Review of "Addressing Multiple Aspects of Future Radar and Tomographic Microwave Diagnostic imaging", thesis for the degree of "Dottorato di Ricerca in Bioingegneria, Bioinformatica e Tecnologie per la Salute", Università degli Studi di Pavia, Italy, by Alessia Cannatà.

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The thesis addresses the development of innovative imaging systems for diagnostics based on the use of microwaves. In particular, the first part of the thesis is focused on a microwave/millimeter-wave imaging system for breast cancer detection via radar-based approaches. On the other hand, the second part of the thesis concerns the development of a microwave imaging system for the diagnosis of bone diseases, particularly osteoporosis and osteoarthritis, via tomographic approaches. This last activity is performed in collaboration with the Translational Medical Device Lab, at the University of Galway, in Ireland.

The description and presentation of the state of the art in the specific field of the Thesis is quite good and exhaustive. The research problem is well formulated and discussed. The results are presented in clear terms, and all experimental procedures appear to be sound and quite rigorous from a scientific point of view.

The contribution of the Thesis to the advancement of knowledge and methodologies in the design of microwave system for imaging is relevant. The candidate addressed several challenges, from characterization of the tissue phantoms to design of the antenna systems.

The candidate has published in scientific journals with impact in the specific field. In particular, the candidate published research papers in *IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology, Physics in Medicine and Biology* and *IEEE Access*, and a number of contributions to relevant conferences. An additional paper is under review in *IEEE Access*. Moreover, some papers are the results of an international collaboration with the University of Galway, in Ireland.

Overall, I believe that Cannatà's research is of quality and certainly deserving of granting her the PhD degree.

Some comments and suggestions on some Chapters of the Thesis are reported in the following.

Chapters 3

The calibration plays a key role in the final accuracy of the imaging, both in tumor detection and quantitative characterization of the electromagnetic properties (Chapter 4). Is the VNA calibrated before its use? What kind of calibration is performed? The successive phase of calibration performed on the collected data takes into account some reference object. It seems that this last phase of calibration is different in Chapter 3 and 4. Can the candidate given more details on that? Does this calibration depend on frequency and the incident field view?

As far as the inversion performed in Chapter 3, an analysis with a reduced number of frequencies and antennas measurements can be useful.

Chapter 4

In Section 4.2, the issues of non-linearity and ill-posedness must be better explained, as well as the rationale underlying DBIM method. It is not so clear in the Thesis that DBIM is an iterative method and seems to be a standard linear method as the Born Approximation. Moreover, it can be useful to present L2-IMATCS as a way to regularization the inverse scattering problem and face its ill-posedness.

More details on the inversion tests are required:

- How is selected the properties of the matching medium?
- How many DBIM iterations? What is the DBIM stopping criterium?
- Is the support of the bone phantom assumed known during the DBIM inversion or given as starting guess?
- What is the starting guess?
- The inversion results seem better in case of circular array. What is the reason and a possible interpretation ?

Finally, the mathematical formulation in Eqs. (4.1) e (4.2) needs to be fixed. The second equation is incomplete. Also, the language sometimes needs to be reviewed. For instance, "the measured data are non-linear and approximated as linear in this specific application". The relationship among data and unknown can be non-linear not the data.

Conclusion

The candidate is suggested to better analyze and clarify the future developments at the end of the Thesis.