Design and Fabrication of a Dynamic Heart Model for Ultra Wideband Transmission Systems

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Heart models (HMs) for electromagnetic (EM) simulations and testing have been previously explored. To the author's knowledge, however, no EM HM developed to date (1) simulates dynamic change of the heart chambers and (2) has been constructed for ultra wideband (UWB) transmission signal testing. Here we introduce a EM dynamic HM (EM-DHM) derived from a nuclear imaging DHM (NI-DHM) (P. Pretorius et al., Med. Phys., 26, 2323-2332, 1999), for use with UWB systems. The NI-DHM represents the heart with eight half ellipsoids (HEs), two for each heart chamber. The inner HE for each chamber describes the blood pool and the outer HE describes the heart muscle. Heart dynamics are modeled by changing the dimensions of each of the HEs to create a HM for each stage of the heart cycle. The sequence of HMs forms the EM-DHM.

A rubber urethane based tissue mimicking materials (TMMs) (J. Garrett and E. Fear, IEEE Antnnas Wireless Propag. Lett., 13, 599-602, 2014.) was used for construction; each HM was cast with two 3D printed moulds. For each HM, one mould (see figure 1a upper) creates the atriums and a second mould (see figure 1a lower) creates the ventricles. The first stage of our constructed EM-DHM is shown in figure 1b.

The EM-DHM was simulated at several different stages of the heart cycle. Two stages of the HM were constructed and measured. Agreement in UWB behavior was shown between simulation and measurement of the EM-DHM. Results suggest our DHM meets requirements (1) and (2). Future work includes full characterization of the EM-DHM and the use of different TMMs
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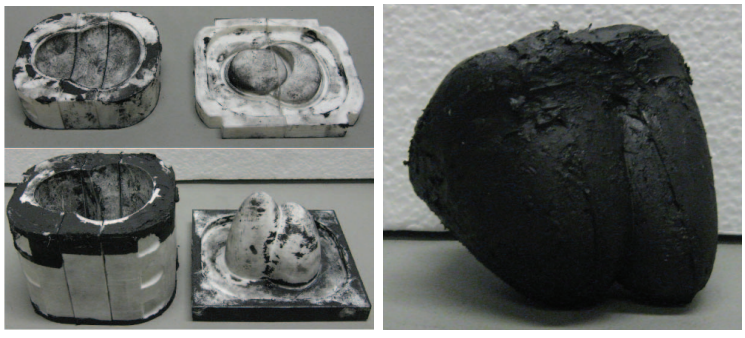

(a) (b)

Figure 1: 3D printed DHM moulds (a) and a constructed EM-DHM stage (b)