Acoustic Levitation: Which Phase Offset Pattern Maximizes Range of Movement?

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The project utilizes high and low-pressure zones of 40kHz acoustic standing waves to levitate an object in three-dimensional space using two opposing arrays of 36 ultrasonic transducers/speakers each and then investigates optimizations to maximize the levitation range and stability. While levitated, the object can be moved in any direction using an 8 button hand-held controller for input. First, a microprocessor running custom C code uses the object's current position, input from the handheld controller, and a pattern of phase offsets to dynamically calculate the required phase shift to focus the sound waves from each of the 72 speakers at the object's location. Second, FPGA then uses the processor's input to create 72 3.3V peak to peak waveforms with phase offsets as specified by the calculations. The waveforms are amplified to 15V peak-to-peak and applied to the speakers. Every 10 milliseconds, the processor reads the hand-held controller and repeats the calculations to move the object according to the buttons pressed. Multiple phase offset patterns are tested to determine which pattern provides the greatest amount of range in all directions. For each test, the object is levitated in the center of the two opposing arrays and then moved, using the controller, along an axis until it falls. The test was repeated for each axis. It was found that different phase offset patterns had different strengths and no overall best phase offset could be found. Each time the phase offset pattern that best fits the scenario must be chosen.