

**Progetto:****Comunicazioni e trasmissione di potenza con onde ultrasoniche****Research project:****Communications and wireless power transmission with guided waves**

This research project is funded by the ENERGY ECS project within the H2020-ECSEL framework.

The activity that will be carried out at the University of Bologna concerns the development of novel technologies for ultrasonic guided waves (GWs) communications and wireless power transfer.

The permanent integration of GWs technology is limited by several factors: bulky hardware instrumentation and large number of connecting cables, high power consumption and, consequently, high integration costs. Such limitations hampers the adoption of the GW technology in application domains with stringent weight requirements (e.g. aerospace and automotive).

The aforementioned limitations will be addressed with both 1) novel transducers and 2) dedicated electronic systems. The transducers will consist of a set of devices with inherent beam steering capabilities, able to generate and detect directional ultrasonic guided waves within a structure with minimal hardware requirements. The peculiarity of the proposed devices is the capability to generate ultrasonic waves along arbitrary directions on the structure depending on the frequency content of a single excitation signal (frequency steerable transducers- FSAT), or to automatically detect the direction of arrival of mechanical waves generated by impacts and propagating within the structure. Time- and low-depth-encoding approaches to enhance power efficiency in probe actuation and readout will be implemented. In parallel, dedicated signal-processing algorithms will be developed and the specifications for the front-end electronics will be provided.

The principal result of the research activity will consist in the assessment of the performances of the FSAT technology for communication and wireless power transfer task. Thanks to its unique features, FSAT will rely on an extremely simplified circuitry. The novel transducers and their dedicated signal conditioning electronics will be a cornerstone for the realization of distributed sensor networks for monitoring applications.

**Training programme**

The research training programme combines uniquely, inter-sectoral and multidisciplinary research activities (simulation, signal processing, sensor integration) in the field of ultrasonic technologies. Only the proposed multidisciplinary approach of combining simulation and signal processing tools, transducer integration, reliability studies, and standardisation activities with the goal of fully exploiting the huge potential of this cutting-edge technology. The training curriculum starts with methodological training in ultrasound physics and materials science basics, simulation, signal processing of guided waves and ultrasound and continues with technical training in electrical circuit design for energy harvesting applications.

The specific training objectives are:

- to convey substantial fundamental knowledge of all aspects of guided wave systems implementation, including simulation, data analysis and reliability,

- to develop researcher's transferable skills: to work effectively and efficiently, to communicate with different audiences, to identify and exploit entrepreneurial opportunities and to prepare him/her for future PhD studies or industry.