3D Realistic Head and Neck Phantom Generator for Microwave Imaging Applications

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Abstract
In this work, we present a 3D anthropomorphic head and neck phantom generator capable of creating 3D head and neck phantoms, from more simple anatomical models to more anatomically realistic and complex models, designed to cover all development stages of a novel MicroWave Imaging (MWI) medical device tailored to Cervical Lymph Nodes (CLNs) screening. The resulting head and neck phantoms vary in complexity – number, type, and/or features of biological tissues – and the dielectric properties (relative permittivity and conductivity) are assigned to the tissues included in the phantom based on magnetic resonance images, for a fixed frequency ranging from 1 to 10 GHz.

Introduction
887,659 new cases in 2018 [1]

Head and Neck Cancer Over 51% death incidence [1]

In 80% of these cancer cases, cancer cells metastasise through lymphatic and blood vessels [2]

CLNs Standard Diagnosis – Neck Dissection [4]
- X Invasive;
- X Slower physical recovery;
- X Physical appearance deformed (scars);
- X Speech and swallowing hampered;
- X Higher risk of lymphedema;
- X Economical burden associated to continuous monitoring and treatment.

CLNs Alternative Diagnosis Modalities

Ultrasound with fine-needle aspiration cytology [4]
- X Invasive;
- X Highly dependent on the operator.

Computed Tomography (CT) [5]
- X Cannot reliably detect CLNs smaller than 5 mm;
- X Ionising radiation exposure.

Magnetic Resonance Imaging (MRI) [6]
- X Prone to motion and swallowing-related artifacts.

Positron Emission Tomography (PET) [7]
- X High costs;
- X Radioactive materials exposure.

Medical Microwave Imaging [8]

Non-invasive;
Non-ionizing radiation;
Portable;
Low-cost;
Low power;
User-independent.

Main goal:
Design head and neck phantoms to initiate the development of radar-based MWI devices.

Methodology and Results

Tissue(s) selection

CLNs personalization

Dielectric Properties Assignment

Conclusions
- First and unique realistic head and neck phantom generator available to all.
- Researchers have total freedom of choice regarding the MRI exam from which the phantom is derived, and choice of features in the phantom.
- A multitude of phantoms can be produced with this generator under 30 seconds.
- Although we have focused on microwave imaging research field to inspire the generator, this could be easily adapted to other research fields increasing the range of applicability of the developed work.

References