

## LEVITATION USING ACOUSTIC DEVICES

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**Abstract** – Sound waves possess momentum thus it can be used to levitate objects such as body tissues, particles without touching them. But the problem is that the particles is to be enclosed within acoustic elements to levitate it. Here we are using a single sided emitter transducers to produce sound waves and thus levitate the particles. Furthermore, we can use holographic acoustic elements framework that produces better acoustic traps and thus produces better levitation of particles. Acoustic levitation using single beams has become fundamental tool in targeted drug delivery inside body and in controlling of micro-machines in chip manufacturing scenarios.

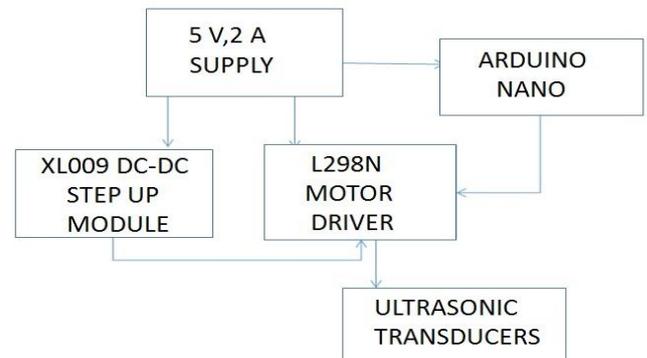
**Key Words:** momentum, levitation, acoustic, holography, targeted drug delivery

### 1. INTRODUCTION

A method for levitating small particles using single beam(tracker beams) is demonstrated. The method encodes the required phase modulation in passive unit cells into which the ultrasonic sources are mounted. These unit cells use wave guides such as straight and coiled tubes to act as delay-lines. Acoustic tractor beams capable of holding millimeter-sized polymer particles of density 1.25g/cm<sup>3</sup> is demonstrated. Thus a acoustic tracker beam can be constructed using simple components which can be used in microscopy and biophysics applications.

Sound is a mechanical wave and as such it carries momentum that can generate acoustic radiation forces. When these forces are strong enough and converge from all directions, particles can be levitated against gravity. Acoustic levitation is becoming a fundamental tool in labon-a-chip scenarios, microscopy, pharmaceuticals and the levitation of biological samples, and even small animals. Recently, single-beam acoustic levitators have been generated using phased arrays. We adopt terminology common in optics and term these single-beams that can trap objects in three dimensions tractor beams. Acoustic tractor beams have the potential to revolutionize contactless manipulation due to their high exerted force to input power ratio and the wide variety of supported particle materials as well as sizes. However, phased array systems are currently necessary in order to generate and amplify dozens of independent electric signals making tractor beams not generally accessible due to cost, space, or complexity of operation.

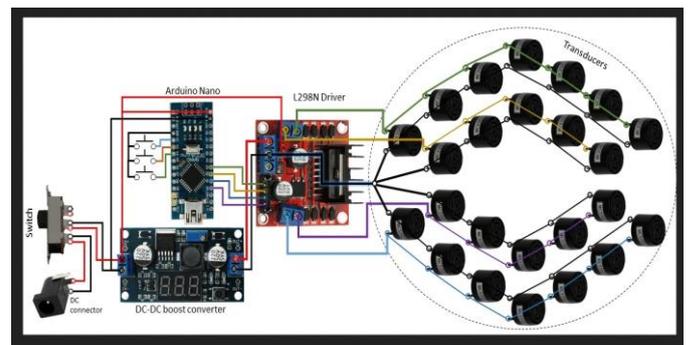
### 2. BLOCK DIAGRAM



**Fig -1:** Block Diagram

A 5V,2A supply is used to power Arduino nano and logic part of the motor driver. The Arduino nano is programmed so that it generates 4 half-square signals at 5Vpp 40 kHz with different phases. The signals from the Arduino get amplified to 25Vpp by L298N motor driver and fed in to ultrasonic transducers. The ultrasonic transducers converts electrical energy into acoustic energy.

### 3. CIRCUIT DIAGRAM & COMPONENT DESCRIPTION

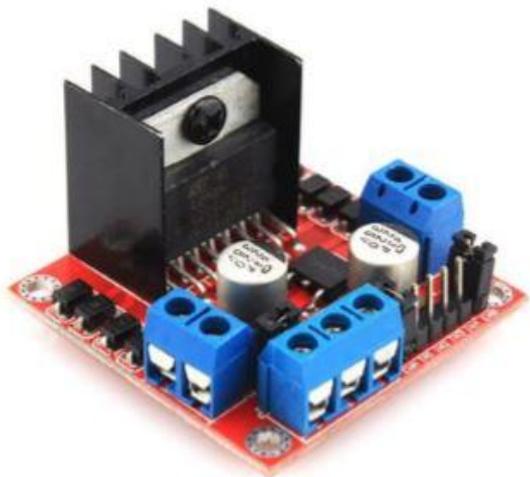


#### 3.1. XL6009 DC-DC STEP UP MODULE



- Mix range , current mode DC-DC converter.
- Capable of generating either positive or negative output voltages.
- Can be configured as control functions of step-up(boost),flyback and forward converter switching regulators.
- Available in three output voltage versions : 12V,15V and adjustable
- Requires minimum number of external components.
- Cost effective and simple to use.
- Module Properties: Non-isolated buck Module
- Input voltage range: 3.2 to 30Vdc
- Output voltage range: 5 to 35Vdc
- Output rated current: 2A
- Output maximum current: 3A (need to add heat sink)
- Conversion efficiency: 94

### 3.2. L298N MOTOR DRIVER



- Dual H-bridge motor driver board that can be used to drive two robot motors.
- Uses L298N Dual H-bridge motor driver chip .
- Powerful enough to drive motors from 5-35 Volts at up to 2 Amps per channel.
- This board provides a handy 5V regulator that can be used to power other circuits.

### 3.3. ULTRASONIC TRANSDUCER



- Converts AC into ultrasound, as well as the reverse.
- Typically refers to piezoelectric transducers or capacitive transducers.
- Piezoelectric crystals change size and shape when voltage is applied.
- AC voltage makes them oscillate at the same frequency and produce ultrasonic sound.
- Divided into 3 broad categories: transmitters, receivers and transceivers.

### 3.4. ARDUINO NANO



- Small, complete and breadboard-friendly board based on ATmega328.
- Can be powered via the Mini-B USB connection, 6-20V unregulated external power supply.
- Automatically sense and switch to the higher potential source of power, so no need for the power select jumper.

## 4. EXPERIMENTAL SETUP AND OPERATION

The bowl is designed such that the transducers mounted on it produce ultrasonic waves. These waves intersect at about the centre of hemispherical bowl. In phase and anti-phase waves are produced simultaneously on both halves of the bowl, which would led to the formation of acoustic traps. A particle of specified diameter and density is suspended to

the bowl. The traps will persist even if the whole assembly is tilted down. Therefore the particle in the trap does not change its position (upside down). The three control button enables up and down motion of the particles which is being levitated.

## 5. CONCLUSION

In this project, we have seen about how the sound waves can be utilized to levitate the small particles in the mid-air. Currently, it is proved that particles up to 10mm diameter can float in the mid-air using ultrasound waves. By using high frequency sound waves this technology can be used to levitate large objects. Hence, In future acoustic tractor beam can be applied in medical field to remove tumors, Cancer treatments, delivering drugs. It should operate above 40kHz since sound waves between 140-150dB is harmful to human beings That is by creating acoustic traps we can levitate object by counter act against gravity. But it is difficult to create exact pattern of sound waves for tractor force. It is a great challenge to implement mathematical equations which are governing this behaviour into a real world.



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