



Ultrasound Innovations: CMUTs

No, CMUTs are nothing to do with old sea dogs. These are capacitive, micro-machined, ultrasonic transducers, to give them their full title. CMUT transducers use a technology which is fundamentally different from that of the familiar piezoelectric ultrasound transducer. The piezoelectric transducer contains a thin solid wafer of piezoelectric material with electrodes on its surfaces. The thickness of the wafer changes in response to an alternating electrical voltage applied to the electrodes making it vibrate at the required ultrasonic frequency. The basic element of the CMUT transducer is rather like a very small, hollow drum with a solid base and a flexible membrane above. An electrical voltage applied between electrodes on the membrane and the base produces an electrostatic attraction which draws the membrane towards the base. The membrane can be made to vibrate at ultrasonic frequencies by using an alternating voltage, rather like a very small electrostatic loudspeaker. The electrodes also act like a small capacitor. When receiving an ultrasonic echo, movement of the membrane causes changes in the capacitance which can be used to produce an electrical signal.

The basic cell of the CMUT transducer is only about 100 μm across, much too small to function on its own as an element of a linear array, for example. So each rectangular element in the row of a linear array transducer is formed of a small matrix of CMUT cells (say 3 x 50) connected together electrically. However, the small cell size gives great flexibility in terms of the size and shape of transducer element that can be formed. The small size of the cell membrane also enables the transducer to be used at a wide range of ultrasound frequencies, extending to several tens of MHz, enabling a one probe solution for a range of applications. CMUT transducers are manufactured using the same silicon technology as used for computer chips, creating the possibility of integrating the transducer onto the image forming electronics and reducing manufacturing costs. Work to develop commercially viable CMUT transducers has been ongoing for many years but has finally begun to bear fruit. Hitachi Medical Systems introduced a CMUT linear array transducer in 2018 ([4G CMUT \(hitachi-medical-systems.co.uk\)](https://www.hitachi-medical-systems.co.uk)). In the same year, the Butterfly IQ hand held ultrasound system (see: <http://www.journaladvancedultrasound.com:81/EN/10.37015/AUDT.2019.190819>) was introduced. This is an all in one ultrasound probe containing a CMUT transducer array and imaging system, which connects to a smart phone or tablet display and is designed for point-of-care use in emergency departments or 'in the field'. High frequency CMUT ultrasound transducers are also available now for scanning small animals (<https://verasonics.com/cmud-hf-transducers/>). The compact and flexible nature of CMUT transducers may enable future applications such as intravascular imaging – watch this space!