A TWO DIMENSIONAL PVDF TRANSDUCER MATRIX
AS A RECEIVER IN AN ULTRASONIC TRANSMISSION CAMERA

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ABSTRACT

A two-dimensional ultrasonic receiver matrix with the piezoelectric polymer PVDF has been developed and tested in an ultrasonic transmission camera. The major advantage of this matrix over known receiver devices for ultrasonic cameras is its high sensitivity along with high bandwidth, its large number of small receiver elements and its pure electronic read-out. No mechanical moving of either the image or the receiver array is needed. The matrix read-out is realized by a stack of 29 thin film substrates with 128 switchable preamplifiers each. One side of the stack forms a contact matrix with 29 * 128 metal contacts of the size 0.75 mm * 0.65 mm, covering a total area of 26 mm * 96 mm. The contact matrix is pressed against a common 25 um PVDF foil as a common transducer. A parallel signal procession results in a homogenous image presentation. Transmission images of technical and biological objects with a frame rate of 25 Hz and a sensitivity of 6 * 10^-6 V/Pa are shown. The intrinsic resolution of the camera - 1.7 mm at 2 MHz is reproduced in the image.

1. INTRODUCTION

An ultrasonic transmission camera produces medical images which are substantially different from common B-scan images. The image plane lies normal to the direction of propagation of the ultrasound and the transmitted part of the ultrasound contains other information about the structure of the human body than the reflected one. Transmission cameras with linear arrays working in the field of medical research are used to examine hip-joints of babies 1 or the extremities 2. In both camera systems additional expense has to be introduced for the mechanical movement of either the ultrasonic image or the receiver array. This mechanical movement results in a limited frame rate.

This limitation can be overcome by means of a receiver matrix with a high number of densely packed receiver elements. Each of these elements (and their number can be up to 10,000) has to be distinguished from any other by an electronic switch. Because the area of one element is usually very small, this switch has to be a preamplifier as well. There are strict constraints on the size of these switches: they have to fit into the
The principle that helps deal with this geometric constraint is demonstrated by Gelly and Papallardo. Their matrices are joined together by a stack of very flat linear arrays. The material sensitive to ultrasound is piezoelectric ceramics diced to single elements which work either in the 33 or the 31 mode. Their bandwidths are relatively small. The switching is done by a multiplexer chip or by other means of hybrid electronics concentrated on one area on the flat side of every linear array.

Figure 1: Configuration of an ultrasonic transmission camera

An ultrasonic camera is shown schematically in figure 1. A transmitter matrix of piezoelectric transducers, each excited by a signal generator, transmits ultrasound which insonates an object field. The portion of the ultrasound which is not absorbed or reflected by the object, e.g. a finger, is collimated by an acoustic lens into the image plane. The piezoelectric receiver matrix in the image plane converts the pressure image into a charge image. The charge image is then electronically read out and finally converted into a video signal.