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Acoustic Levitation

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Abstract *-Acoustic levitation is a technique for suspending things in mid-air by using acoustic radiation forces to overcome gravity. Although acoustic levitation was initially demonstrated about a century ago, it was limited for a long time to objects much smaller than the acoustic wavelength levitating at fixed points in space. Recent advancements in sonic levitation now allow for not only suspending but also rotating and translating of objects in three dimensions. Acoustic levitation is no longer limited to small things; it may now be used to elevate objects that are larger than the acoustic wavelength. The advancement of acoustic levitation is reviewed in this article, with a focus on the working mechanisms of several types of acoustic levitation devices developed to date. We'll begin with a quick overview of the theory. Following that, we go over acoustic levitation methods for suspending things in fixed places, as well as approaches for manipulating objects. Finally, we give a quick overview and discuss some potential possibilities for acoustic levitation.*

I. INTRODUCTION

Acoustic levitation is a strategy for suspending matter in air against gravity utilizing acoustic radiation pressure from focused energy sound waves.

It chips away at similar standards as acoustic tweezers by outfitting acoustic radiation powers. Anyway acoustic tweezers are by and large limited scope gadgets which work in a liquid medium and are less influenced by gravity, though acoustic levitation is basically worried about conquering gravity.

Technically unique acoustic levitation is a type of acoustophoresis, however this term is all the more regularly connected with limited scope acoustic tweezers.

Typically solid waves at ultrasonic frequencies are utilized consequently making no strong perceptible to people. This is basically because of the extreme focus of sound needed to balance gravity. Nonetheless, there have been instances of discernible frequencies being utilized.

There are different strategies for producing the sound, however the most well-known is the utilization of

piezoelectric transducers which can productively create high adequacy yields at the ideal frequencies Levitation is a promising strategy for holder less handling of central processor and other little, fragile items in industry.

II. LITERATURE SURVEY

On the acoustic levitation of droplets
Published online by Cambridge University Press: 10 February1998 .This paper deals with the theoretical and experimental investigation of acoustically levitated droplets. A method of calculation of the acoustic radiation pressure based on the boundary element method (BEM) is presented. It is applied to predict shapes of droplets levitated in an acoustic field (and as a result, deformed by it). The method was compared with several known exact and approximate analytical results for rigid spheres and shown to be accurate (and a widely used approximate formula for the acoustic levitation force acting on a rigid sphere was found to be inaccurate for sound wavelengths comparable with the sphere radius). The method was also compared with some other theoretical approaches known from the literature.

III. BLOCK DIAGRAM

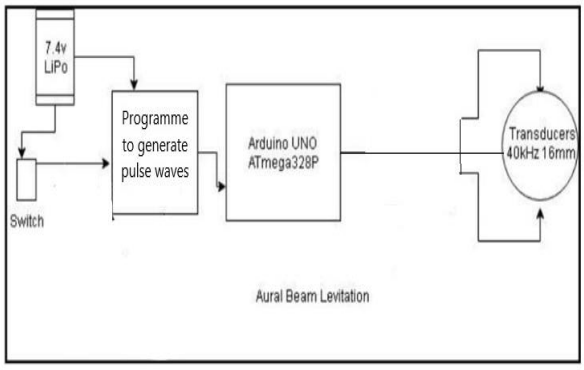

Figure no 1: Block diagram

IV. METHODOLOGY

To see how acoustic levitation functions, you first need to know a little about gravity, air and sound.

To begin with, gravity is a power that makes objects draw in each other. The least complex approach to comprehend gravity is through Isaac Newton's law of all inclusive attractive energy. This law expresses that each molecule in the universe draws in each and every other molecule. The more huge an item is, the more firmly it draws in different articles. The nearer protests are, the more unequivocally they draw in one another. A colossal item, similar to the Earth, effectively draws in objects that are near it, similar to apples swinging from trees. Researchers haven't chose precisely what causes this fascination, yet they trust it exists wherever in the universe.

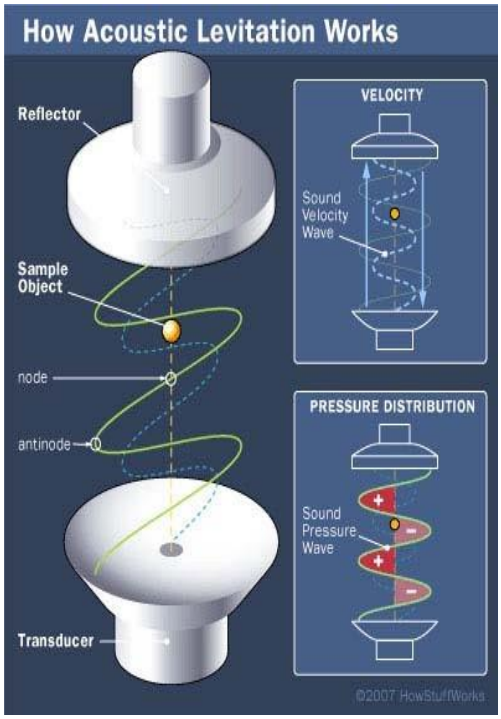

Figure no 2: Levitation Working

Second, air is liquid that acts basically similar way fluids do. Like fluids, air is made of minuscule particles that move according to each other. Air additionally moves like water does - indeed, some streamlined tests happen submerged rather than noticeable all around. The particles in gasses, similar to the ones that make up air, are essentially farther separated and move quicker than the particles in fluids

Third, sound is a vibration that movements through a medium, similar to a gas, a fluid or a strong item. A sound's source is an item that moves or changes shape quickly. For instance, in the event that you strike a ringer, the chime vibrates noticeable all around. As one side of the chime moves out, it pushes the air particles close to it, expanding the pressing factor around there of the air. This space of higher pressing factor is a pressure. As the side of the ringer moves back in, it pulls the particles separated, making a lower-pressure district called a rarefaction. The chime then, at that point rehashes the interaction, making a rehashing arrangement of compressions and rarefactions. Every redundancy is one frequency of the sound wave.

Different materials that can levitate using two transducer method as shown In below fig shows how we can place the material to levitate in between the two transducers.

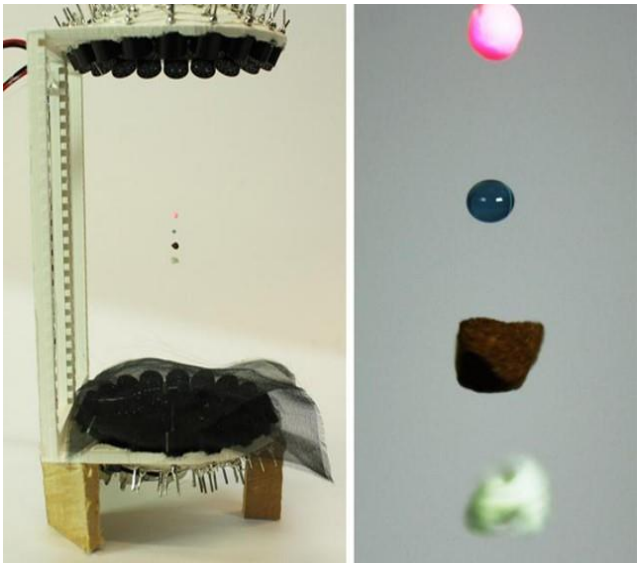

Figure no 3: two transducer method

V. CIRCUIT REQUIREMENTS

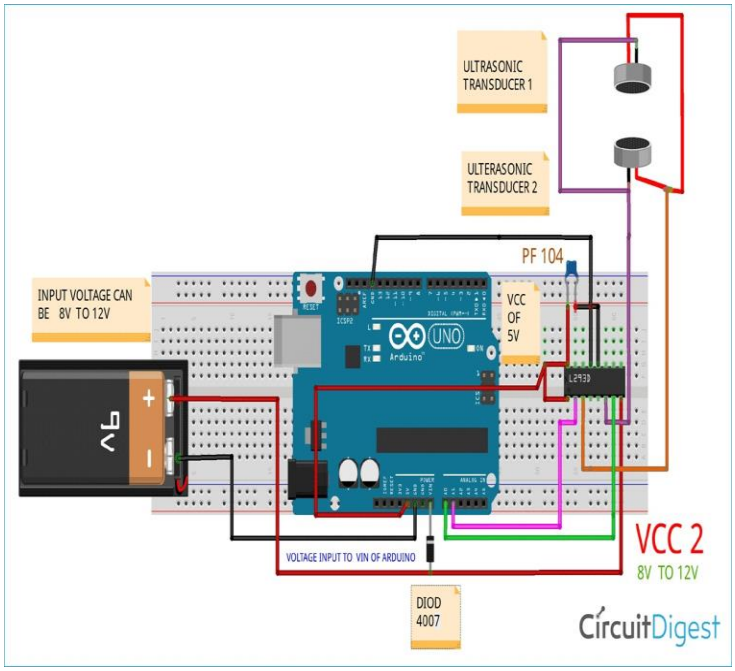

Figure no 4: Circuit Diagram

VI. ARDUINO CODE

```
boolean toggle0 = 0;

void setup(){

DDRC = 0b00001111; //A0 to A3 are the signal outputs
PORTC = 0b00000000;

cli();//stop interrupts

//set timer2 interrupt at 80kHz
 TCCR2A = 0;// set entire TCCR2A register to 0
 TCCR2B = 0;// same for TCCR2B
 TCNT2  = 0;//initialize counter value to 0
 OCR2A = 24;//   (16*10^6) / (80000*8) - 1 (must be <256)   // set      compare match register

TCCR2A |= (1 << WGM21);  // turn on CTC mode
TCCR2B |= (1 << CS21);    // Set CS21 bit for 8 prescaler
TIMSK2 |= (1 << OCIE2A);  // enable timer compare interrupt

 sei();//allow interrupts

} //end setup

ISR(TIMER2_COMPA_vect){//timer1 interrupt 80kHz toggles pin A0-A1 and A2-A3
 //generates pulse wave of frequency 80kHz/2 = 40kHz (takes two cycles for full wave)

 if (toggle0){    PORTC=0x05; //01 01 outputs      toggle0 = 0;

 }
  else{
  PORTC=0x0A; //10 10 outputs
  toggle0 = 1;
 }
}
void loop()
```

VII. ADVANTAGES :

1. Acoustic levitation enjoys some upper hands over different kinds of levitation, for example, attractive and optical, because of its capacity to follow up on all articles. Issues with acoustic levitation incorporate the need of a media to spread through and the levitation of plainly visible items.

2. Acoustic levitation gives a holder less climate to drop drying investigations to contemplate fluid dissipation and molecule arrangement

VIII. FUTURE SCOPE :

The levitation of little living creatures has likewise been contemplated and the imperativeness of creatures which normally exist in air was not affected.[23] In future it very well may be utilized as an apparatus to consider the actual creatures.

There is dynamic exploration in the field of contactless gathering. The levitation of surface mount electrical parts has been demonstrated[11][45] as has miniature gathering with a blend of acoustic and attractive fields.[62] There is likewise business premium in 3D printing while suspended, with Boeing recording a patent on the concept.[63]

Acoustic levitation has likewise been proposed as a strategy for making a volumetric showcase, with light projected onto a molecule, which moves along the way to make the picture quicker than the eye can measure. This has effectively demonstrated possible[64] and has been united with sound and haptic input from a similar PAT

IX. RESULT :

Distance between the levitating objects were measured both in the small and big levitators , and was found to be half-wavelength, as expected. According to Table I the maximal longitudinal pressure values are different in each levitator. The highest pressure differences were created in the big levitation, due to the 72 transducers fixed in it.

Table 1 – The heaviest object which could levitate

	Small levitator	Big levitator	Ultrasound stick
Material	Styrofoam	Rubber	Styrofoam
Δp (Pa)	1.26	11.77	0.25

Correlation between the tilt of the levitator and the objects levitating in it was found in the experiment carried out with big levitator. As shown in Figure 4, the more central the position is, the more resistant the object is. The experiment was conducted on different voltages, the tendencies were the same, and higher voltages meant greater angles. These results were also verified when external forces were applied.

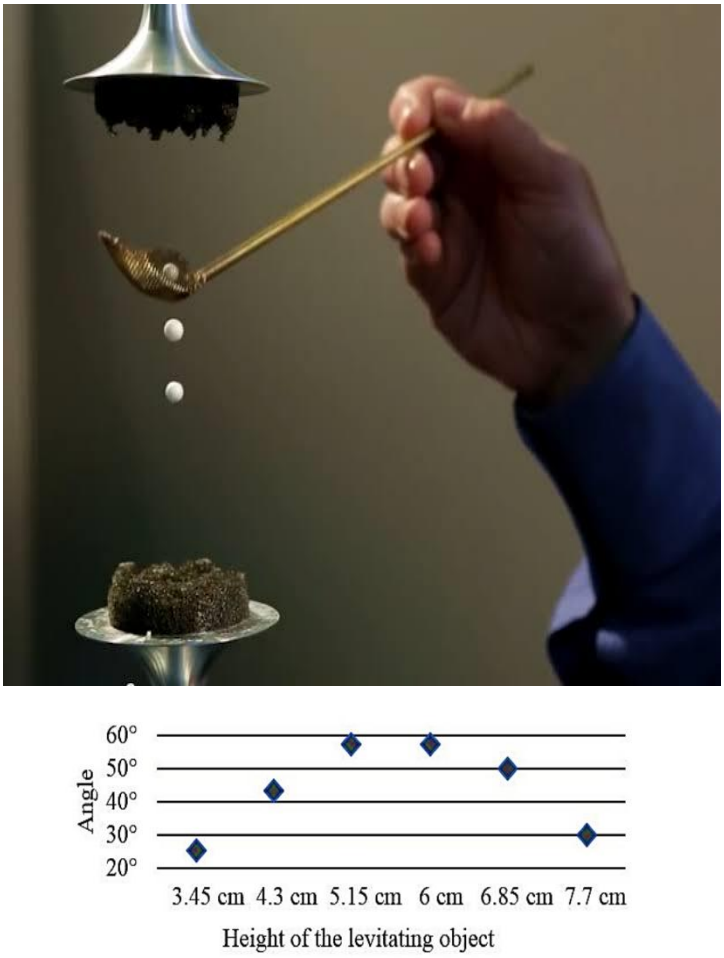

Figure no 5: The tilt of Levitator when the levitating object falls

X. CONCLUSION :

Our venture just starts to expose acoustic levitation. We have shown that it very well may be finished with a sensible basic and rich plan. We have accomplished some work in setting up possible traps and troubles in doing tests. We are generally glad for our twofold transducer plan. Albeit a lot of persistence is needed to set up the plan and complete analyses, we had the option to take a gander at some exceptionally weird and energizing conduct.

Successor gatherings will actually want to gather more information in the spaces we couldn't acceptably investigate. Materials other than pieces of destroyed Styrofoam ought to be tried to tentatively decide basis for whether an object and be suspended.

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