Impedance auto-tuning of ultrasonic transducer for non-invasive cancer treatment by High Intensity Focused Ultrasound (HIFU)

Jingbo-Xu[1], M. Zhang[1*]

1 Centre de Nanosciences et de Nanotechnologies, University of Paris-Sud, University of Paris-Saclay, Orsay,France

circle8993 @hotmail.com, *ming.zhang@u-psud.fr

Abstract

Cancer is one of the diseases that kill many people every year, and still a great threat to human beings. There're many new emerging technologies aiming at cure this disease. HIFU is one of these, compared to other methods HIFU technology has many advantages, its non-invasive, no side-effect, more precise…the mechanism is the heating and vibration effect of the ultrasonic, we focus the ultrasonic beam from different direction to the focal area, so with the heating and vibration effect of the ultrasonic, tumor cell is killed.

The transducer is equivalent to series connected R(resistance)&X(reactance).Normally the impedance of the transducer used for generating the ultrasonic is not always pure resistance, typically capacitive. If the transducer is not working at its resonant state, the energy converting efficiency is low, the machine will heat, and at last "bomb". What's more, the amplitude of the ultrasonic differs with its impedance so it's very hard to control the temperature and the precision. So we need a tuning system to tune the impedance to make sure the transducer always works at its resonant condition.

In this paper we present a way with a switched capacitor to auto-compensate the impedance drift of the transducer, so to make sure the transducer always work on its resonant state. Table.1 is the aim of our design. And Fig.1 is the simulation results of our design, the results shows that the auto-tuning system has a very good tuning ability, the impedance drift has little influence on the system. The simulation results show that this system has a very quick response time, high precision, easy to integrate.

Table.1 Indicators of our project in this paper.

Power supply	5V
Working frequency	1MHz
Output Power	3W
Input stimulation	Square wave
Output Waveform	Sinusoidal

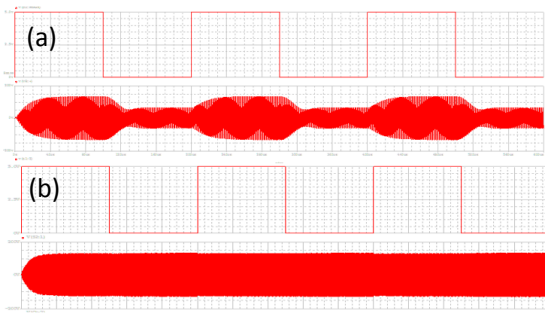

Fig.1 simulation results of (a).static tuning (b).auto-tuning