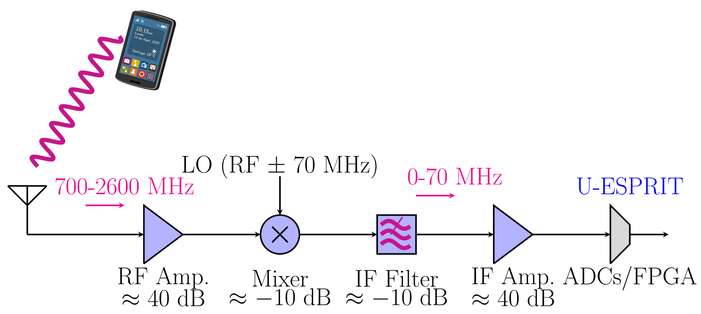

Fig. 5: Diagram of the digital-analog system.

- The ADCs operate at 140 MSPS, which allows a bandwidth of 70 MHz (higher than that used in any LTE/UMTS band).
- The used algorithm is U-ESPRIT 2D.
- The digital system allows locating sources with a duration of less than 1 ms.

5. Conclusions and Applications

A smart antenna array used for the detection of microwave sources was designed, fabricated, and validated.

- The antenna consists of a miniaturized spiral and a metamaterial reflector.
- The 7.5 cm size (0.18λ at 700 MHz) allows operation without grating lobes (or phase ambiguities).
- The system is capable of locating more than one source simultaneously.
- Phone beacons can be located, which last less than 1 ms.
- The detection range is 100 meters.

The final version of Radiovision is shown in Fig. 6 and examples of its graphical user interface are shown in Fig. 7.

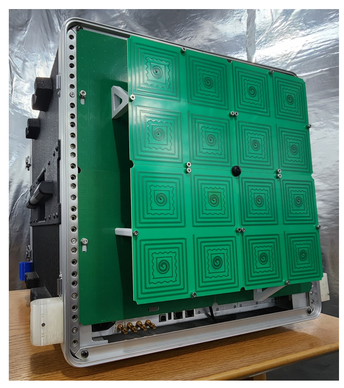

Fig. 6: Radiovision.

Fig. 7: Examples of the Radiovision GUI. The optical image is obtained from the camera, while the purple markers correspond to the estimates of the phone positions.

6. Acknowledgements

The authors are grateful for the support of ANID through its Basal funds ACE210002 and FB210003.