



Contactless and microwave tomography based radar imaging for surveying reinforced concrete structures

Ilaria Catapano¹, Giovanni Ludeno¹, Gianluca Gennarelli¹, Giuseppe Esposito¹, and Adriana Brancaccio²

¹National Research Council of Italy, Institute for Electromagnetic Sensing of the Environmental, Napoli, Italy
(catapano.i@irea.cnr.it)

²Università degli Studi della Campania "Luigi Vanvitelli", Department of Engineering, via Roma 29, 81031, Aversa (CE), Italy

Since the beginning of the 19th century, reinforced concrete has been used to build infrastructures and urban buildings and nowadays is the main material employed in the construction industry. Although reinforced concrete structures are designed in such a way to maximize their life cycle, discrepancies between design and executive phases as well as the joint action of mechanical and environmental effects may cause damages or serious and even fatal accidents. Accordingly, there is a constant attention towards the development of non-destructive technologies (NDTs) capable of improving knowledge about the structure health state while reducing times and costs of the inspections. Among NDTs, ground penetrating radar (GPR) [1] is widely used to perform on-demand high-resolution subsurface surveys and continuous efforts are made to improve the effectiveness of GPR investigations. In this frame, a current open challenge is the design of systems capable of coupling the potentialities offered by GPR systems and autonomous vehicles.

As a contribute to such an issue, this communication aims at presenting the preliminary results achieved in the frame of the Italian PRIN 2022 Project ARACNE - A RADar system for Contactless surveys of reinFORced concREte, whose goal is the design of a compact and lightweight GPR system able to perform contactless analysis and provide as output an image that is easily interpretable by non-expert users. The project started at October 2023 and the initial months have been focused on the definition of the system requirements and on the data processing. Specifically, a study aimed at evaluating the influence of the parameters like frequency bandwidth, polarization and radiation pattern of the antennas has been performed. Moreover, microwave tomography (MWT) [2], [3] has been exploited as an effective and flexible tool to achieve high-resolution focused images from contactless, as well as contact, GPR data. In this regard, an analysis devoted to investigating how the distance between the GPR antennas and the structure under test affects the achievable performance has been carried out. Further details on the ARACNE project and its initial results will be provided at the conference.

[1]. Daniels, *Ground penetrating radar*. Vol. 1. Iet, 2004.

[2] Catapano et al., "Ground Penetrating Radar: Operation Principle and Data Processing," *Wiley Encyclopedia of Electrical and Electronics Engineering*: 1-23.

[3] Catapano, G. Gennarelli, G. Ludeno, C. Noviello, G. Esposito, and F. Soldovieri, "Contactless ground penetrating radar imaging: state of the art, challenges, and microwave tomography-based data processing," *IEEE Geosci. Rem. Sens. Mag.*, vol. 10, no. 1, pp. 251-273, 2021.

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