International Journal of

Young Scientist Research

Contents

WELCOME TO THE INTERNATIONAL JOURNAL of YOUNG SCIENTIST RESEARCH

Young Scientist Research is a research journal based on scientific projects and we are pleased to present our students' work in scientific activities. This open-access journal includes young students' research in any field of science which publishes full-length and abstract research on any aspects of applied sciences in relation to work presented in both national and international conferences, competitions and tournaments of all types.

Programs that have educational opportunities for high school students to present their distinguished projects from regional, national and international events such as International Conference of Young Scientists (ICYS), International / Persian Young Physicists' Tournament (IYPT/ PYPT), International / Iran Physics' Tournament (IPT/ IRPT).

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By submission of a manuscript to the Journal, all authors warrant that they have the authority to publish the material and that the paper, or one substantially the same, has neither been published previously, nor is being considered for publication elsewhere.

This journal belongs to Ariaian Young Innovative Minds Institute, AYIMI, and one to two issues is published in a year. All details are on the YOUNG SCIENTIST RESEARCH Journal website (http://journal. ayimi.org)

CURRENT ISSUE
Vol 3 NO 1 AUG 2019

AYIMI AND THE MAIN GOALS IN EDUCATION

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A B S T R A C T

To find how scientific communities can encourage students to learn science in a friendly atmosphere and then combine scientific fields and arts to show the beauty of different solving problems by the creativity is explained in this report.

A R T I C L E   I N F O

This is about the main scientific activities have been organized in AYIMI

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1 About AYIMI

AYIMI is an international institute which is representing of different international tournaments such as IYPT, IJSO, ICYS and so on. In our experience, you need to be both imaginative and practical in drawing up your research in physics, chemistry, biology and other scientific fields and this institute gives you the opportunity to learn basic sciences practically. This network enables members also to share information and exchange their own ideas on a wide range of topics. National and international awards are given to top participants in several activities from all over the world every year which will bring our young talents even closer together.

AYIMI has been founded about 10 years ago to educate innovative minds , encourage young generation to learn science to enhance their potential in living better on Earth and to use natural resources in a correct way. AYIMI has been the organizer of two different international events in 2011 and 2012 to introduce IJSO and IYPT to young students and also to give the chance to all the participants from around the world to know Iran and its culture much better it is also a way to develop scientific tourism industry.

2 The Main Goals

AYIMI main goals are as follows:
- Building capacity from idea to manufacturing
- Communicating with other national and international institutes
- Organizing and performing different national and international tournaments, conferences and workshops
- Cooperating with different administrative organizations
- Developing scientific tourism

To change some students' beliefs that learning science is difficult and boring, we tried to combine the arts and standard curricula together. By attracting students in different national and international activities which are based on applied sciences, we got to our main goal which Arts in Science Education (ASE) can give students the opportunity to express their thoughts , feelings and their abilities in solving problems and also understand science through the lens of their creative activity .

In scientific communities we can encourage students to solve problems by finding connections between different scientific fields and arts in different cultures . Students find the beauties of science with its complexities by looking carefully at nature and everything around them in their everyday life. Then by using Art they can illustrate their observations and interpret their main ideas, or analyze real scientific problems using their own creative approaches.

Arts in Science Education (ASE) offers a new model for 21st century teaching to help the shift from human labour to mechanical labour based on human imagination and novelties so it should be considered that:

·   Science and Arts can impact to each other
·   Problems cannot be solved alone just by Science and Arts can help to find the solution too [1].

Imagination is a key to bringing dreams into reality, and in science education it is necessary to ask students to try to make imagination deeper. Thus, our students should take an active role in both their own development and that of those around them. A way to include project-oriented learning combined with art can help their scientific imagination and strengthen it. By constructing mental images and building models they will overcome difficulties in the construction of long-lasting science knowledge. Students should learn to design their own model related to the scientific concepts and draw from their imaginations.

By adding some ink in water to show circulation and ocean currents , making beautiful lens, making origami in modeling a physics problem and other beautiful experiments students can show their imaginations (Fig. 1) [2].
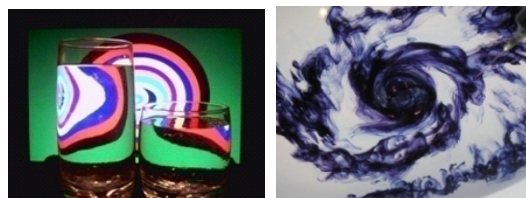

Fig. 1: Imagination in scientific experiments

Origami in Science as ORIGA-SCIE (Was introduced in Birmingham University, ICWIP 2017) as one of AYIMI festivals , asks students to build their own models by using an A3 or smaller sheet paper and investigate some scientific phenomena and measure the most important parameters in solving the proposed problems by these models. Designing and construction a paper model and calculating the factors affect the structure to access the optimal designs in reality, is one of the models in Active Learning by Innovation in Teaching (ALIT) [3] which during several years has caused the improvement of learning physics (adib.ayimi.org) .

Students in our institutes have a lot of freedom to move in any direction of interest they would like. While this approach may seem more difficult logistically or pedagogically in our traditional system, a large fraction of students are prepared to study and are more engaged in learning when given the freedom to pursue their interests (such as participating in different national and international activities). Solving open-ended problems in basic sciences through their own models, imaginations, illustrations and learning analog skills in conceptual drawing and prototyping, helps students to learn even more difficult subjects and create new industries in the future too [4].

3 Different Forms of Communication

The enthusiasm for participation in various activities of the Institute in the form of group and individual work is according to the rules in each section. All the participants should pay for international programs include an entrance fee (registration) and training workshops by experienced professors in various fields and also publication of articles in international journals.

 Institutes and various scientific centers, cooperate with AYIMI in accordance with the short-term Memorandum of Understanding, which will be renewed by the willingness and consent of the parties.

4 AYIMI and Engaging in Several Activities
4-1 IYPT

The International Young Physicists' Tournament, IYPT, referred to as "Physics World Cup" too, is a theoretical and practical competition involves teams of five high school students from all over the world, preparing solutions to seventeen problems. The official language in IYPT is English, and IYPT is a member of WFPHC (World Federation of Physics Competition). IYPT was initially organized in 80's in Moscow. As the popularity grew, this tournament spread out and different countries started to participate. Now it takes place in different countries each year with more than 30 countries.

The rules for presentation of the results, opposition, reviewing and judgment by the independent jury are fixed in the Regulations of IYPT. During each Physics Fight (PF) students have not only to present their solution to one of the 17 problems as chosen by their opponent but they have to oppose the presentation of other students. The reporter then has to defend his solution against the opponent. The reviewer then summarizes what have been done by reporter and opponent (iypt.org).

AYIMI has been in IYPT from 2007 and in 2011 as the host , organized this event with coordination of Amirkabir university .

Team Iran succeeded to get **Silver medals** in IYPT 2010 and 2011 in Vienna and Tehran, successively , **Gold medal** in IYPT2012 in Germany and **Bronze medal** in IYPT

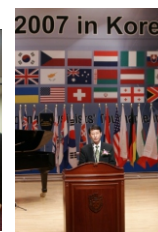2019 in Warsaw University of Technology.

IYPT 2007, Korea   Professor Gunnar Tibell (past IYPT president)

IYPT 2008, Croatia

IYPT 2019, Warsaw

4-2 PYPT

To provide a program of educating and supporting teaching assistants, Persian Young Physicists' Tournament, PYPT, has been organized to develop assessment tools to evaluate student progress in problem solving, technical presentation in English which is not their native language, and team working. The 1st Persian Young Physicists' Tournament (PYPT) was in March 2008 which two selected teams participated in Austria (AYPT) and IYPT to get the first experience from this attractive challenge. Now students from different high schools in Iran are able to request entry into PYPT , which is carried out in a period determined by the PYPT Executive Committee (ECO) every year. The best teams receive rewards but the best students with highest individually scores as the PYPT Regulations are selected and after education, participate in International Young Physicists' Tournament, IYPT.

4-3 IJSO

International Junior Science Olympiad (IJSO) is an annual individual and team competition in the Natural Sciences for students who are fifteen years or younger.
It has been established in recognition of the significance of the Natural Sciences in the general education of young

people and in all aspects of their lives.

The aims of the IJSO are:

- to promote and reward the pursuit of excellence in scientific endeavor.
- to challenge and stimulate gifted science students to develop their talents.
- to select the top young science student teams at the annual IJSO.
- to encourage the continued participation in the study of the Natural Sciences.
- to create friendship and relationships among students around the world from an early age.

The 1st and 2nd IJSO was in Indonesia , 2004 and 2005 and then it spread to different countries . Every year about 50 countries participate in this great event.

The competition is divided into three tasks, prepared by the SC and conducted over three days with an interval of at least one day between each task. The time allotted to each task should normally be three to four hours. The OC decides the sequence of the competition days.

The problems consist of three tests. Test One and Two are individual competitions. However Test Three is a team competition, where one team consists of three students of each delegation (each country may have two teams for task three).

Test One is a multi-choice-questionnaire (MCQ). The number of questions should be 30 (thirty). Questions for Test One should include Physics (10 problems), Biology (10 Problems) and Chemistry (10 problems). Each question shall have four possible answers with only one is correct.

Test Two is a theoretical test. The number of tests should be 2 (two) or 3 (three). Test Two should be more complex involving a combination of Physics, Chemistry and Biology.

Test Three is a experimental task. The number of tasks should not exceed 2 (two). Questions for Test Three should be the combination of Physics, Chemistry and Biology and should be in equal proportion.

The problems must

• be related to the syllabus of IJSO, and cover all content of the syllabus as much as possible.

• be reviewed by the IJSO Scientific Experts (not the local SC, but an ad-hoc Scientific Committee formed by the EC) prior to the problem discussion.

• be created innovatively and the answers must be language independent (IJSO official website).

4-4 IRJSO

AYIMI participated in IJSO 2008, Korea for the 1st time and then Iran Junior Science Olympiad (IRJSO) was organized as a country Olympiad to encourage junior students and to select team Iran for IJSO.

The 9th International Junior Science Olympiad with participants from 32 countries was held by AYIMI on Dec. 1-10, 2012 in Iran. All the problems were provided by

AYIMI Scientific Committee (SC) and they tried to introduce Persian Gulf and one of the most important botanic samples, Mangrove(Avecina Marina) forests to the participants.

4-5 IYNT and PYNT

International Young Naturalists' Tournament (IYNT) is held in order to find and support talented young people, to develop creative abilities of students who show a strong interest in science classes. The initiative group headed by representatives of the Lomonosov Moscow State University, MIPT, Bauman MSTU and the journal "Potential" has decided to develop a special program of extracurricular activities to enhance students grades 6-9 – the program of the Young Naturalists' Tournament. Exactly naturalists, because children of this age don't divide science into certain areas (physics, chemistry, etc.).

IYNT regulations is the same as IYPT but a little difference in some items.

The 1st IYNT was held in Eskisehir, 2013 and every year it is held in different countries (iynt.org).

Persian Young Naturalists' Tournament (PYNT) was organized by AYIMI from 2013 and every year students from several schools participate in PYNT . To encourage young students , AYIMI gives the best teams gold, silver and bronze medals.

Iran has participated in the 1st IYNT 2013 which was held in Eskishehir in Turkey . The science federation of Russia was the organizer of this tournament with cooperation of Osman Gazi University in Turkey and minister of Science &Technology.

IYNT 2016, Shiraz

4-6 IPT and IRPT

International Physicists' Tournament (IPT) was born in Ukraine in 2009 as a continuation of a long tradition of physics competitions in USSR. It brought together 16 teams from the leading universities of Ukraine and neighboring countries. In the following years, the tournament was held in Kiev and Moscow. Over the years, more and more countries took part in this event. In the 2013 edition, the tournament welcomed ten countries:

China, Denmark, France, Poland, Romania, Russia, Singapore, Switzerland, United Kingdom and Ukraine.

A list of 17 problems is created every year for the IPT. and in April, all teams gather to compare their solutions in several rounds of so-called Physics Fights. During each Physics Fight, 3 teams confront each other. Fight after fight, they play the roles of Presenter, Opponent and Reviewer.

The performance of the teams is judged by an experienced jury, and the 3 best teams get into the final . On top of the challenge that the tournament represents, to take part in, it is an amazing experience in which you will learn how to constructively criticize scientific solutions. This is something that you cannot find in any University course, and it is very close to how real science works!

AYIMI participated in IPT 2015 in Poland for the 1st time and IRPT 2015 is the country selection tournament.

4-7 ICYS and IRCYS

International competitions play an important role in the education of highly talented   students opening new possibilities to extend their knowledge in sciences. There are many types of competitions, the International Conference of Young Scientists (ICYS) is a special type of individual competition, in physics, mathematics, computer science and ecology for up to 20   years-old students. Every participant has to prepare a research report on a subject chosen by herself/himself from any part of the above mentioned sciences. The language of these ten-minute reports is English and an international jury evaluates and rewards the presentations.

Every year generally 60-70 lectures are delivered in 4 section on the Conference. This kind of competitions has

importance in teaching the students:
·   to do research work,
·   to present and discuss their own results,
·   to formulate research reports,
·   to give presentation in foreign languages

The subjects of the presentations must be connected with any topic of physics, Mathematics, Computer Science, Environmental science and Life Science (ICYS Regulations and official website).

The first ICYS was in Visegrad in 1994. Then 70 lectures were presented by students from 5 countries. In 1996 the number of participants increased, 86 lecturers from 9 countries gave their lectures. The Conference has a good reputation not only in the Middle European countries, but outside Europe too and now more than 30 countries participate in ICYS every year .

AYIMI has participated in ICYS from 2010 and Iran teams are selected in IRCYS each year.

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TO GET ELECTRICITY FROM THE PLAY TOOLS IN PARKS

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A B S T R A C T

Many children are busy playing in the parks and game fields every day, and a lot of the movement energy of the children are wasted, while this energy can be used appropriately. The purpose of this project is to use the rules of electromagnetic induction, by placing the magnet and the coil together and changing the gap between them which causes changing the magnetic flux so the induction driving force creates a flow of electricity that turning it into a luminous energy and lighting the park lights will prevent waste of energy.

1 Introduction

The pollution crisis and the excessive use of fossil fuels as energy sources have brought up many problems, such as a variety of diseases, rising global temperature, melting of polar ice and so on.

Fossil fuels are the driving force behind technological progress. But the evacuation of fossil fuels and the disastrous effects of excessive consumption have forced humanity to rethink the use of fossil fuels as a source of energy. Fossil fuels are capable of supplying the energy of the whole world for several hundred years. The modern world owes most of its technological progress to these fuels. But unreasonable consumption of fossil fuels has caused many problems around the world.

Earth is the planet that has been the most important source of energy and fossil fuels for its inhabitants at the heart of the planet, but these resources are not infinite and end up, and at the same time they can be used only once, and for this reason, human beings have to think differently to supply their source of energy. The Mother Nature has the response to this human need.

Failure to produce air pollutants in the use of renewable energies compared to fossil fuels is a very important advantage to bring a variety of new energies.

That led to the idea for this project take shape in our minds, so that in addition to clean electricity generation and help to resolve environmental crisis, the energy loss of children is prevented.

2 Research literature

Michael Faraday, stated that the main factor in the creation of an electric flow is changes in flux, $\Delta\varphi$ (Eq.1).

$$\phi = ABCos\,\theta \qquad\qquad (1)$$

According to the   electro-magnetic induction and Faraday's   law , by the flux changes we can produce the induced current in a circuit .

Faraday summarized the results of his experiments as follows:

 (a) An e.m.f is induced in a coil if the magnetic flux through the coil changes

  (b) The magnitude of the induced e.m.f depends on

   (I)the rate of change of flux

(ii) the number of turns on the coil, and

(iii) the cross- sectional area of the coil.

Points (ii) and (iii) simply refer to the amount of change of flux. The faster the flux is changed the greater is the e.m.f. produced.

The direction of the induced e.m.f. is explained by Lenz's law :

The direction of induced e.m.f. is such that it tends to oppose the change that produced it [1].

We have found all by the following experiment (Fig.1).

1.	By inserting a magnet, the galvanometer hand was distorted.

2.	By removing the magnet, the galvanometer was diverted in the opposite direction.

3.	The direction of movement of the galvanometer in two poles N is similar to the exit of the polarity S and vice versa.

4.	The faster you move the magnet, the more divergent the hand was.

5.	When the magnet was not moving in the coil, the galvanometer did not deviate.

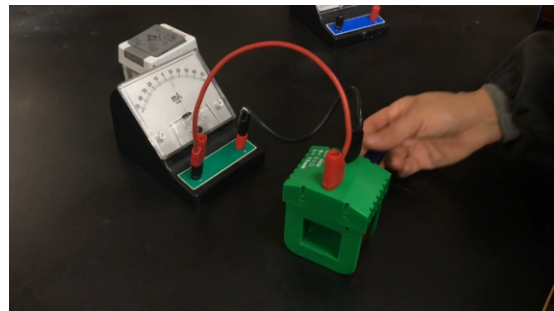6.	The more the number of wires in the coil, the more divergent handles are diverted .

Fig. 1: Electricity production with coil, galvanometer and magnet

Results of the test of the difference in the electric current in terms of direction of movement and the direction of the magnet pole are shown in Table (1).

Table 1: Testing the difference in the amount of electric current produced in direction of movement and direction of the magnet pole

Flow (µA)	Magnet pole direction	Direction of magnet movement	Number of turns of the coil
-10	N	in	300
10	N	out	300
12	S	in	300
-12	S	out	300

The results of the test of the difference in the electric current in terms of the change in the speed of the magnet entry and exit are shown in Table (2).

Table 2 : Testing the difference in the amount of electrical current produced in terms of the change in the speed of magnet entry and exit

number of turns in a Coil	Magnet pole flow	Direction to move	Speed	Flow (µA)
300	N	Exit	slow	10
300	N	Inter	fast	-15
300	S	exit	slow	-10
300	S	inter	fast	15

3   Research method and experiments

3-1 The Selection of Coil Materials

According to our research, wires that are good conductors and yet easy to find are copper wires.

The conductivity of gold and silver is greater than copper, but not used because of the very high cost for the consumer. The results of the wire test are shown in Table (3).

Table 3: The choice of coil type

Electric Resistance (Ohm Meter)	Metals
1.59×10^{-8}	silver
1.68×10^{-8}	copper
2.82×10^{-8}	aluminum
10×10^{-8}	Iron

3-2 The Number of turns on the Coil

According to the experiments, the diagram of increasing the amount of electric current in terms of increasing the number of turns on the coil is a sinusoidal diagram and after 1000 turns, due to the high energy loss in form of heat, we will face reduction in the amount of generated electric current (table 4).

Table 4: The number of turns on the coil

Number of the coils	Magnet pole direction	Direction to move	Wire diameter (mm)	Electrical current (µA)
300	N	enter	0.3	4
500	N	enter	0.3	10
1000	N	enter	0.3	18
1200	N	enter	0.3	16

3-3 Magnetic Power Test

Test hypotheses of the determination of the magnet's power is as follows:

1. According to research, the strongest magnets in the market are neodymium magnets and are available at this time, which is why this type of magnet was used.

2. Because of the circular shape of the coil, pill shaped magnet are used that could easily be inserted into and out of the coil.

3. Due to the presence of two coils on two sides of the magnet, two magnets were used.

4. Because of the limitation in the size of the coil and force, the size of the magnet and the coil of magnets 1 cm (diameter) at 2 centimetres (height) was used.

The results of the test for determining the strength of the magnet are shown in Table (5).

Table 5: Testing the strength of the magnet

Type of magnet	Magnet shape	Magnet volume (cm³)	Number of Magnets	Magnet Power (Gauss)	Number of lamps turned on
Neodymium	Pill shaped	2π	2	1000	2
Neodymium	Pill shaped	2π	2	2000	4
Neodymium	Pill shaped	2π	2	5000	8
Neodymium	Pill shaped	2π	2	5500	6

3-4 Type of the Lamps and the Numbers Required

SMD bulbs are famous for low electric consumption and high efficiency. As a result of our first research between SMD and LED bulbs, SMD lamps were much more successful at low consumption.

Assuming equal number of turns on the coil, type of the magnet, number of the magnets, the size and power of the magnet, experiment was conducted to determine the number of lamps required. The results of the test of the number of lamps needed are shown in Table (6).

Table 6: The number of light bulbs required

Number of the coil	Type of magnet	Number of Magnet	Volume (cm³)	Magnet Size (cm)	Number of bulbs	Did all the lights turn on?
1000	neodymium	2	2π	5000	4	yes
1000	neodymium	2	2π	5000	6	yes
1000	neodymium	2	2π	5000	8	yes
1000	neodymium	2	2π	5000	10	no
1000	neodymium	2	2π	5000	9	no

3-5 Testing the Height of the Flip-Flop and the Number of wires Turn on the Coil

The height of the flip-flop and the amount of electric current are in direct relationship with each other and according to the experiments, the more height of the flip flop from the ground increased, due to the increase in the speed of coils at the moment of collision with the magnet, more currents are generated. But because of the limitations in the construction of the flip- flop in our experiment, the maximum altitude of utilization was eight centimetres. The results of the test for determining the flip-flop height and the number of turns on the coil are shown in table (7).

Table 7: Testing the height of the flap and the number of turns on the coil

Number of turns on the coil	Type of magnet	Number of Magnets	Volume (cm³)	Magnet shape	Electrical current (µA)	Height (cm)
1000	Neodymium	2	2π	Pill shaped	4	2
1000	Neodymium	2	2π	Pill shaped	6	4
1000	Neodymium	2	2π	Pill shaped	8	6
1000	Neodymium	2	2π	Pill shaped	10	8

4   Results and How to Build a Replica (Moquette)

The procedure, requirements and test results are as follows:

1. Initially, in accordance with the tests carried out, the coil was selected for 1000 rounds, and two of them were made.
2. According to the research, it was concluded that the best type of lamp for this purpose is SMD lamps.
3. Then, the lamps were illuminated according to the tests, and the lamps were prepared and connected to the flip-flop.
4. According to research, the strongest available magnets are neodymium magnets with a diameter of one centimetre in diameter and two centimetres in height, which were used.
5. According to the experiments, the 5000 Gauss magnet = 0.5 Tesla has the best possible return.
6. According to the tests, the best possible height for the flip-flop is 8 cm.

As a result the replica was made using written gadgets (Fig.2).

Fig. 2: Experimental replica

5 Conclusions

According to the results of the experiments and research, two coils with 1000 rounds of copper wire with a diameter of 0.3 mm on each side of the flip-flop were used and with the up and down movement of the flip-flop each time, four SMD bulbs were lit with the use of 2 pill shaped neodymium magnet with one centimetre (diameter) at two centimetres (altitude) and a power of 5000 Gauss per side of the flip-flop.

We know if the magnetic flux through a coil is altered then an e.m.f. will be generated in the coil. According to the Faraday's laws and Lenz's law , either moving the coil or source of the flux relative to each other or changing the magnitude of the source of the flux in some way, e.m.f. could be generated and also faster the flux is changed , the e.m.f. is produced greater.

6 Future work

This research is trying to save energy and it can be used this energy source for playing music as well.

We are trying to assemble this kind of system on another play tools like, swings and carousels in future.

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AQUA OPTIMIZER DEVICE (AOD)

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A B S T R A C T

Aqua Optimizer is a device which has been designed to help people with using water in various background, including home use, especially in bathing. Three steps are defined for the device, each step indicates the amount of water consumed by the water in which the green, yellow and red lights are respectively lit when the water is being used, and if the user exceeds the limits then the device will cut off the stream and eventually prevents it from wasting the water.

1 Introduction

Water it is one of our most precious resources but our water supplies a limited. 97.5 % of the earth's water is salty and only 2.5 % is fresh water but over two third of this fresh water is locked in the polar ice caps and glaciers. This leaves only 0.5 % in our lakes for agricultural, industrial and personal use.

Based on the news agency the quality of this water is under threat. According to the world health organization, only 0.007% of the world, total water supply is safe for consumption and this amount of water needs to be shared by the more than 7 billion people on the planet. Water scarcity is the lack of fresh water resources to meet water demand. It affects every continent and was listed in 2019 by the World Economic Forum as one of the largest global risks in terms of potential impact over the next decade[1].

A water crisis is a situation where the available potable, unpolluted water within a region is less than that region's demand and based on the information nowadays two-thirds of the global population (4 billion people) live under conditions of severe water scarcity at least 1 month of the year. Half a billion people in the world face severe water scarcity all year round. Half of the world's largest cities experience water scarcity [2].

It also occurs where water seems abundant but where resources are over-committed, such as when there is over development of hydraulic infrastructure for irrigation. Symptoms of physical water scarcity include environmental degradation and declining groundwater. While the concept of water stress is relatively new, it is the difficulty of obtaining sources of fresh water for use during a period of time and may result in further depletion and deterioration of available water resources[3].

Water shortages may be caused by climate change, such as altered weather patterns including droughts or floods, increased pollution, and increased human demand and overuse of water. Therefore, challenges rise up more rapidly without solution. Two in 5 people are affected by water scarcity. It is a water crisis because it starts with water but water effects everything. Education, health, poverty and specially women and children.   Well population growth increases demands for water , food and, energy. Meanwhile Rivers dry up and no longer reach the sea.

As clearly stated in researches by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity and two third of the world's population could be living under stressed conditions[4]. So the main reason of this research is designing a device as Aqua Optimizer to help people with using water in various background, including home use, especially in bathing.

Three phases are define in this device and each phase indicates the status of water consumed by the users thus the green, yellow and red lights will respectively turn on in order to manage the consumption in which the red lights flashing means it might be using too much water and accordingly our device will cut off the water flow and actually prevent it from wasting the water.

2 Modeling

Aqua means water and optimizing means make the best or most effective use of (a situation or resource). Our device is divided in two major parts: first part is the Warning box, which includes LEDs, Printed circuit board and adopter, which has to connect to an electrical outlet for running the device and the second part, is Tube section, which includes the sensors (Fig. 1).
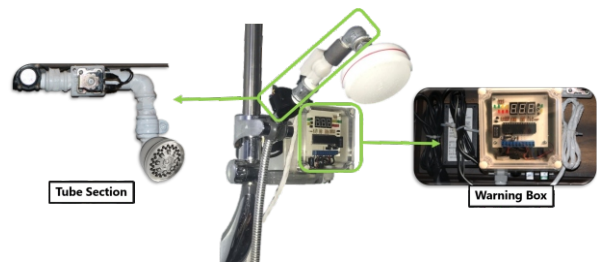

Fig. 1: The schematic of our Aqua Optimizing

At the beginning of the tube section, we have a sensor called flow meter, in which there is a turbine wheel inside that and there are some magnets upon the wheel. According to the volume flow rate every time that turbine wheel rotates it means a pulse. So after the water flowed through the tube section, our microcontroller will start counting the pulses and then the order to illuminate the LEDs.

Five phases are launched and united on this device. Each of them bring a specific kind of order and concept. In this way, the first phase that turns on is due to start Run; it means that the device is working.

The second phase is green and in fact, it condemns that the amount of water consumption is scanty and low. This step has been provided for users to realize that they can continue using water on those moments.

The third phase is the warning, which has Yellow lights, so that you will find your water consumption has reached its normal range or you are at the middle of your standard usage and you should probably leave.

The next phase is high water consumption with Red lights that illustrates indication quote of warning that you have used too much water. On those moments, your water usage and consumption are riding out of the standards and you must leave the bathroom immediately after.

The last phase is stream interrupting. At the end of the High water stage, Red lights are going to flash, and after flashing, the device will cut off the water flow and eventually prevent it from wasting water .

The stages related to light phase are clear in figure (2).
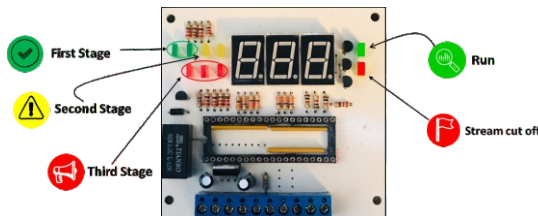
Fig. 2: Light phase stages in Aqua Optimizer

3 Materials and Methodology

The features and options of Aqua optimizer:

1)This invention expands the Contractual use of water in several steps with lights flashing and LEDs so that users can realize at what phase of water consumption they are! In addition, they could be able to schedule their consumption with water in order to take advantage while using water.

2)This product has the ability to cutoff the water flow, so Red lights flashing mean after over-use of the water it will cut off the water stream so the water is not going to being wasted by the users.

3)We installed the Restart button into AODs options by over thinking so that if there is anyone in an emergency, they could repeat this process by pressing the button and go through another course of water stream.

4)We can vary our defined limits for the lights related to any situation. For example, the standard water consumption for bathing in each country may vary, so we put an option to change the limits

5)There is a genuinely great access to connect AOD device into your home, tube section is near the waterspout and the warning box can be connected anywhere with the tag or the dealer because it is lightweight and water proof.

6)We use some panels which are seven segment most of the people are familiar with that as we can observe in streets in traffic lights counter that shows some number. this panel in AOD shows how much water you have used from the beginning of opening tap.

7)Leak of the valves and pipes in many cases can lead to a lot of water loss, but when AOD is connected to your spout water, no drop of water can escape from the head shower.

8)AOD is not used solely for bathing, but wherever a stream of flow is passing away. For example, washing the

dishes or like in traditional agriculture, when farmers open the faucet and leave it, the device can be stand according to standard value and limits which we are going to define for and when it reaches the high level of consumption it will cut off the stream and there is no one to press the restart button. It is done by inserting a microcontroller which is the connector between AOD and our computer .

4 Theory

We code AOD with C++ and also two related physics theories , Bernoulli's principle in fluid dynamics and volume flow rate are used in AOD calculations .

Bernoulli's principle in fluid dynamics (Eq.1) , states that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy and the volumetric flow rate (Eq.2) is the volume of fluid which passes per unit time [5].

The flow rate in different pulses is found in table (1) [6].

$$\rho gh + \frac{1}{2}\rho v^2 + p = \text{constant} \tag{1}$$

$\rho = Density$

g = Gravity acceleration

h = Height (length)

v = Velocity

P= pressure

$$Q = A \times V \tag{2}$$

$Q = quantity\ flow\ rate$

$V = average\ velocity$

$A = cross\ sectional\ area$

Table 1: The flow rate in different pulses

Flow ($\frac{L}{H}$)	Frequency (Hz)
120	16
240	32.5
360	49.3
480	65.5
600	82
720	90.2

Figure (3) shows the schematic of AOD and also figure (4) Position of each component in the whole system in.
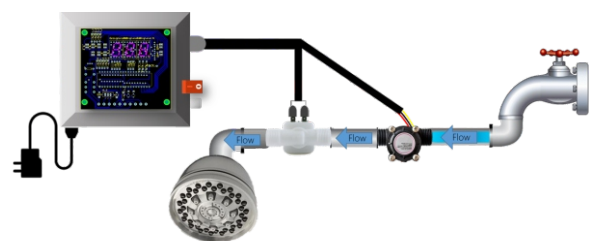

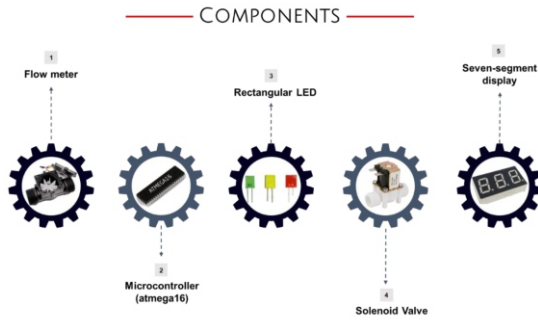**Fig.3:** AOD experimental setup and calibration

Fig.4: The components of AOD

5 Calibration

It is observed in different pressures, you are able to catch the flow with different pressures in different times without changes in AOD's function so as the experimental results, the pressure of the flow has no effect on AOD. (Fig.5 and 6) .
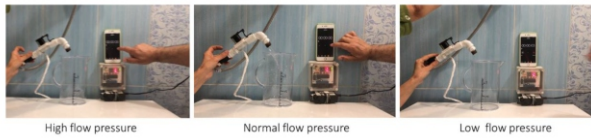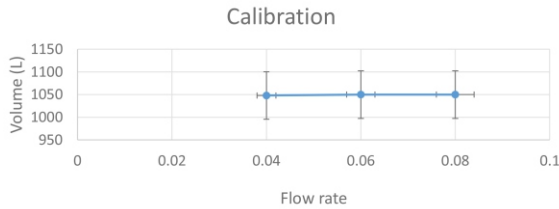

Fig. 5: Three different pressures in AOD's function

Fig.6: Volume versus flow rate in AOD

About the calibration Process, we can refer to the data sheet of the components as it is observed from the equation in 1 pulse/s the amount of flow rate is about 0.002 lit/s so in each frequency 1 litre of water stream should be about 500 pulses . Comparing theory and the experimental results shows only 20 pulses error in AOD (Fig.7).
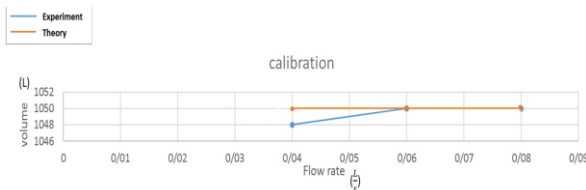
Fig.7: Comparing theory and experiment in AOD

Washing dishes and washing the head are compared with and without AOD. The comparison of water consumption by using this device(blue line) and without it (Red line) in washing the head shows water is saving (Fig. 8) and due to the result of our experiments, we are saving 41% of consuming water with AOD. It happens again in washing dishes (Fig. 9) and again we are saving 45% of consuming water while washing the dishes with AOD.
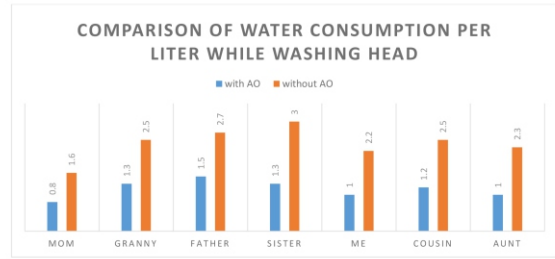
Fig.8: The comparison of water consumption with AOD (blue line) and without AOD (Red line) in washing the head
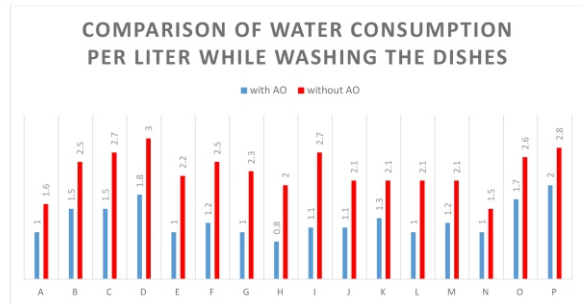
Fig.9: The comparison of water consumption with AOD (blue line) and without AOD (Red line) in washing the dishes

By using this device, we are saving and managing our water, time and other natural resources such as electricity, but the most important part is that we are making appropriate and perfect behaviour through our nature .

6 Conclusions

AOD helps people for a better consuming of water and save more green energy, which means more money and better nature. According to the results we can save water by AOD in all different types of usage such as washing dishes or shower (Fig. 10).
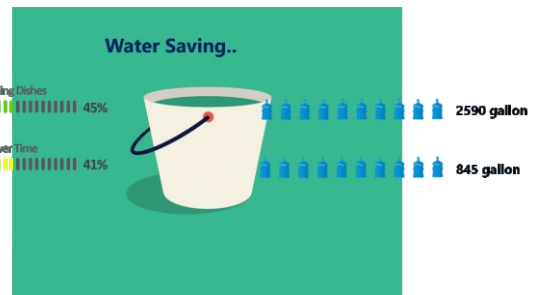

Fig.10: Saving water by AOD

Now we will talk about the future option:

1) There are different ways to warn and alert users. This warning can be a vibration, a beep-sounding alert, or simple and imaginable form of consumption (Fig. 11).
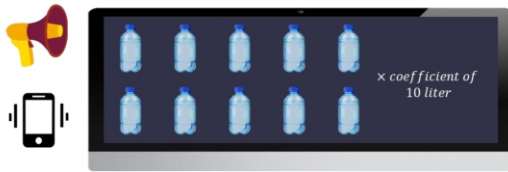

Fig. 11: Different ways of alarming

2) We can improve our device by sending Emails to let you manage your water consumption. To see your past and current consumption monthly , daily and even hourly and comparing your consumption to previous period of usage (Fig.12).

Fig. 12: Ways to improve AOD

3) However, the best option for those who do not pay attention to the warning is that, after the red light, the water pressure will gradually reduce until the moment of flow completely cutoff and you are not able to consume water after that for a certain time.

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SWIMMING VIBRATED BUBBLES

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ABSTRACT

This experiment is about the motion of the gas bubble in vertical oscillating fluids. Bubbles which are made on the surface, sink instead of rising in a tank with low-viscosity liquid. When a container of liquid oscillates vertically it is possible that bubbles in the liquid move downwards instead of rising. This phenomenon was first observed in rockets engines. There are some pressure sensors in the rockets that make the parts of the rocket release in each layer of space. Because of the oscillation in the engine, sinking bubbles effect on the sensors and made the rocket to release its parts sooner and this makes the rocket explodes. This phenomenon has been investigated in this research.

1 Introduction

By shaking a container of liquid , it oscillates vertically and the bubbles in the liquid moves too. When the container moves up it makes the bubbles move down and visaversa . Bubble moves downward more than it moves up because of the smaller volume and smaller amount of water it needs to replace , when it wants to move down. These frequent phenomenon makes the bubble sinks.

2 Experimental Setup

A 50V speaker is connected to an amplifier (to empower the volume) and the amplifier is also connected to a smart device which has a frequency generating APP . A cylindrical glass with a plastic cap is used as the container. The container height and diameter is 10cm and 2cm, respectively. A slow motion camera, 240 frame /second is used to take the videos. Movements of the bubbles are tracked for collecting and analyzing data (Fig. 1)

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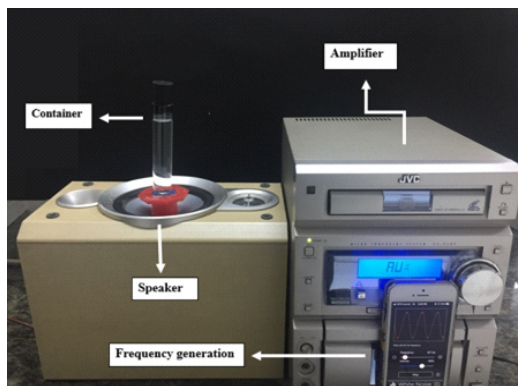
Fig.1: Experimental Setup

3 Theory and Model

3-1 Pressure and Acceleration

When fluids with different viscosity and density are next to each other there will be an instability in the system which causes the development of turbulence and makes the liquid grab the air and make some bubbles.

In order to investigate this phenomenon theoretically some conditions are considered .The fluid is considered incompressible and bubble is considered isothermal and the gas inside is considered as ideal gas . Because n, R and T are constant so in the 1st and 2nd situations in our system, S_1 and S_2, PV will be constant in the whole container (Eq.1).

$$PV = nRT \qquad P_T V_B = P_E V_{B_0} = const. \qquad (1)$$

Pressure in S_1 is equal to external pressure and in S_2 is equal to pressure of the water over it and external pressure (Eq.2) (Fig.2).
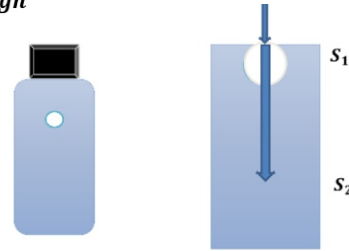
$$P_t = P_E + \rho g h \qquad (2)$$

Fig.2: Position of bubble in two situations, S_1 and S_2

The movement of the speaker is sinusoidal so the place of the container and the acceleration which is applied by speaker can be calculated (Eq.3).

$$\ddot{x} = A\omega^2 \sin(\omega t) \qquad (3)$$

The acceleration of the bubble is equal to g plus acceleration applied by speaker(Eq.4).

$$a_{bubble} = g + A\omega^2 \sin(\omega t) \qquad (4)$$

3-2 Volume of the Bubble

Volume of the bubble can be calculated according to the ideal gas (Eq.5).

$$P_T V_B = P_E V_{B_0} = const.$$
$$V_B = \frac{P_E V_{B_0}}{P_E + \rho x(g + A\omega^2 \sin(\omega t))} \qquad (5)$$

According to Taylor's expansion this equation can be changed and simplified with two variables (Eq. 6 and 7).

Part 1: $\dfrac{\rho x(g+A\omega^2 \sin(\omega t))}{P_E} \ll 1$ (6)

$$V_B = V_{B_0}(1-\frac{\rho x g}{P_E}(1+\frac{A\omega^2}{P_E}\sin \omega t))$$

$$\gamma = \frac{\rho H_0 g}{p_e} \qquad W=\frac{A\omega^2}{g}$$

$$V_B = V_{B_0}(1-\gamma\frac{X}{H_0}-\gamma\frac{X}{H_0}w \sin \omega t) \qquad (7)$$

3-3 Forces Affecting on the Bubble

There are three forces affecting on the bubble; buoyant force, weight force and drag force (which is always in opposite direction of the movement)(Fig. 3). According to the Newton's Second Law we have (Eq. 8 and 9):

$$w - f_{(b)} + f_{(v)} = \frac{dp}{dt} \qquad (8)$$

$$w = m(g+A\omega^2 \sin(\omega t))$$
$$f_b = \rho_l V_B(g+A\omega^2 \sin(\omega t))$$
$$f_V = -4R^2\Psi(Re)\dot{x}^2 sgn(\dot{x})$$

$$m(g+A\omega^2 \sin(\omega t)) - \rho_l V_B(g+A\omega^2 \sin(\omega t)) + -4R^2\Psi(Re)\dot{x}^2 sgn(\dot{x}) = \frac{dp}{dt}$$
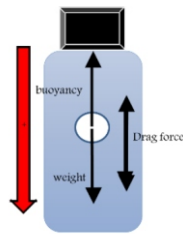
Fig. 3: Three forces affecting on the bubble

Because of the acceleration of the bubble inside the liquid, added mass should be considered (Eq.10 and 11) .

$$p = \bar{m}v \qquad p = (m_b+m_a)\dot{x} \qquad m = m_b+m_a \qquad (10)$$

$$m_a = \frac{v_b\rho_l}{2}$$

$$\frac{d((m_b+m_a)\dot{x})}{dt} = \dot{m}_a\dot{x}+(m_b+m_a)\ddot{x} \qquad (11)$$

$$m(g+A\omega^2 \sin(\omega t)) - \rho_l V_B(g+A\omega^2 \sin(\omega t)) + 4R^2\varphi(Re)\dot{x}^2 sgn(\dot{x}) = \dot{m}_a\dot{x}+(m_b+m_a)\ddot{x}$$

By tracking the bubble its position and radius versus time are analyzed (Fig.4).
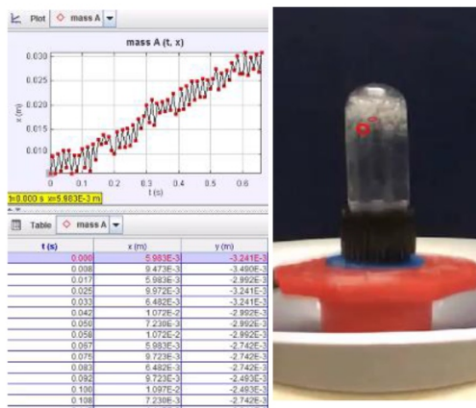
**Fig. 4:** Analyzing data by tracking the bubble and MATLAB software
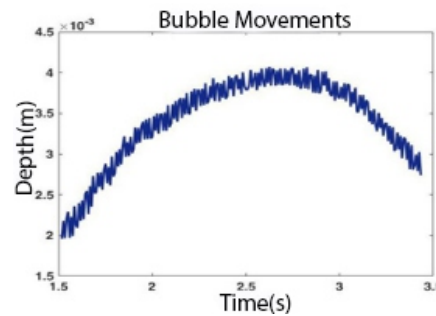
4 Experimental Procedures
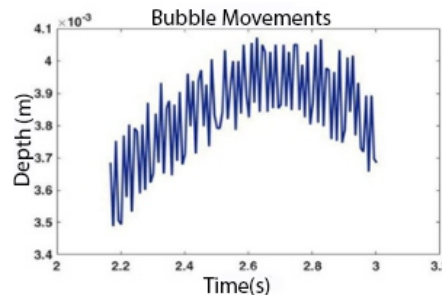### 4-1 Movement of the Bubble

There are three kinds of movements of the sinking bubbles. Ones which go down and will be constant ones go down a little and trap near the initial depth and a floating ones which go down a little and then they return to the surface because they couldn't pass the initial depth (Fig. 5 a, b and c).
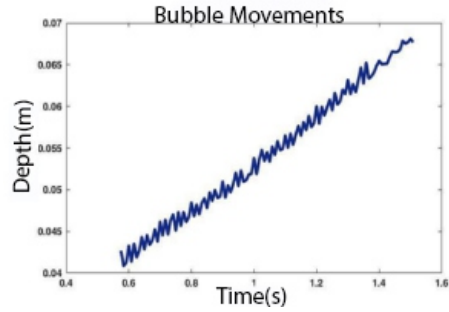

(a)

(b)

(c)

Fig. 5: Depth of the bubble per time , a) sinking bubble; b) floating bubble and c) constant bubble, respectively

4-2 Length of the Containers

In different lengths of container the behavior of bubbles are studied. The charts are not matched completely that is because of the turbulence in the system or amplifier is not perfect. That means the frequency which is applied to the system, might not always be sinusoidal (Fig.6a,b and c).
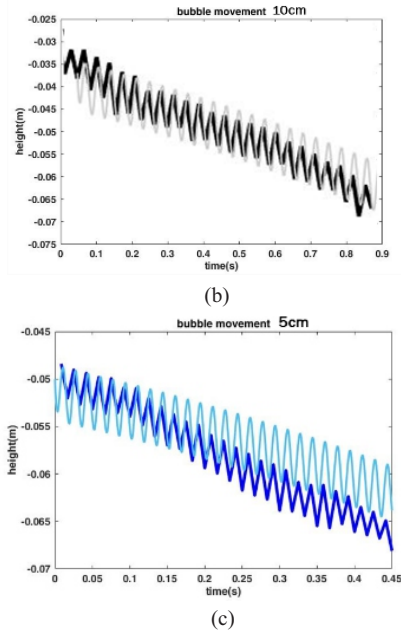

(a)

(b)

(c)
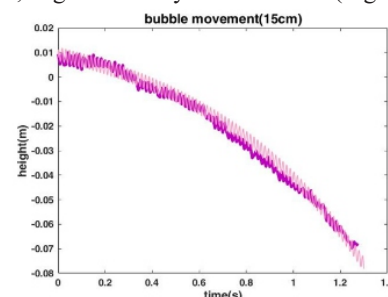
Fig. 6: Place of the bubble per time in containers with different lengths, a) 15 cm, b) 10 cm and c) 5 cm, receptively

4-3 Different Frequencies

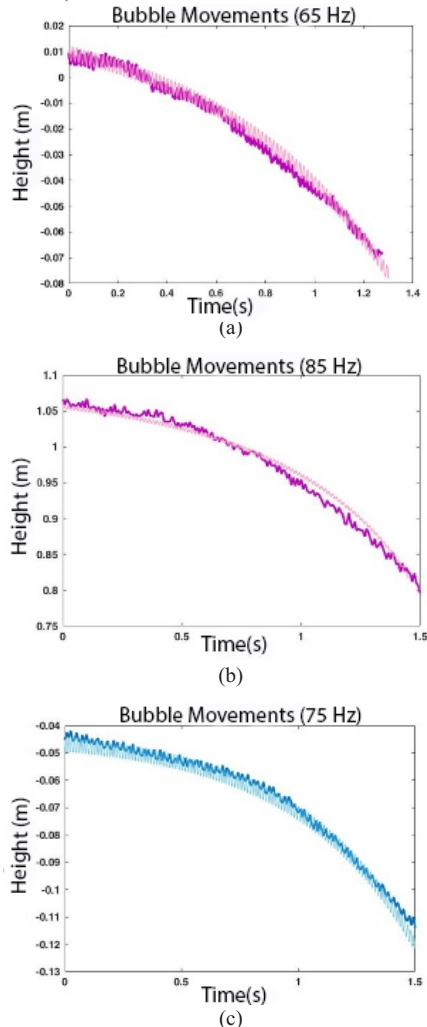Place of the bubbles are studied in different frequencies (Fig. 7 a, b, c).

(a)

(b)

(c)

Fig. 7: Place of the bubble per time in different frequencies a) 65 Hz; b) 85 Hz and c) 75 Hz, receptively

4-4 Using Different Liquids inside the Container

The situations of bubbles are studied in different liquids such as water and alcohol (Fig.8 a and b).

(a)

(b)
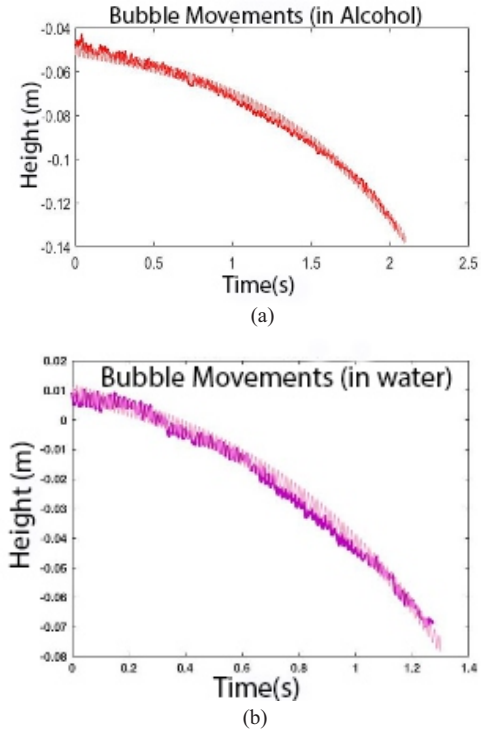
Fig. 8: Place of the bubble per time in containers with different viscosities, a) alcohol; b) water, receptively

5 Conclusions

By investigating the forces affect on the bubbles, differential equation was solved then we compared three kinds of movements of the bubbles according to four parameters .

• By comparing different frequencies in our experiment, it is clear that, in an specific range of frequency the bubbles can sink (Fig. 9).
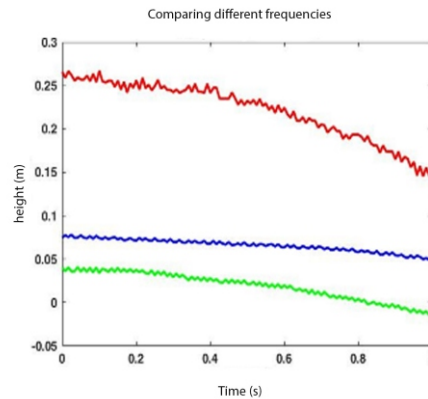

Fig. 9: Place of the bubble per time (comparing frequencies)

• As much as the viscosity and density of the liquid is lower the bubbles can move easier so it will sink sooner. So bubbles sank sooner in alcohol than water (Fig. 10).
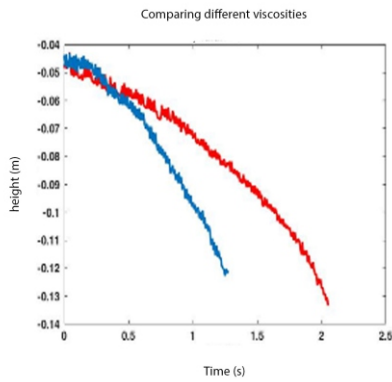
Fig. 10: Place of the bubble per time (comparing viscosities)

- As much as the container is shorter there is shorter distance in order to sink the bubble so it will sink sooner in 5cm than 10cm (Fig.11).
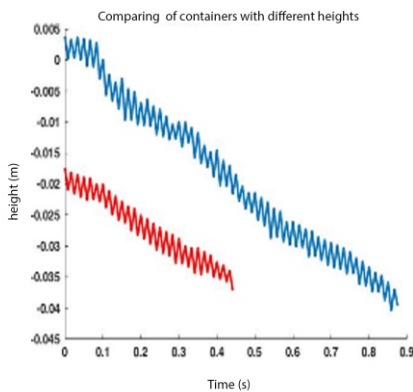

Fig. 11: Place of the bubble per time (comparing different containers)

- As much as the volume of the bubble is bigger, when it is made, the difference between added mass when it moves up and down will be more and it can be compressed more (Fig.12).
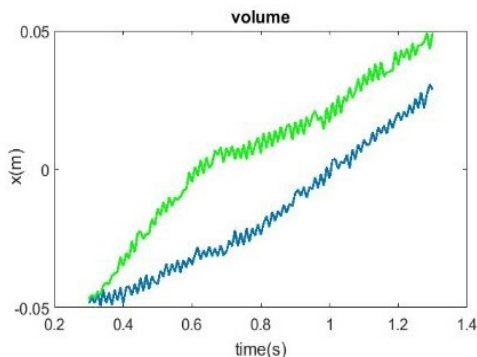

Fig. 12: Place of the bubble per time (comparing volumes)

In order to prevent the explosion of rockets some perforated cover plates can be used to increase the surface tension so bubbles will stick and won't affect on the pressure sensors . Another solution is that we can use a liquid with higher density and viscosity.

An application for this phenomenon is that we can use a gas solvent and a fluid with some resolvable in a container. It is oscillated then this bubbles will separate the particles from liquid. In some industries in order to separate particles from liquid they blow the bubbles but

with this set up we don't need to blow (Fig.13). This set up can be used in different industries.
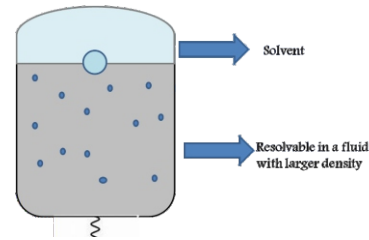

Fig. 13: An application for this phenomenon to separate the particles from liquid

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External Antioxidants; an Effective and Affordable Way to Overcome Salinity Stress in Plant

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ABSTRACT

Salinity stress is one of the threats for plants in deserts and some parts of the world. Plants exposed to NaCl suffer from oxidative stress, and their growth disrupts through DNA damage and enzyme inactivation. It seems that exogenous antioxidants can increase plant tolerance to salinity. Therefore, the effect of fruits peel extract such as pomegranate, sweet lemon and pistachio as extracted antioxidants on improving germination and growth of susceptible seeds to salinity, such as beans, lettuce and fennel were examined by using polar and semi-polar solvents, and ultrasonic bath and two positive (absence of sodium chloride and extracts) and negative (presence of sodium chloride and absence of the extracts) control groups.

1 Introduction

One of the most important environmental issues in Iran is desertification, which reduces the potential for biological production of saline soils [1]. The high tensions in the environment and soil of deserts and arid areas make vegetation vulnerable. One of these tensions is salinity, which negatively affects plant growth and weakens it. All plants can't withstand the salinity of the environment. A few species can survive in these conditions. Therefore, the vegetation of these areas is reduced [2, 3, 4].By reducing the absorption of water by root or by disturbing the ionic balance, salinity has an inhibitory effect on growth, production and metabolic processes of plants, such as photosynthesis, respiration and biochemical activity of the plant. Most environmental stresses, such as dryness and salinity, lead to the production of reactive oxygen species (a variety of free radicals), oxidative stress in plant cells, and ultimately cell death [4]. There are several ways to cope with this problem and help the plants grow in saline soils, such as; the use of osmoprotectants, the transfer of the gene of plants resistant to saline sensitive plants, and the use of Antioxidants [5,6,7]. During the optimum plant growth, the balance between the formation of free radicals and their use are strongly controlled by the antioxidant defense system of the plant [7,8]. The results obtained in this research can be used to regenerate degraded ecosystems, prevent soil erosion, and also convert saline lands to arable land in Iran, which leads to an increase in the quality and quantity of agricultural products.

2 Materials and Methods

Using studies from other researchers on the subject, seeds of three herbs, including beans, lettuce and fennel, were selected as salinity sensitive plants and their sensitivity was re-examined. Pomegranate, citrus limetta, and pistachio peels were selected as three high oxidant sources because of their antioxidant activity. Selected sources were exposed to air, and extract from 10 g each using four solvents with different polarity: aqueous the ability of various solvents to extract bioactive compounds from the peel fruit; through a chromatography of a paper layer using silica-coated aluminum and methanol and dichloromethane solvents; and studying the formation of

bands of extracts by UV light, was done. The extracts were dried using nitrogen gas so that the chemical solvents with the extracts did not enter the growth environment of the plants and did not damage the seeds. Each dried extract was mixed with distilled water and, to prevent the entry of any microorganisms and impurities, the solution was passed through a sterilization filter (0.22 μm). Seeds of selected plants were sterilized with diluted bleach under biohood. After three times washing, three seeds from each plant were entered into the growth medium containing 50 mM NaCl. The protective effect was studied in two groups of control- a positive control sample (absence of sodium chloride and extracts) and a negative control sample (presence of sodium chloride and the absence of extracts)- and treatment group- presence of a variety of extracts- to compare the growth rate of the seeds in the treatment and control groups (especially with negative control samples). In order to investigate the antioxidant ability of the extracts in antioxidant activity with DPPH, a clear solution of 200 μg of extracts extracted in methanol was prepared. 10 μl of extract with 200 μl of DPPH solution was heated at ambient temperature and in the dark for 30 minutes. Finally, absorption of each well was read at 570 nm. In order to focus on the research process, based on the results obtained in the initial test, repeat testing on bean seeds (its cost-effectiveness in broad applied scale in the case of lettuce with high water requirements and faster germination in the presence of extracts, unlike fennel) as a salinity sensitive plant, and citrus limetta (the greater effect of its polarized extracts on the growth of bean seeds, compared with other polar extracts) that it was used as an antioxidant source, was done.

3 Results and Discussion

According to the results, the type and amount of bio-compounds extracted by solvents used in different polarities are completely different. Aqueous extract of citrus limetta, improved seedling growth of beans (3 seeds of 3 seeds, length of buds of 5 cm) and its ethylated extracts increased the growth of lettuce seeds (3 seeds of 3 seeds, 3 cm long buds) significantly compared to the negative control group. The aqueous extract of pistachios, significantly increased the growth of bean seeds (1 seed of

of 3 seeds, length of 2 cm buds) and its ethyl acetate extracts improved growth of lettuce seeds (3 seeds of 3 seeds, length of bud 3 cm) and fennel (2 seeds of 3 seeds, 1 cm length). Superior extracts showed significant antioxidant activity in the DPPH test. According to this study, the pistachio ethyl acetate extracts (74%), the citrus limetta (69%) and the aqueous extract of citrus limetta (55%) have antioxidant quality. (Fig.1, 2 and 3)
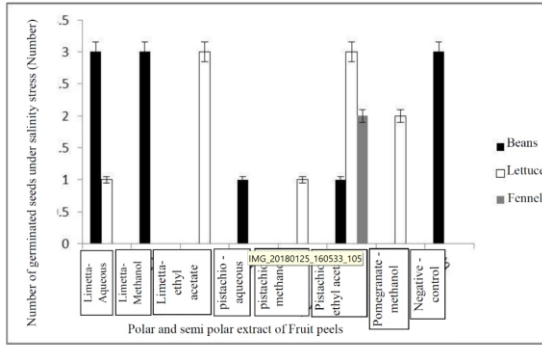

Fig.1: Number of germinated seeds of each plant under salinity stress (repeat = 3)
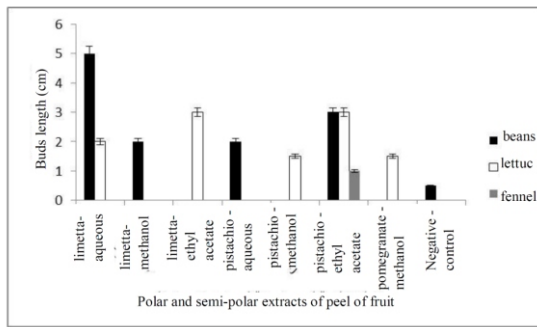
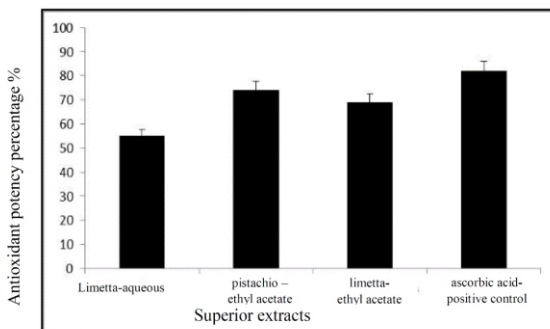**Fig.2:** Seed length of each plant under salinity stress (repeat = 3)

Fig.3: Antioxidant potency of superior extracts using DPPH, ascorbic acid and methanol was used as positive and negative control. (Repeat = 3)

According to the results of the repeated test, the effect of the bio-compounds extracted by the polar solvents used, namely, water and methanol, is different. The aqueous extracts of citrus limetta peel and methanolic extracts of citrus limetta peel significantly improved growth of bean seeds (9 seeds of 10 seeds with average length of buds of 56.9 mm and 8 seeds of 10 seeds with an average length of 19.5 mm buds) compared to the negative control group. (Fig.4, 5 and 6).
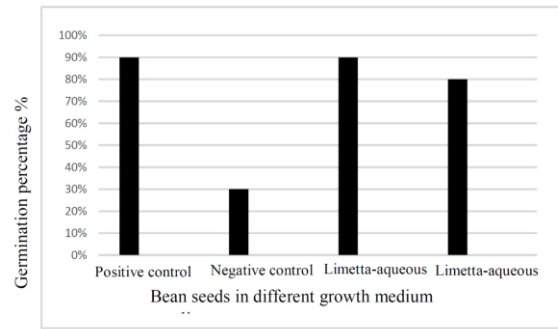

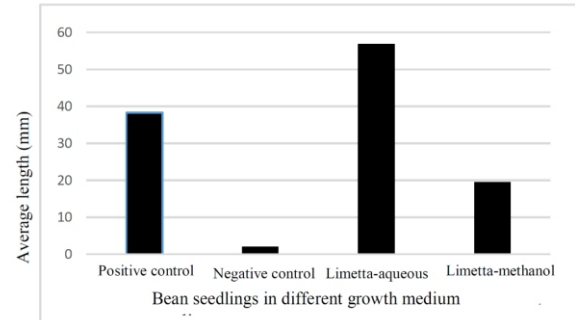**Fig.4:** Germination percentage of bean seeds in different growth medium
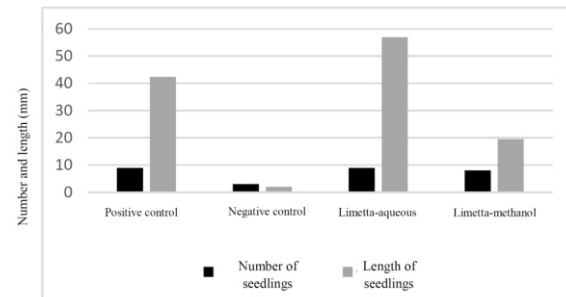

Fig.5: Average length of seedlings per mm

Fig.6: Comparison of bean seed function in different growth media

According to the observations, antioxidants in selected extracts increased the tolerance of saline-sensitive plants. The compounds of aqueous and ethyl acetate extracts have a significant effect on the growth of bean and lettuce seeds. Therefore, the compounds that affect the growth of bean seeds are polar, and the compounds that affect the growth of lettuce seeds are semi-polar. The factor that distinguishes this project from other research is extracting antioxidants from natural wastes which makes it very economical and applied solution in environmental issues. One of the important results of this study is the effect of antioxidants on plant tolerance to salinity, which is consistent with the results of other investigations.

4 Conclusions

According to the results, vegetable wastes, especially peel of pigmented fruit, are rich and affordable sources of antioxidants that can be extracted using various solvents and increase tolerate salinity sensitive plants to oxidative stress caused by salinity and growth retardation.

Some suggestions are made to continue this research; 1) Antioxidants are extracted with different solvents. 2) Experiments are conducted on different plant species with

different resistance. 3) Test are carried out on various bean species (Navy bean and Cowpea, etc.), which have different resistance to salinity. 4) In a separate project, instead of peeling pigmented fruits, antioxidant compounds from their nuclei are extracted. One of the limitations of this research was the lack of time for a sampling of natural saline soils and the plants were artificially subjected to salinity stress. And another limitation was the lack of time to carry out the experiment in the soil.

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BUILDING AN ELECTROSTATIC MOTOR

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A B S T R A C T

In this project, the motor was built to create torque using the corona discharge phenomena. The DC excitation was replaced with electrostatic generators. Effect of some parameters (e.g. geometrical configurations and input voltage of the electrodes) were investigated. The fabrication was somehow done that with a fixed input voltage, the maximum rotation speed of 2150 rpm was attained.

1 Introduction

Electrostatic motors are usually used in special environments. Their non-magnetic fabrication and structure simplicity make them have great potential for limited, magnetic or other environments that electromagnetic motors' operation could be disturbed [1].

On the other hand, corona motors work with low repulsive forces and the smaller their dimensions are, the higher is their force per volume and thus, the higher would be the output per unit weight [2]. Also, their insensitivity to material properties and their ability to produce torque with DC excitation makes them a possible interest in miniature applications [3].

In previous works by M. Hattori, et al, J. D. N. Van wyk and G. J. Kühn, M. K. Bologa, et al and Mazen Abdel-Salam, et al, the voltage on the electrodes was supplied by high voltage sources [2,4,5,6]. In this case, an exchange for a high voltage source and investigation of some effective parameters on the rotation is desired.

2 Materials and Methods

For experiment, a hollow cylindrical rotor made of polyethylene with aluminum coating beneath was used. The inner lining is used for sake of obtaining stable output. It has a constant potential. As a result, it plays the role of an opposed electrode against the corona electrodes. Thus, corona occurs in stable position.

The rotor was placed between two metallic electrodes and the electrodes were connected to the containers of Kelvin water dropper. The Kelvin water dropper is neutral after each spark; so, a Van de Graaff was continuously supplying it with charge. A syringe was used as the shaft so that the height of the rotor could change. Also, the electrodes were placed on EPS because of the high resistivity and the fact that the air gap spacing could change (Fig.1).
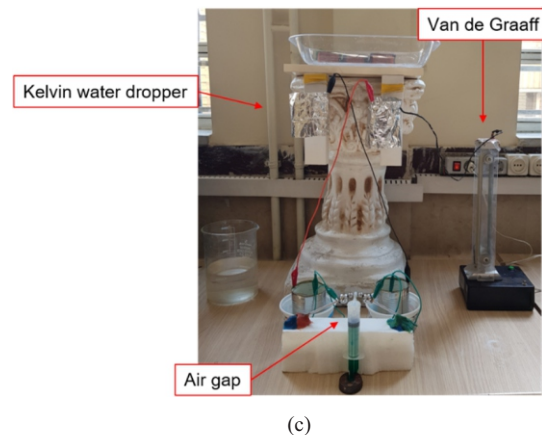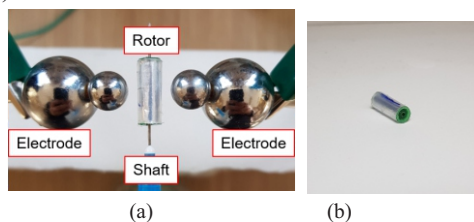

(a)   (b)

(c)

Fig. 1: a) (a) Placing the rotor between the electrodes ; b) the rotor; c) Experimental setup

For collecting data, a noticeable sign on the rotor was marked on the rotor. The rotor and a stopwatch were both placed in one frame and the rotation was recorded using a camera with the shutter speed of 240 fps. For sake of the precision, the recordings' speed was reduced one more time, then, the analyzing process took place.

3 Theory

There are two perspectives to explain the rotor's rotation, one of them is based on the ionization of the molecules and the other one is conferring to the charge dissipation. The explanation would be as following.

The voltage on the electrodes increases until the air in the air gap ionizes, then a charge which is the same polarity as the electrode, will be deposited on the rotor. If the rotor is slightly disturbed, a couple of charges will act on it, which according to Coulomb's law, causes the rotation, carrying the charge with it [4]. By reaching the opposite electrode, the charges would be neutralized by the ionized air gap of the other electrode with the opposite polarity. If this process carries on continuously, the rotor will rotate.

Relaxing time is another explanation to complete the rotor's rotation clarification. This term refers to the time that takes the charges to dissipate in the surrounding air. The time interval for charge dissipation could be calculated

using the following formulas (Eq.1 and 2)

$$\Delta t = Q_0 e^{\frac{-t}{\tau}} \tag{1}$$

$$\tau = \varepsilon\rho \tag{2}$$

where Q_0 is the initial charge placed on the surface, ε is the electrical resistivity and ρ the dielectric constant of the surface material.

To have a prediction over the motion of the rotor, the torque equation could be used to obtain a foresee over the rotation speed per time (Eq. 3), where C is a constant and depends only on the mechanical configurations and environmental effects.

$$\tau = c\omega \tag{3}$$

By simplifying equations (4-8) we will find the angular velocity of the rotor (Eq.9) , where I is the length of the rotor.

$$\tau = \int_0^\omega \frac{d\omega}{F_e - c\omega} = \int_0^t \frac{dt}{I} \tag{4}$$

$$\int_0^\omega \frac{-1}{c}\ln(F_e - c\omega) = \frac{t}{I} \tag{5}$$

$$\frac{-1}{c}(\ln(F_e - c\omega) - \ln(F_e)) = \frac{t}{I} \tag{6}$$

$$e^{\ln\left(\frac{F_e - c\omega}{Fe}\right)} = e^{\frac{-ct}{I}} \tag{7}$$

$$\frac{F_e - c\omega}{F_e} = e \tag{8}$$

$$\omega = \frac{F_e}{c}\left(1 - e^{\frac{-ct}{I}}\right) \tag{9}$$

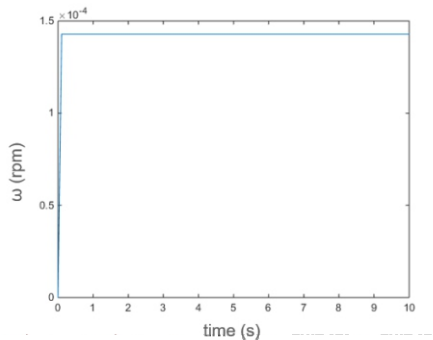Using MATLAB, the rotation of the rotor per time based on equation (9) can be observed.

Fig. 2: Rotation of the rotor vs time

4 Experiment

The effects of input voltage of the electrodes, air gap spacing, lining of the inner surface of the rotor and the material of rotor's surface are investigated (table 1). The material of rotor is affected by the relaxation time of rotor's surface which could be calculated using the equation (1), where ε_0 (= $8.85 \times 10^{-14}\,F/cm$) is the electrical resistivity of vacuum air.

Table 1: Rotor's properties and relaxation time

Surface Material	Electrical Resistivity ε ($\times \varepsilon_0$)	Dielectric Constant ρ (Ohm.m)	τ (F.Ohm)	Δt (s)
HDPE (High Density Polyethylene)	2.30	$16\sim18$ $\times 10^{13}$	$3.2568\sim3.6639$ $\times 10^3$	149.38
PVC (Polyvinyl chloride)	40	$10\sim16 \times$ 10^{13}	$3.54\sim5.664$ $\times 10^4$	149.38

The time interval of charge dissipation is bigger than duration of one rotation. Thus, the charge dissipation theory could be neglected. As a result, the only effect of the surface material is caused by its changes on the inertia.

5 Results and Discussion

According to the experiments, based on the theory, the data are analyzed. The lesser the air gap spacing causes, the stronger the electric field thus, the rotational speed would increase (Fig. 3). The input voltage has a direct influence on the rotation. The rotor's inner lining plays the role of an opposed electrode against the electrodes. So, the electric field strength increases which makes the rotation speed increase too (Fig.4). The maximum speed of 2150 rpm was attained in the air gap of 0.6 cm using the rotor with the height of 12mm.
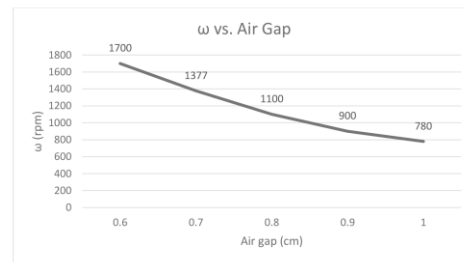

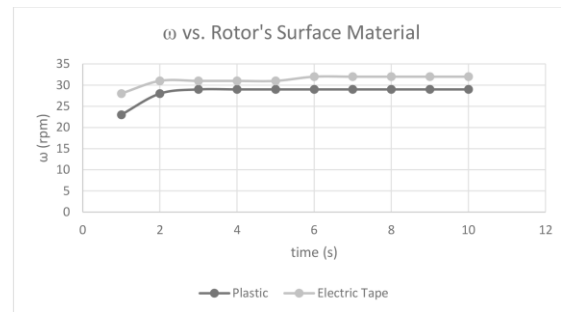**Fig.3:** The effect of air gap spacing between the electrodes on the rotational speed

Fig. 4: The effect of rotor's surface material on the rotational speed

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        ANALYSIS OF CORONA DISCHARGE IN
        ELECTROSTATIC MOTOR GAPS.

LOOPING PENDULUM

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ABSTRACT

In this paper we will witness that by tying both ends of a string to unequal weights, lifting the end tied to the smaller weight with a specific angle would conclude in a small fraction of the string wrapping around the bar, thus stopping the larger weight from falling on the ground. On some conditions we observe that the light load spins around the rod because of the friction between rod and thread and prevent the heavy load from hitting the floor.

(This is just a short explanation)

1 Introduction

By connecting two loads, one heavy and one light, with a string over a horizontal rod and lifting up the heavy load by pulling down the light one we can observe that release the light load will cause its sweeping around the rod, which keeps the heavy load from falling to the ground (iypt.org). So to investigate this phenomenon several experiments are done . Accordingly, we will consider two major physical principles; Archimedes Spiral and Newton's Law of Motion . By experiments we came to the conclusion that the effective parameters are: weights' masses, angle, width of the bar, length and material of the string (Fig. 1).

In order to study the phenomenon, we designed a setup to investigate the effective parameters. A bar, a string and two unequal weights make up the main parts of our setup.

1) We commence by analyzing the effect of its amplitude on the smaller weight's turn around the bar.

2) The bar's width and surface .

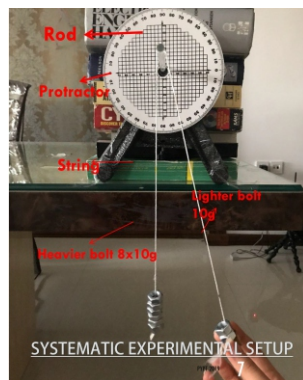3) The string's height difference after multiple turns around the bar.

Fig. 1: Experimental setup

2 Experiments and Theory

Parameters in this experiment are:
- Difference between the two bolts
- Releasing angle
- Heavier bolts' distance from the ground
- Friction between the string and rod

There are 4 forces acting on the light mass:
- Gravitation force ,
- Centripetal force,
- Tension force and
- Coriolis force

We can find the motion of the light load according to the equation (1) and (2).

$$\ddot{x} = -\left[\frac{g - \frac{m_2}{m_1}(g \sin\theta + \ell\dot{\theta}^2)e^{\mu(\theta+\frac{\pi}{2})}}{1 + \frac{m_2}{m_1}e^{\mu(\theta+\frac{\pi}{2})}} + r\ddot{\theta} \right] \tag{1}$$

$$\ddot{\theta} = \frac{g\cos\theta - v\theta^2 - 2\dot{\ell}\dot{\theta}}{\ell} \tag{2}$$

Because of the initial angle that the lighter load has in the beginning of the experiment, it spins around the rod and the friction between the thread and rod causes the lighter load to stop the heavy load from hitting the ground. The tension force of the thread can be calculated by equation (3).

$$T_1 = T_2 e^{\mu\theta} \tag{3}$$

In our experiment we started from 10 g mass and when the mass in both sides are equal the movement is observed.

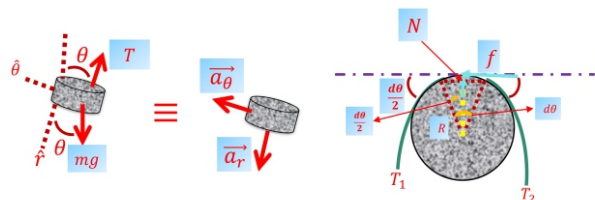According to free body diagram (Fig. 2) we can find T$_1$ and T$_2$ (Eq. 4 and 5).

Fig. 2: Free diagram in our experimental setup

$$T_1 = \frac{2m_1 m_2 g}{m_1 e^{\mu\alpha} + m_2 \cos\theta} \tag{4}$$
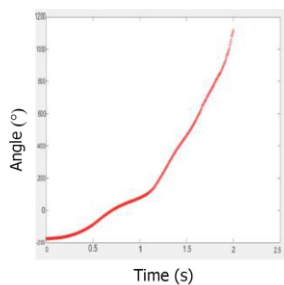
$$T_2 = \frac{2m_1 m_2 e^{\mu\alpha}}{m_1 e^{\mu\alpha} + m_2 \cos\theta} \tag{5}$$

For doing this experiment, we need two different loads, a thread and a horizontal rod. We connect two loads with a thread and hang it on the rod. We lift up the heavy load and hold the light load with a yarn and cut it for starting the experiment. We wait till the heavy load is constant and release the lighter load. We tested with 4 to 1 mass ratio, 85° angle, 75 cm thread length and 0.35 friction coefficient. We see the light load spinning around the rod and prevent the heavy load from hitting the floor. The experiment was recorded with 240 fps slow motion as the mobile camera is in the direction of the rod from side. Different thread lengths, mass ratios and initial angle were measured .
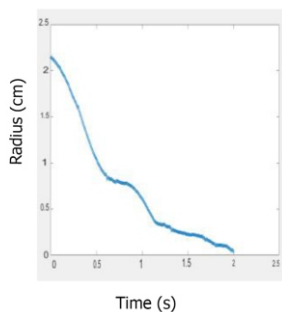
3 Results and Conclusion

After a series of experiments we found, the light load turns around the bar in a form of a spiral then friction and its velocity stop the heavy mass. Hence, the motion is divided into two phases, phase 1: rotation and falling and phase 2: rotation (when the heavy mass no longer falls). It has shown that by increasing the ratio of the masses the velocity of the light load increases but the number of loops decreases. And also if the light mass is released from a higher angle it laps faster and makes more turns because its potential energy is more.

By reducing the length of the string (radius of rotation), rotation velocity increases so the string sweeps around the rod and causes the heavy load stops. If the angle, mass ratio, and the length of string is not big enough the light load doesn't have much force to sweep and the heavy load falls down (Fig. 3 a and b)
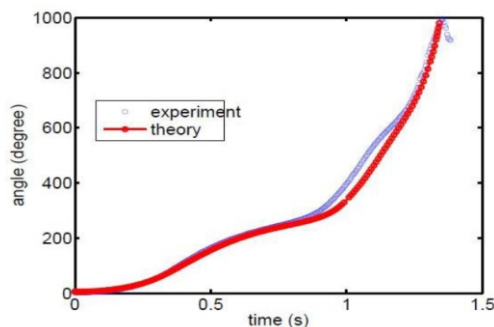

Fig. 4: Comparison between theory and experiment

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            bre_15_16_looping_pendulum_2_bil.pdf

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(a)

(b)

Fig. 3: a) angle versus time (light load) , b) radius versus time (light load)

According to the comparison between theory and experiment (Fig.4) , our experiment is correct. The angle shows the number of spins, so 1000° shows 3 spins with 4 to 1 mass ratio. We have a two-phase motion, which means the light load stops the heavy load but the heavy load starts falling and stops again when the light load keeps spinning.

POPSICLE CHAIN REACTION

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ABSTRACT

When a number of Popsicle sticks are interlocked in each other, a mesh is produced, known as "The Cobra Wave". As one of the sticks from the end of the lattice is taken out, an explosion is happened and the wooden sticks will be thrown consecutively, one after another. In this research this phenomenon was investigated and the affect the chain reactions was shown by using different sizes of popsicle.

(This is just a short explanation)

1 Introduction

Wooden Popsicle sticks can be joined together by slightly bending and make a "cobra wave" chain. It was seen that by increasing the length, in popsicle chain, moving speed decreases. Also the thicker popsicle lead higher speed. The elasticity (The Young's modulus) and the mass of the popsicle has effects on the height of the cobra and the shape of the wave. The width will not change the speed of the explosion. So we realized that it happens because of the tension between the objects in this system and some parameters which can affect on the structure of curves like the distance between sticks, angle between sticks, numbers of sticks and other parameters.

2 Experimental Procedure

In the Cobra Wave, the sticks interlink in each other and a lattice will be formed. First, we create the chain and then shoot it . Our variables are the number of woods, the angle between the woods and, of course, which side of the wood we take from. The phenomenon was investigated by utilizing popsicle in 4 different dimensions (width, thickness and length) in order to construct the cobra wave pattern (Fig 1).
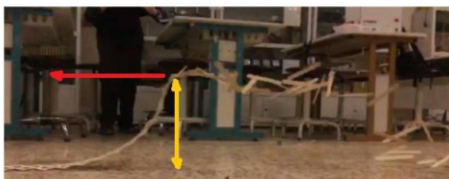

Fig.1: A side view of the observed phenomenon

In our experiment the floor is flat, with low friction . Then we arrange a pattern by connecting sticks together with constant material, size, distance (from each other), length and angle (between them) (Fig. 2). Due to the bending of the woods, potential energy is stored in the chain, and then this energy becomes a kinetic energy and the wave forms inside the chain.

Popsicle will   release its Potential Energy (PE) ,if we make free the last stick of the chain and it will be thrown and make a shape like a wave which is tracked by tracker (Fig. 3).
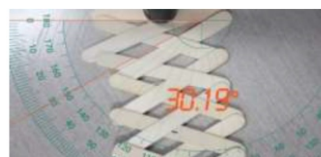

Fig.2: A popsicle pattern

Fig. 3: Releasing the sticks in popsicle (analyzing by tracker)

In our first experiment, we fixed the numbers of sticks and tested different distances (from each stick to the other one) and measured the leaping height. Then we increased the numbers of sticks and fix the distance between sticks, the height of leaping gets higher.

The phenomenon was observed using a 120 frame/ sec camera. The behavior was investigated from two aspects:
- 1) Every single Popsicle and
- 2) A linear continuous medium (Cobra Wave).

It was seen that the height of the wave changes in the explosion for each of the 4 waves. Its height was measured by pointing the center of one chosen Popsicle in 'Tracker' software (it can be measured directly by measuring the height of the highest thrown Popsicle).

3 Results and Discussion

The most relevant parameters for the velocity and the height of the explosion were the length, width, thickness, mass, young's modulus, special period of the mesh and θ (the angel of the lattice, a scaling factor which depends on the geometry of the mesh). It was realized that the width of the sticks doesn't effect on the velocity. The highest changes (especially on the velocity) were obtained by changing the θ angel. As was seen in the experiments, a deformation was observed all over the chain, which was because of the elastic energy. In all the waves, Potential

Energy (PE) was stored in the mesh and by releasing one of the two Popsicle, which are placed in the edges, the stored energy was converted to Kinetic Energy (KE) and explosion was happened. From the balance between the Kinetic Energy (KE) and the Potential Energy (PE), velocity of the wave was derived as: b (θ) (e2/L2) √ (E/ρ)(Fig. 4).
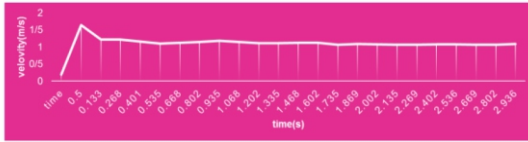

Fig. 4: Wave's speed (m/s)

  As the results , when the angle is smaller, the contact surface of the wood is more and more combined, so   the energy will be increased . Conversely, when angle becomes larger, the contact surface of the wood is reduced and the lower energy causes the lower height .

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SCI-FI SOUND

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ABSTRACT

When we tap a slinky spring we hear an amplified laser sound. Also after we tapped it we can see the slinky moving up and down. We use different slinky springs with different lengths, diameter and we show that there is a delay between higher frequencies and lower frequencies and it's the reason for this laser shot sound. By decreasing the length this delay will decrease.

(This is just a short explanation)

1 Introduction

By angular velocity (ω) which shows frequency and wave number (k), we obtain velocity (v) .In this phenomenon important concepts such as Euler-Bernoulli beam theory, dynamic stiffness, mechanical waves, wave concepts and sound waves are considered . Wire diameter, spring diameter, pitch of spring, and the free height of spring are effective parameters.

Higher frequencies have more velocity than lower frequencies. This difference in velocity causes delay in sound because we hear sounds with higher frequencies sooner. Due to this delay, we hear a laser shot sound.

2 Theory and Experiment

As figure (1), we use a slinky spring in a horizontal way which has a cup at the end as an amplification. It is tapped with a hard object to hear its sound in a certain point . We use a phone as a recorder. We repeat our experiment with slinky springs different in radius, length, thickness, stiffness and other parameters.

Fig. 1: Sci-Fi Experiment setup

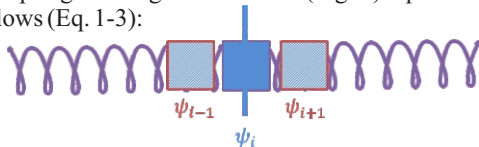In spring the longitudinal wave (Fig. 2) equations are as follows (Eq. 1-3):

Fig. 2: Longitudinal wave in spring

$$v_g = \frac{d\omega}{dk} = c \tag{1}$$

$$\psi = A \sin(\omega t - kx) \tag{2}$$

$$F_T = 2ka^2 \frac{d^2\psi}{dx^2} = 2m \frac{d^2\psi}{dt^2} \tag{3}$$

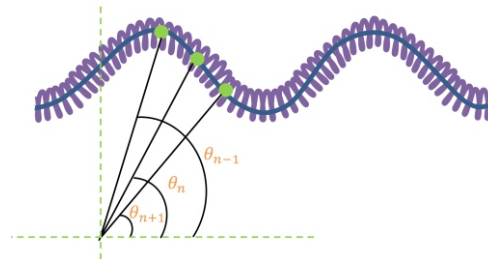In our experiment transverse wave is considered in the spring too (Fig. 3) (Eq. 4-9).

Fig. 3: Transverse wave in spring in our experiment

$$F = ma \xrightarrow{F = s} a\frac{ds}{dx} = m\frac{d^2\psi}{dt^2} \tag{4}$$

$$F_T = \frac{a\left(s\left(\frac{a}{2}\right) - s\left(-\frac{a}{2}\right)\right)}{a} = a\frac{ds}{dx} \tag{5}$$

$$S = -k\Delta x \tag{6}$$

$$s = -kla\frac{d\theta}{dx} \tag{7}$$

$$s_T = -kla\frac{d\theta}{dx}\left(\frac{a}{2}\right) - \left(-kla\frac{d\theta}{dx}\left(-\frac{a}{2}\right)\right) = -kla^2\left(\frac{d^2\theta}{dx^2}\right) \tag{8}$$

$$F_T = -kla^3\frac{d^3\theta}{dx^3} \tag{9}$$

Frequency of the sound is recorded and the plot is compared with theory (Fig. 4) (Eq. 10 - 12).

$$v_g = \frac{d\omega}{dk} = 2ck \tag{10}$$

$$\left.\begin{array}{l} v_g = c'' f^{\frac{1}{2}} \\[2mm] t = \dfrac{L}{c'' f^{\frac{1}{2}}} \end{array}\right\} \qquad \boxed{f = \dfrac{L^2}{c''^2}\dfrac{1}{t^2}} \qquad (11)$$

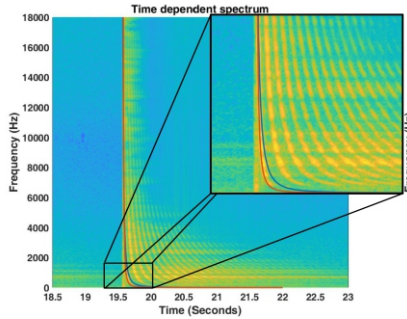$$\boldsymbol{\omega = c k^2} \qquad\qquad (12)$$

Fig. 4: Frequency versus time in sound recorded

We have a sound-recorder and a cup to hear the sound easier. We have a camera to record the slinky spring movement. We record the sound and analyze our data in different lengths.

In different lengths and diameters of the spring (table 1 and 2) , frequencies are compared (Fig. 5 and 6).

Table 1: Different lengths of the spring

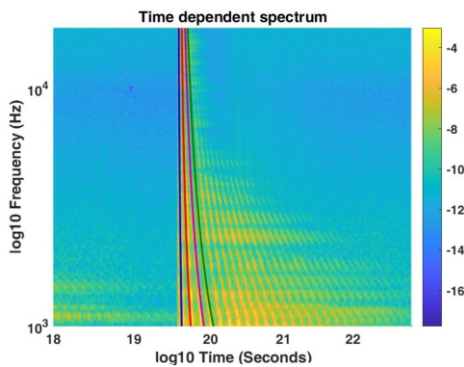| N=1	2.78318
N=2	19.132
N=3	80.132
N=4	150.132

Fig. 5: Frequency versus time in different length of the spring

Table 2: Different length of the sprin

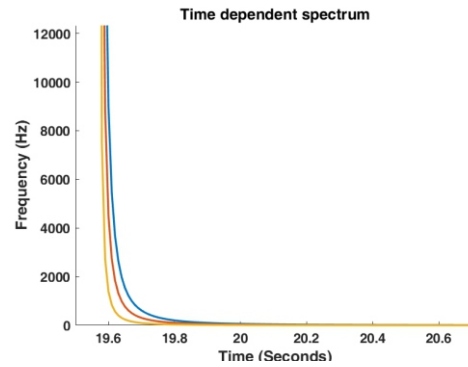| S_1	1.71090909 D=0.075 m
S_2	5.56636364 D=0.05 m
S_3	11.132727272 D=0.025 m

Fig. 6: Frequency versus time in different diameters of the spring

4 Results and Discussion

If we tap the same slinky spring with different intensities, we hear similar sound. The slinky spring with longer length has more delay in compare with the shorter one.

According to the graph , by tapping the slinky spring in several times, we saw the sound seems the same on special condition so the way we tap the slinky is not important. By time passing the frequencies will decrease and when the length decreases the delay will decrease either.

The main acoustic observation is that the helical spring is highly dispersive and the most important parameters in this research are force that is added to the system, spring material, spring diameter, length of the spring , pitch of the spring, and the free height of spring.

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