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A finite element tool for the analysis and the design of capacitive micromachined ultrasonic transducer (cMUT) arrays for medical imaging

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The fabrication technology of capacitive micromachined ultrasonic transducers (cMUTs) is now mature enough to exploit the potential of this new generation of electro-acoustic transducers in the field of diagnostic medical imaging and non-destructive evaluation. Converting a demonstrator into a commercial product often requires many design and process refinements, and sometimes significant modifications to the fabrication process. Because each design-fabrication-and-test cycle is time-consuming and costly, the development of a modeling tool for the computer simulation of cMUTs is an essential aid to reduce the time to market and costs. Much effort has been put by researchers to develop more and more accurate and smart simulation tools, that advanced from the standard equivalent circuit modeling with lumped parameters to more powerful techniques based on the finite element method (FEM). This paper aims to give an overview of the most ordinary modeling approaches used for the simulation of cMUTs. It is shown that the pulse-echo operation of cMUT arrays for medical imaging applications can be analysed by a set of FEM models developed using a commercial software. The important aspects of the cMUT operation, including electro-mechanical-acoustical coupling and nonlinear effects in transmission, are taken into account.