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Preface

We would like to present, with great pleasure, the inaugural volume-6, Issue-4, April 2020, of a scholarly journal, *International Journal of Engineering Research & Science*. This journal is part of the AD Publications series *in the field of Engineering, Mathematics, Physics, Chemistry and science Research Development*, and is devoted to the gamut of Engineering and Science issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Engineering and Science as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Engineering and Science community, addressing researchers and practitioners in below areas

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Algorithm and Computational Complexity	Artificial Intelligence
Electronics & Communication Engineering	Image Processing
Information Retrieval	Low Power VLSI Design
Neural Networks	Plastic Engineering

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with IJOER. We are certain that this issue will be followed by many others, reporting new developments in the Engineering and Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOER* readers and will stimulate further research into the vibrant area of Engineering and Science Research.

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Non-Linear Motion Analysis of Reciprocating Vibro separator

Jayesh V. Desai[1], Divyang H. Pandya[2]

[1]PhD Scholar, Mechanical Engineering, PAHER University, Udaipur, Rajasthan, India
[2]Professor, Mechanical Engineering, LDRP-ITR, Gandhinagar, Gujarat, India

Abstract— *In this paper, dynamic motion behavior of reciprocating vibro separator model has developed and analyzed. Effective of 3 different elasticity of vibro-pad material has computed and nonlinear dynamic motions have investigated. Based on previous empirical data computational model has validated with elasticity value of 25MPa, vibro motor at 1000 rpm and vibro motor angle (α) 30^o has resulted in minimum horizontal displacement and periodic motion of system. For the motion analysis Poincaré, Fast Fourier Transit (FFT) & Time data graphs have used. The computational model of reciprocating vibro separator has observed significant resembling with industrial case study.*

Keywords— Dynamic Motion analysis, Model validation, Material property.

I. INTRODUCTION

We are living in world where technology is most important part of life. Every day new techniques are implemented in different fields but still some of area is having lack behind in usage of modern technology. Agriculture is one of them where some processes have to improve. Like separation process in which researchers are working so that their work will give a very useful output. In separation process Reciprocating vibro separator is used. Some work has been performed for improving its efficiency and its strength.

The present work is to investigate the dynamic motion behavior of Reciprocating vibro separator by using ANSYS software besides using DEM simulation method. In the past, The set up for experimental work is done on the placement of motor at the up side center place of vibro separator box whereas in present work the motor is connected at two side center place of separator box. Aim of this paper work is to analyse the Amplitude and dynamic motion behavior of Reciprocating vibro separator as it has significant effect on particle flow rate and velocity. Authors have attempted to validate the computational model with industrial case study

II. LITERATURE SURVEY

Here Lala Zhao, Yuemin Zhao, Chunyong Bao ,Qinfu Hou , Aibing Yu (2016) have noticed that the average velocities of simulations with both spherical and non- spherical particle models in each case show similar trends with the tests. For most cases, the velocities of spherical particles are more highly over-predicted than those of non-spherical particles because of the simplification of particle shapes.

Changlong Du, Kuidong Gao, Jianping Li, and Hao Jiang (2012) have used the Separator which has unbalanced mass rotor at center & after that they said that by analysing the screening process of three different vibration screens, it proves that the variable linear vibration screen has better power distribution and screen surface movement the flexible screen surface can increase the amplitude of the screen surface and reduce the material blocking phenomenon. The screen experiment results of the two style screen surface vibration screens show the huge advantage of flexible screen surface than fixed screen surface in screen efficiency and avoiding material crush and it also provides a powerful proof to verify the correctness of the simulation work. Xiaohao Li, Mingxu Ma (2012) The research results which carried out in the paper showed that, about the nonlinear vibration system which supported by the soft nonlinear characteristics spring, the amplitude value of the nonlinear system can be automatically compensated when the vibrating mass of the vibrating system fluctuating in small-scope, which make the amplitude approximate remaining constant. ZHAO Lala, LIU Chusheng, YAN Junxia (2010) indicate that The amplitude and the vibration direction angle have a great effect on the particle average velocity and the average throw height considered over the normal range of linear screen parameters. The vibration frequency and the inclination angle of the screen plate have a small influence. To obtain the ideal sieving effect for materials that are difficult to sieve the frequency and amplitude of vibration, the inclination angle of the screen plate and the vibration direction angle should be chosen as 13 Hz, 6.6 mm, 6° and 40°, respectively. A.V. Ramana Rao, CH. Bhanu Prakash, G.H. Tammi Raju(2012) They studied on the separator which was working on linear motion where they give the suitable parameter for motor rpm range from 1000 rpm to 1200 rpm & also use the motor angle from 25 degree 45 degree. Monica Soldinge (2002) has use the monte carlo simulation to check the effect of angle between base line & separator box bottom layer line ,then he conclude that for the β value of 5 degree the rpm

speed is range from 1000 to 800. Liu Chusheng , Wang Hong a, Zhao Yuemin , Zhao Lala , Dong Hailin (2011) have tried to get the optimum angle between base line & separator box bottom layer line β & conclude that the increment of screen deck has a same effect on banana screening process as inclination of discharge end And when the values of inclination of discharge and increment of screen deck inclination are 10 degree to 5 degree the banana screening process get a good screening performance in the simulation.

Dong Hailin, Liu Chusheng , Zhao Yuemin, Zhao LalaThe (2011) they studied on linear, circular & elliptical motion of screen they said that travel velocity of the particles during linear screening is the fastest. This results in a thin material layer but the lowest Overall screening efficiency. The circular mode gives the lowest particle velocity along the screen but the highest screening efficiency. In this case, the material layer is thick but the interaction between particles and the penetration effect are enhanced. Jianzhang Xiao, Xin Tong (2011) has investigated in this paper that the effects of vibration parameters including frequency and swing declination angle on screening efficiency through DEM 3D simulations leading to a set of empirical formula by regression analysis to describe the relationship between efficiency and vibration parameters for swing vibration screen.

Vladimir A.Golovanevskiy, Vasily A. Arsentyev, Iliya I. Blekhman, Vladislav B. Vasilkov, Yuliy I. Azbel, Kira S. Yakimova (2011) says that the description of specific vibration-induced phenomena presented in this paper provides the basis for development of materials handling technologies and process equipment to affect bulk material flow behaviour with vibration. To ensure the highest vibration-aided bulk granular material separation efficiency, it is suggested that the amplitude and frequency of vibration should be selected on the basis of providing the vibration overloading factor w values of $w \approx 3$ or slightly higher. Further research needs to focus on the development of an overall model describing behaviour of granular material under vibration.

Paul W. Cleary, Matthew D. Sinnott, Rob D. Morrison (2009) says that the two key components of screen separation and their differing dependency on the screen acceleration area:

1. Fine particles percolate through the dense shearing bed: Higher accelerations lead to more dilation of the bed and to higher shear which improve this component of screen flow. This is responsible for more rapid stratification of the bed and provision of a layer of fine material adjacent to the screen cloth.
2. Particles smaller than the screen aperture size and which are adjacent to the cloth are captured by and pass through holes in the screen cloth. This process is dependent on the size and shape of the particle and on the flow. The faster the flow speed and the denser the bed directly above the cloth, the lower is the chance of a particle being able to pass through an opening.

Lijun Wang, Zhenjun Ding, Shuang Meng, Huijun Zhao, Huiqiang Song For a particle on the screen moving from the front to the back of the screen, the regimes of the different particle behaviors such as stable periodic motion, period-doubling bifurcation motion, bifurcation motion, and the chaotic motion, were obtained. Chaotic motion was found to beneficial in separating particles effectively from other agricultural threshed materials and avoids at the same time particles accumulating on the screen and enhances the probability that the particle penetrates the screen hole. A detailed investigation on this aspect (passage rate) was not performed and remained open problems.

J. LI, C. WEBB, S. S. PANDIELLA and G. M. CAMPBELL (2002) concluded that For a screening system involving granular materials, it has demonstrated that the critical feeding rate or bed depth for the most effective screening operation can be determined via conducting the DEM simulation. Further work will focus on the implementation of advanced experimental techniques to measure the process and to validate the model.

Zhao Lala, Zhao Yuemin, Liu Chusheng, Li Jun , Dong Hailin (2011) describe that Vibration parameters have significant effects on the circularly vibrating screening process. Too small a vibration amplitude, a throwing index, or a screen-deck inclination angle will cause the accumulation of particles on the deck. But too large values of these parameters will also reduce screening efficiency. HE Xiao-mei, LIU Chu-sheng(2008) have Studied on vibro separator & told that the motion of vibro separator is following the elliptical trace. A theoretical kinematic analysis of the vibrating screen was done to study how varying different parameters affects the motion of the screen. Kinematics parameters of the vibrating screen that motion traces are linear, circular or elliptical are obtained. Their work also conclude that the position of the exciter axle center relative to the center of gravity of the vibrating screen is extremely important for screening efficient Thus; we can design a vibrating screen with higher processing capacity without increasing power consumption by adjusting the relative position of the axle center. Zhao Yue-min, Liu Chu-sheng, He Xiao-mei, Zhang Cheng-yong, Wang Yi-bin, Ren Zi-ting (2009) says that

the dynamic response analysis shows that adding stiffening angle and longitudinal stiffeners to both side plates is able to decrease transverse deformation of side plate and ameliorate the twist deformation of screen frame. The maximum transverse displacement of the vibrating screen is 0.13 mm.

III. COMPUTATIONAL ANALYSIS AND RESPONSES

The reciprocating vibro separator has three type of vibration mode. Out of which elliptical vibration mode is having good result of screening compare to others. To observe that elliptical motion the computational model of reciprocating vibro separator is modeled out in CRE-O 3.0 and analyze in ANSYS 14.5. Model analysis has performed and corresponding 6 mode frequencies were tabulated in table 1.

TABLE 1
MODEL ANALYSIS FREQUENCIES

Mode	Frequency(Hz)
1	174.47
2	174.47
3	185.35
4	384.18
5	385.12
6	442.07

Out of 6 mode of failure, it has imperially concluded the mode 3 is critical mode of failure. Corresponding critical frequencies have observed 185.35 Hz frequency and based on half power bandwidth concept the damping ratio of vibro-pad has investigated and calculated value for ζ is 0.0017. Frequency response graph for mode 3 at 185.35 Hz has analyzed at 70% marginal amplitude of peak which response the concern frequencies as shown in enlarged view. From calculated value for ζ, authors can calculate the damping coefficient for mass & stiffness as ANSYS input parameters.

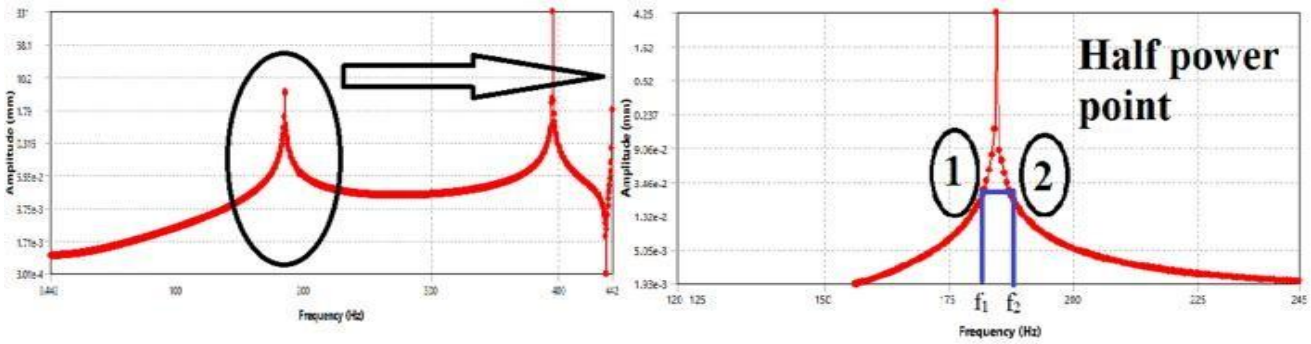


FIGURE 1: Frequency response graph

Computational analysis of developed model is performed with different input parameters like motor angle (α), motor speed & properties of Vibro-pad as varying parameters and the dynamic motion behavior of vibro separator is observed.

From the earlier data the range of motor angle is selected from 25 to 35 degree. Also range of motor rpm is selected from 1000 to 1200 rpm. Then the computational work for different motor angle and different speed combination is performed and corresponding FFT plots and Poincaré graphs have plotted for motion analysis.

IV. INDUSTRIAL ON SIGHT EXPERIMENT

The setup was prepared as per the computational work. Here the two vibro motors are running at 1000 rpm. The variation in motor speed is ± 20 rpm. Each vibro motor is having 0.5 Hp power. The Experimental Setup is running in between 980 to 1020 rpm motor speed with 30 degree motor angle. The experimental work is performed at **GAJANAND** industries at **UNJHA.**

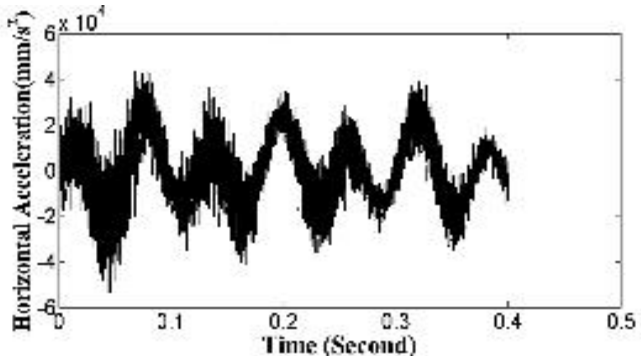
FIGURE 2: Experimental Setup in GAJANAND Industries

Here the separator box has two motor connected at two side walls at the middle point of separator box height. Four unbalanced masses are connected to each motor, which has weight of 3.34 kg each. The experimental results are taken at 3 point, one point is at the top center place of vibro separator box and remaining two points are at top side end position of separator box as shown in figure 2. The piezoelectric accelerometers sensor (uni-axial) is used for picking up the vibration signals from the point on separator box. These special piezoelectric pickup type sensors are used with a frequency of range from 1-10 kHz. The sensitivity of sensor 107 mV/(m/s2) with integral electronics piezoelectric accelerometer (IEPE) input mode of sensor. The analyzer used to measure the acceleration data is made by Crystal Corporation. The model of analyzer is CoCo-80. As shown in figure 3.

FIGURE 3: Vibro Analyzer.

V. RESULT AND DISCUSSION

In the present work the material property of vibro-pad & Motor angle (α) is considered as the input parameter. From all that consideration of input parameter the motion of reciprocating vibro separator is observed. To observe the motion of vibro separator different tools are available. Out of which the time domain data, fast Fourier transform (FFT) & Poincaré are taken in consideration for motion behavior. The Reciprocating vibro separator box. The computational data & Experimental data both are taken for 10 KHz sampling frequency. As per one of the input parameter the vibro-pad elasticity is changed. For computational work the elasticity for vibro-pad is taken as 10 MPa, 25 MPa and 40 MPa. The computational model is Analyze based on motor angle (α) of 30 degree & 1000 RPM speed for all three elasticity. In experiment the speed of motor is varying between 920 rpm to 1020 rpm. The computational work is analyze for 0.4 to 0.5 set



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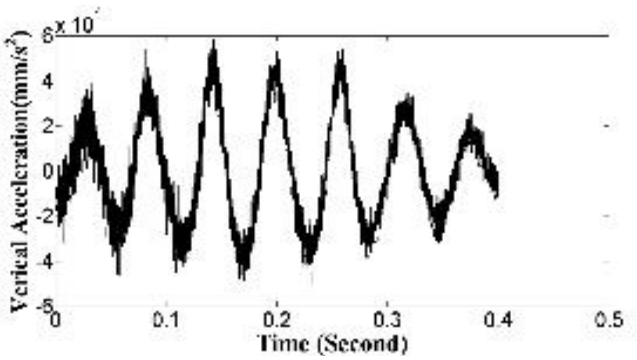

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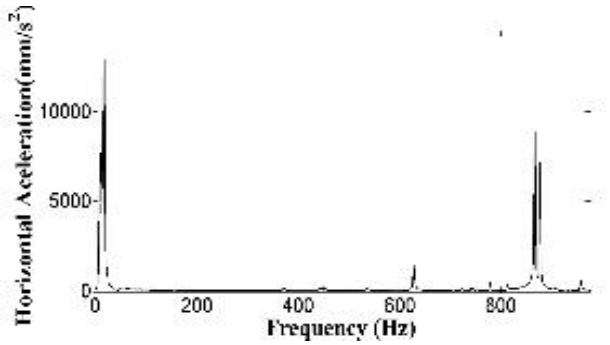

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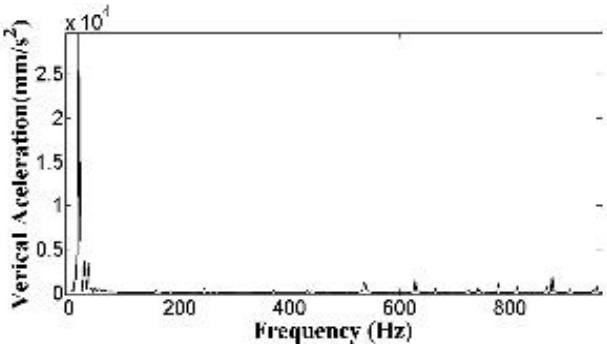

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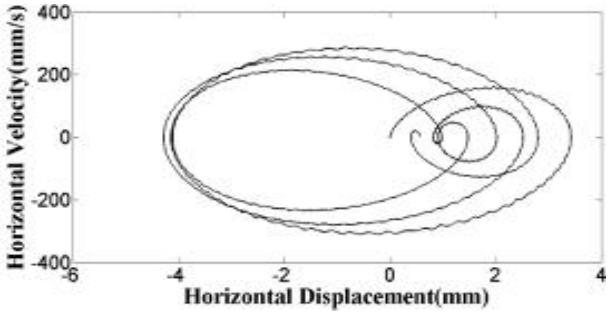

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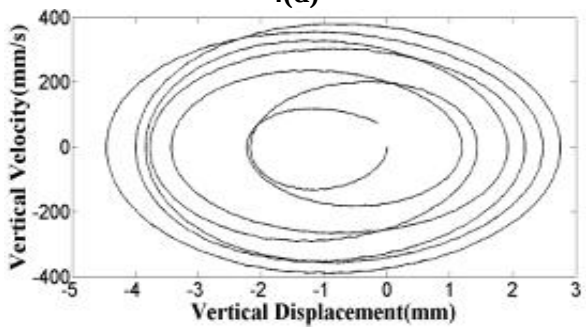
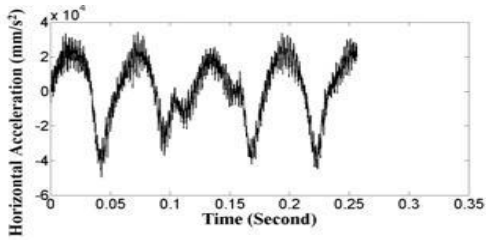


4(f)

FIGURE 4: Computational Dynamic Motion Analysis at 30 degree & 1000 rpm 40 Mpa elasticity

Figure 4(a-b) are the acceleration graph that indicate that the acceleration value of vibro separator is higher in vertical direction compare to horizontal direction. Figure FFT plot have indicated the super harmonic response in horizontal direction and neither sub harmonic nor super harmonic responses have observed in vertical direction as shown in figure 4(c-d), which would lead to conclude the periodic behaviour of system. Figure 4(e-f) are Poincaré graph it shows that motion of reciprocating vibro separator has periodic motion in vertical and multi periodicity observed in horizontal direction. Horizontal Poincaré responses have displacement of +3 to -4 mm.



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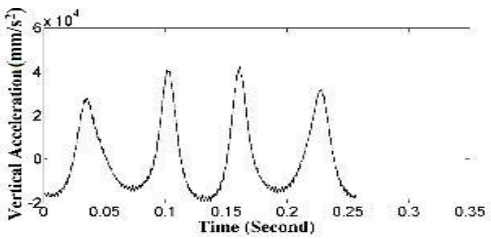

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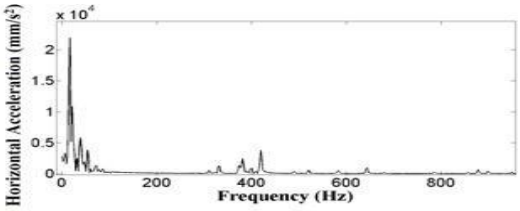

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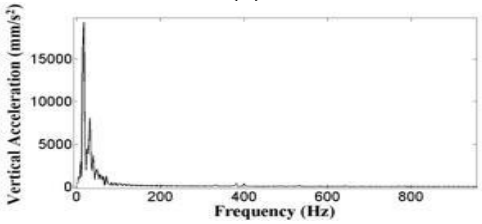

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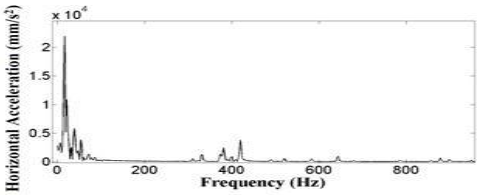

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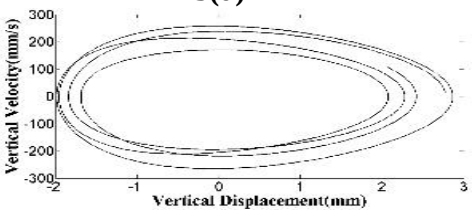
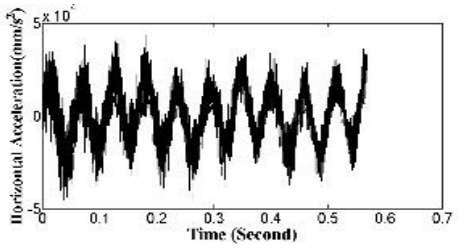


5(f)

FIGURE 5: Computational Dynamic motion analysis at 30 degree & 1000 rpm with 25MPa elasticity

Figure 5(a-b) are shows that the value of acceleration in horizontal direction is approximately doubled than in vertical direction. As we decreases the elasticity the clear stable equilibrium time response have observed in horizontal as compare to horizontal time response for elasticity of 40 MPa. Vertical time responses have clear indication of the periodic motion behavior of system. FFT plots have mentioned that the motion is periodic as no such super harmonic or sub harmonic peaks have observed as shown in Figure 5(c-d). Figure 5(e-f) are Poincaré maps for horizontal and vertical direction clearly indicated periodic motion with less multi periodicity as compare to rubber elasticity of 40MPa. Horizontal Poincaré responses have displacement of +2.2 to -3.5 mm.



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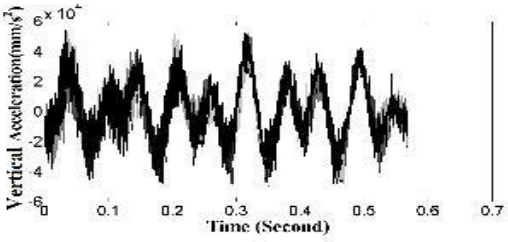

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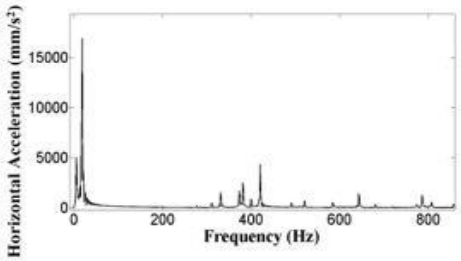

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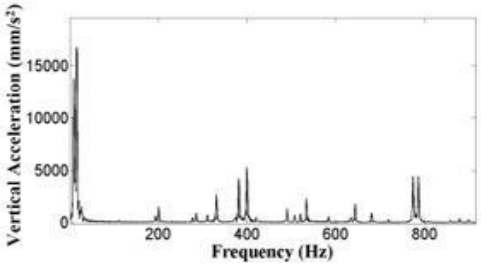

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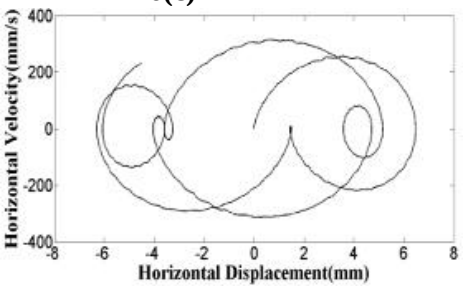

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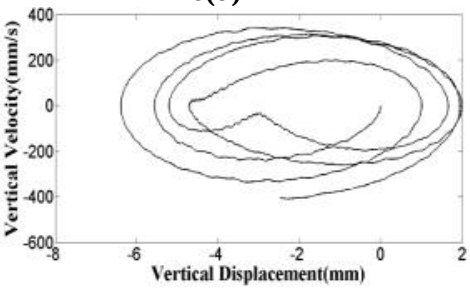
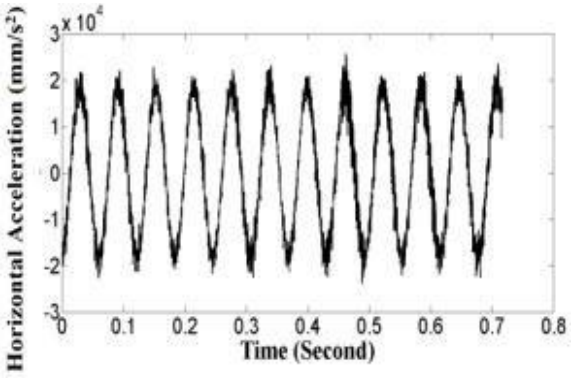


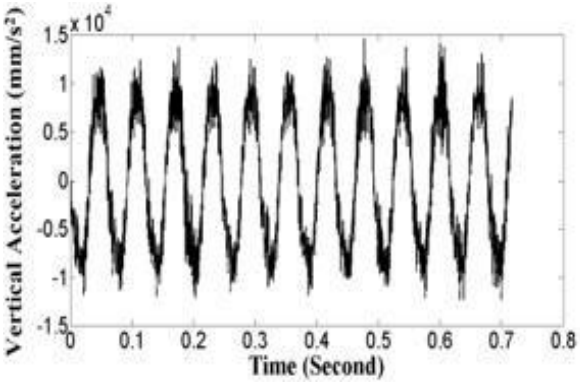
6(f)

FIGURE 6: Computational Dynamic motion analysis at 30 degree & 1000 rpm with 10 MPa elasticity

On further decreases the elasticity of vibro-pad, more instable responses in both directions have observed as shown in Figure 6(a-b). Figure 6(c-d) are the FFT plots have sub harmonic responses in horizontal direction with significant sidebands in horizontal responses while in vertical responses have observed with higher range super harmonic responses. Poincaré maps clearly indicated 5T periodicity in horizontal responses and multiple periodicities in vertical responses. Horizontal Poincaré responses have displacement of +7 to -6.3 mm.



7(a)



7(b)

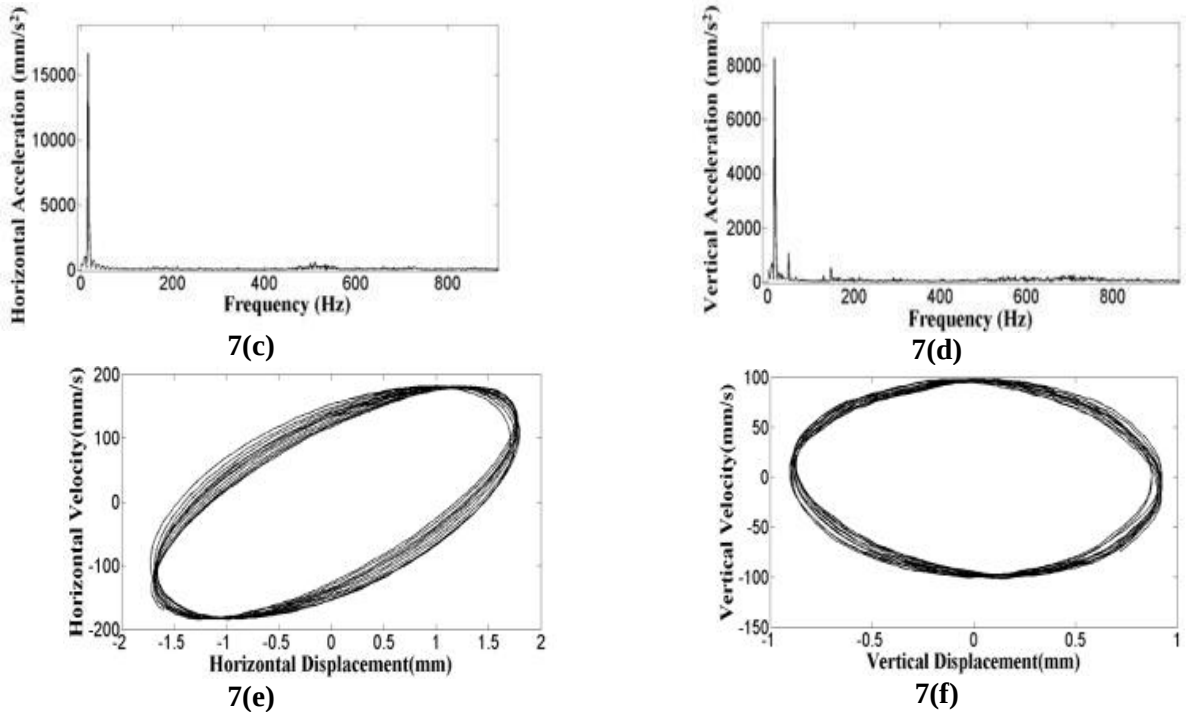


FIGURE 7: Experiment Dynamic motion analysis at 30 degree & speed is varying between 980 rpm to 1020 rpm.

Experimental time responses have concluded stable and periodic response to system as shown in Figure 7(a-b). Figure 7(c-d) are the FFT plot that indicate that the motion is periodic. Figure 7(e-f) are Poincaré maps which clearly indicate periodic motion behavior of system. Horizontal Poincaré responses have displacement of +1.8 to -1.75 MM.

Computational model with elasticity value of 25MPa, vibro motor at 1000 rpm and vibro motor angle (α) 30° has resulted in horizontal displacement of 5.7 mm with periodic responses. As elasticity increases horizontal displacement of system has increased to 7 mm and multi periodicity have reported. And as elasticity of vibro-pad decreases horizontal displacement of system has increased to 13.3 mm and multi periodicity have reported. Horizontal amplitude responses have reported more than the vertical amplitude responses in Time domain responses in computational and experimental as well. Computational model has validated with industrial experiments.

VI. CONCLUSION

In the present work, computational model has developed and analyzed for different nonlinear motion behavior of vibro separator with 3 different elasticity of vibro-pad. Require damping coefficient of mass and stiffness has evaluated using half power band width method. Analyzed computational model have shown significant validation with industrial case study which lead to conclude the following conclusions:

1. Authors have lead to conclude that as decreasing the elasticity of vibro pad material it will make the system more and more unstable as shown in figure4(a-b), 5(a-b) & 6(a-b).
2. Nonlinear motion behaviors of system have concluded that system has less multi periodicity with at 25MPa elasticity of vibro pad in computational model which shown more resembling with experimental Poincaré responses.
3. Effective operating parameters to be concluded from Computational model with elasticity value of 25MPa, vibro motor at 1000 rpm and vibro motor angle (α) 30° has resulted in minimum horizontal displacement of 5.7 mm bi-directional with periodic responses. Authors would like further extend this work for varying motor angle for future work.

ACKNOWLEDGEMENTS

This work is financially supported by the Gujarat Council of Science and Technology (GUJCOST) (Grant no GUJCOST/MRP/2016-17/527).

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Automation Security System

Avinash Singh[1], Bharat Singh[2], Divyanshu Rawat[3], Bhavnesh Jaint[4]

Department of Electrical Engineering, Delhi Technological University, NEW DELHI

Abstract**—** *Security systems has seen a rapid rise in its place in research and development, in the field of home automation and industries. This is a field where development occurs regularly yet still always leave some room for growth. In this paper, an endeavour has been made to develop advanced automation security system with ultrasonic range module, stepper motor and GSM module to detect theft. When a person comes within the range of the system, along with an alarm buzz and led indication, an alert message is sent using GSM module touser's mobile. Use of stepper motor and ultrasonic module in system also provides an omni directional security of home detection. This system also very economical yet simple to implement. The system successfully developed, implemented and tested and that we found that its working is satisfactory. The abstract should summarize the content of the paper. Try to keep the abstract below 250 words. Do not make references nor display equations in the abstract. The journal will be printed from the same-sized copy prepared by you. Your manuscript should be printed on A4 paper (21.0 cm x 29.7 cm). It is imperative that the margins and style described below be adhered to carefully. This will enable us to keep uniformity in the final printed copies of the Journal. Please keep in mind that the manuscript you prepare will be photographed and printed as it is received. Readability of copy is of paramount importance.*

Keywords— ATmega-328 Microcontroller, Stepper Motor, Buzzer alarm, GSM SIM900.

I. INTRODUCTION

In this era, need for security makes many folks quest for ways to safeguard their property. Many systems assure limited security in both indoor and/or outdoor environments. But, variety of them has very complicated connectivity and so the implementation cost reaches high values. In some of the cases this makes system highly inaccessible for the users. This includes hard and complicated locks or camera/sensor operated systems that are not economically viable. Furthermore such camera/sensor based systems are prone to blind spots intruder can take advantage of. This produces a requirement for security with decent number of varied systems integrated together, with as less resources as possible. This paper attempts to tackles these obstacles. The system proposed can be utilised in both security and safety of non-public sectors like homes, work places or other site that user wishes to protect. Security provides protection to our life and variable assets. Hence, we made an endeavour to develop an industrial security system with AVR microcontroller-At mega 328. Intruder is detected using ultrasonic sensor using its object detection capabilities [1]. Ultrasonic sensor is mounted on top of stepper motor. This stepper motor is rotated step by step using microcontroller and uses step angle to determine direction of intrusion [[3]]. Microcontroller, interfaced to GSM-SIM900 [[4]], sends distance and directional information of detection through GSM. Proposed system hence will be able to avoid problem of blind spots while being economical due to minimal design implemented.

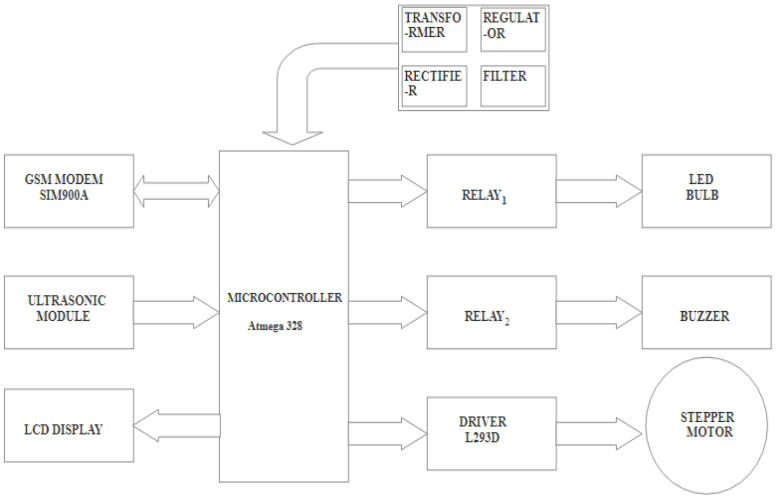


FIGURE 1: Block Diagram ATmega 328

II. LITERATURE SURVEY

As per the National Crime Records Bureau (NCRB), 2,44,119 cases of robbery, theft, burglary, dacoity, among others, happens in residential premises in 2017. This was a jump of over 10% from 2016 when the amount of such cases stood at 2,20,854. The loss thanks to these thefts and burglaries are staggering. In 2017, value of property stolen from residential premises was in more than Rs. 2065 crores, a 40% jump from Rs. 1,475 crores stolen the previous year [1].

A literature survey of GSM based Security system is conducted and presented: -

M. Sravan Kumar, M.Mounika proposed a system that uses GSM module, IR LED and Gas detector interfaced to OP AMP LM324.Whenever there is physical detection in IR LED or smoke detection through fire in gas detector, OP AMP will notify the user through GSM module [[5]]. B.Rama Murthy, O.Jagadish, proposed a home locker consisting of fingerprint scanner module and password protection through keypad and seven segment display and alert system through GSM using Arduino Uno. System will the alert the user if one enters wrong fingerprint data or password[[6]].E. Isa and N. Sklavos developed a password protected, camera monitored, home locker system with a GSM based alert system, using Arduino Uno, protection. System will alert the user when some enters wrong password 3 times or when someone not closes the door within predefined time. It alert user through sound, camera image and SMS sent through GSM [[7]]. Abhishek S. Parab and Amol Joglekar constructed an system with 8051 microcontroller, attached on the door, using magnetic relay alerts user through GSM if the door is opened in the absence of the user. Whenever door is opened magnetic rely, which acts like a switch, turns ON causing microcontroller to notify user through GSM [[8]]. B.Lakshmi Prathyusha and J.Anusha developed an all-round security system with object, fire, gas, voice and magnetic relay for door movements. User is alerted through GSM if any of the sensors in activated due to some intrusion. All sensors are controlled through Arduino Uno [[9]]..

III. PROPOSED WORK

As per the research conducted, conventional security system has developed in many areas but still consists a drawback of having blind spots. Whether it is a proximity sensor or a camera they can be easily avoided if approached in their blind spot. This can be avoided using many sensors but then system loses its economic viability. This paper attempts to tackle this obstacle, by proposing a 360 degree/omni directional security system with no blind spots. Using same Atmega 328 and ultrasonic sensor but with modification through inclusion of stepper motor onto which ultrasonic module is mounted rotating it step by step to whole 360 degree, thus providing an all-round security. Combining this technique with conventional security methods enhances its all around capabilities. Additionally using GSM module and simple AVR commands user can be alerted of distance as well as direction (in terms of steep angle of stepper motor) along with alert through an alarm buzz and led indication.

3.1 Development of Hardware

The block Diagram of the Industrial security System with ATmega 328 microcontroller, ultrasonic sensor and sending alert massage with GSM Technology and the schematic diagram in figure. The Industrial security consists of the mainly following units. They are:-

1. Ultrasonic ranging module
2. Positive voltage regulator
3. Character LCD
4. GSM Module
5. Microcontroller ATmega328

The description of each of these units and their interfacing with ATmega328 as presented below.

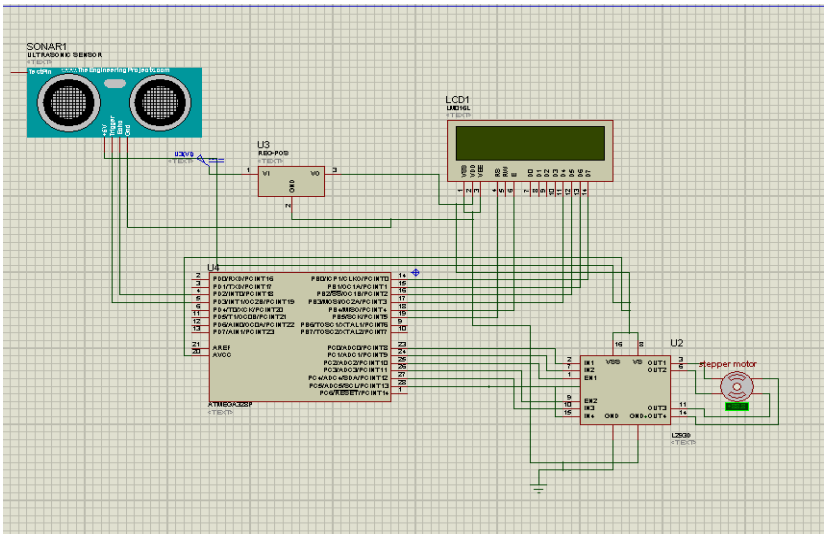


FIGURE 2. Simulation diagram of working model

3.2 Ultrasonic Ranging Module (HC - SR04)

Ultrasonic ranging module HC - SR04 provides object detection from 2cm - 400cm, with a ranging accuracy that can reach up to 3mm. This module includes ultrasonic transmitters, receiver and negative feedback circuit. The basic principle of work:

IO trigger, for a minimum of 10 micro seconds (μs), used to start the ranging module.

The Module automatically sends eight 40 kHz and detect whether there's a pulse signal back.

If the signal is received, through high level, time of high output IO duration is that the time from sending ultrasonic to returning.

Test distance can be calculated as = (high level time × velocity of sound (340M/S) /2.

FIGURE 3. Ultasonic Ranging Module (HC-SR04)

3.3 GSM modem – sim900

The worldwide System for Mobile communications (GSM) is the most used and popular standard in the world of mobile phones. Wireless communication module SIM900 which supports the standard of GSM is produced by SIMCOM Company and is employed within the developed application. To send the alert messages by implementing its commands within the software program. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form. Proposed system uses TX, RX pins for connection with microcontroller so that direct connection without the use of serial port can be established.

FIGURE 4: GSM Module SIM900

3.4 ATmega 328 Microcontroller

The ATmega328 is a single-chip device. It is an 8-bit microcontroller with 28 Pins. Manufactured by Atmel, a part of AVR family, it follows RISC Architecture and has a flash type program memory of 32KB.It has an EEPROM memory of 1KB and its SRAM memory is of 2KB.It has 8 Pin for ADC (Analog to digital converter) operations, which consists of Port A (PA0 – PA7). It also has 3 built in Timers, two of them are 8 Bit timers while the third one is 16-Bit Timer. Its operates in the range of3.3V to 5.5V but normally 5V is used as a standard. Atmega328 is known for its cost efficiency, low power dissipation, programming lock for security purposes, real timer counter with separate oscillator. Most commonly used in Embedded Systems applications with some applications in robotic, and many other applications.

FEATURES:
No. of pins: 28
CPU: RISC 8-bits AVR
Operating Voltage: 1.8 to 5.5V
Program Memory: 32KB
Program Memory Type: Flash
SRAM: 2048 byte
EEPROM: 2048 byte
ADC: 10-Bit
No. of ADC Channel: 8
Timer(3):16-Bit Timer(1)
8-Bit Timer(2)
I/O pin: 23
Oscillation: up to 20 MHz
Minimum Operating Temperature: -40 C to +85 C

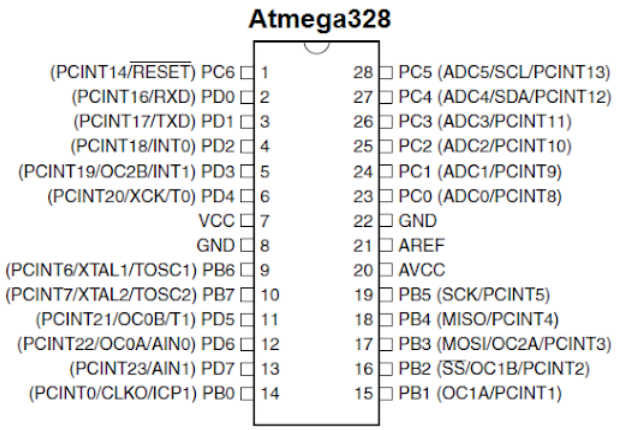


FIGURE 5. Atmega 328 Microcontroller

3.5 16*2 Alphanumeric Lcd Display

The LCD has been implemented to display the detected distance and angle which is also being sent to the user. It can exhibit 16*2 or 32 ASCII characters with 2 character lines where each line having 16. It has 8 data pins used in carrying the data from user to character LCD. Every Character has its unique bit code in accordance to ASCII format and is implemented to display characters on LCD. Other pins include enable, read/write and register selector. Ground, VCC, VO (LCD contrast) and Anode and cathode. Whenever the enable pin is low, the LCD is OFF and it is ON if the pin is high. The read/write pin, if high, reads the info from LCD and if low, writes data in it. The register select pin decides the sort of knowledge transferred through the info pins. If it is high, a character is written in LCD and if the low, command is sent to LCD.VCC is the power supply, which is 5V. VO sets contrast and brightness for the LCD display.

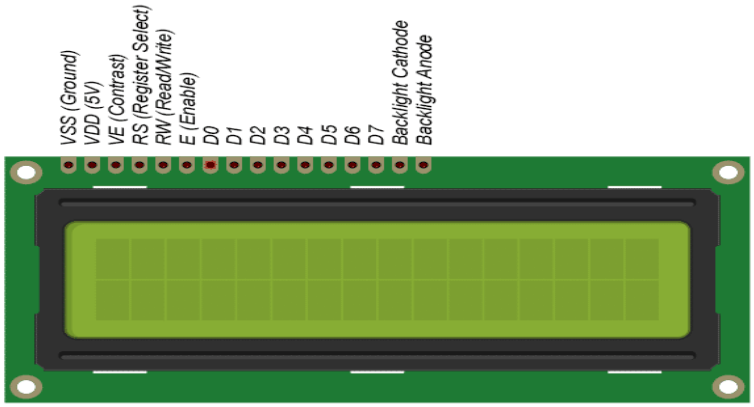


FIGURE 6: 16*2 LCD

3.6 Stepper Motor & L293D Driver IC

Stepper motors are DC motor that rotates in discrete step Stepper motor consists of many coils that are grouped together to form the phases. In order to rotate the stepper motor coils are energized phase wise using computerized sequences. Each phase is energized sequentially and each phase rotates rotor by some degree which is termed as step angle. Stepper motor used in the project has a step angle of 1.8 degree in or 200 turns per rotation. Other settings are also available including 24

and 48 turns per rotation. There are two types of stepper motor- unipolar and bipolar. Unipolar are energized in a constant manner. One coil will be positive while other is negative. Meanwhile in bipolar motors H-bridge connectivity is used for bidirectional functioning of motor.

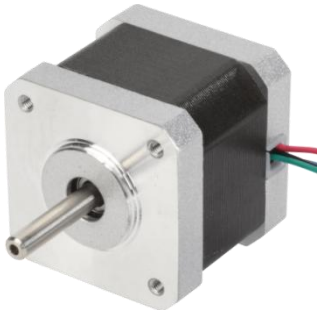


FIGURE 6: Stepper Motor

L293D (16 pin IC) is a Motor Driver IC which allows motors, be it stepper or DC, to drive on either directions. It is required as microcontroller itself cannot provide enough power for operation of stepper motor. It works on the concept of H-bridge. H-bridge is type of circuit with capabilities to allow voltage to change polarities which is essential in rotating the motor in both direction. It requires a supply of 5V for its functioning. The stepper motor rotates with the help of the driver IC.

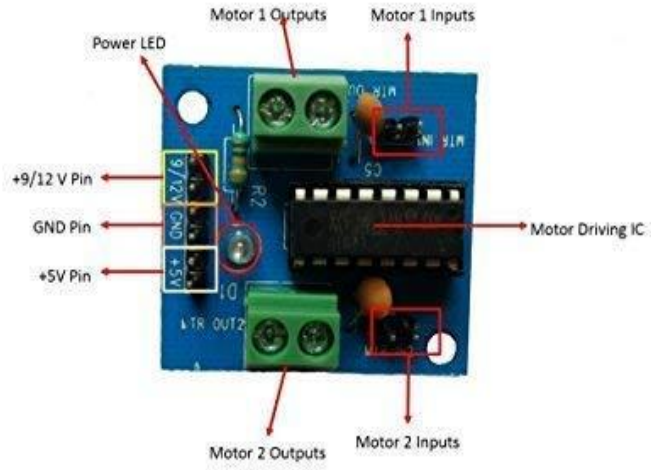


FIGURE 7: Motor Driver (L293D)

IV. SYSTEM DESIGN

The system is fully controlled by the microcontroller and it continuously monitors the sensors, detector and GSM modem.

Microcontroller repeatedly rotates stepper motor through L293D driver IC. Motor completes 1 revolution in 200 steps in accordance with its step angle 1.8 degree. Angle or Tracking is calculated based difference between variable "new angle" and "set angle" with "set angle" fixed at 0 and "new angle" calculated from number of pulses send to stepper motor.

Ultrasonic is mounted on top of stepper motor where object detection takes place and distance is calculated as (time* 0.34)/2 where 0.34 is speed of sound in cm/µs. When distance calculated is less than 10 cm then an alarm will buzz off along with activation of GSM. In that instant then it will send the "AT +CMGS ="USER MOBILE NUMBER" to GSM modem through serial port.

GSM modem will send the detected distance as well its direction of detection in terms of angle.

V. TEST AND RESULTS

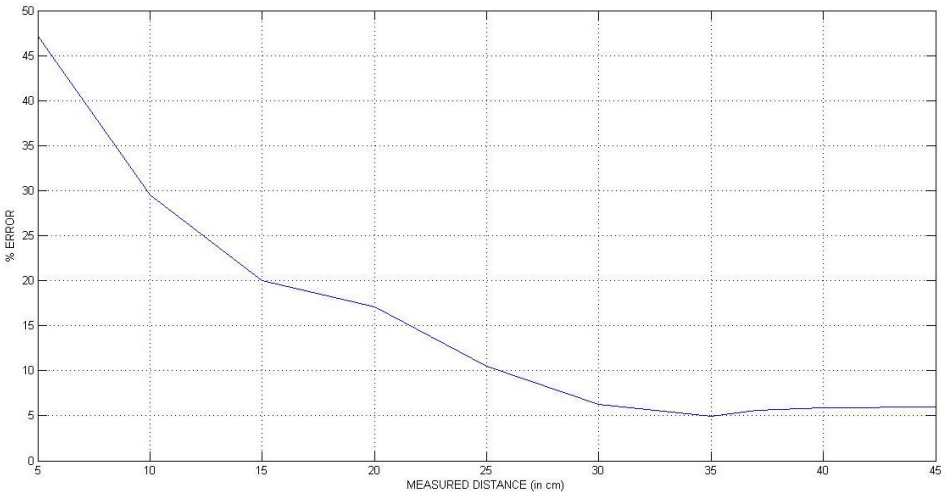
System is tested for ultrasonic sensors ability to detect distance while being in motion. For this, Ultrasonic sensor is rotated through stepper motor and distance detected is observed at different measurements. Data for this observation is shown below.

TABLE 1
DATA COLLECTED FROM OBSERVATIONS

MEASURED DISTANCE (in cm)	SMS DISTANCE(in cm)	Error(in cm)	Error (in %)
5	7.36	2.36	47.2
10	12.97	2.95	29.5
15	18	3	20
20	23.41	3.53	17.05
25	28.22	3.22	10.48
30	31.87	1.87	6.23
35	36.77	1.77	4.91
37	39.08	2.08	5.62
40	42.36	2.36	5.90
45	47.86	2.86	6.35

Below graph and above table are use to show the existence error in cm and %.

Plotting the graph between measured distance (in cm) and error (in %):-



GRAPH: Plotted of Data collected from observations

According to data and graph, accuracy decreases as distance is increased, and achieves a near constant accuracy in the range of 4-5% in the terms of percent error starting from 35 cm.

VI. OUR WORKING MODEL

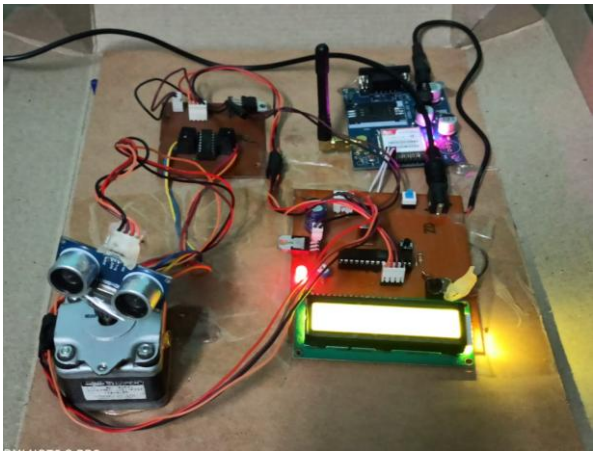
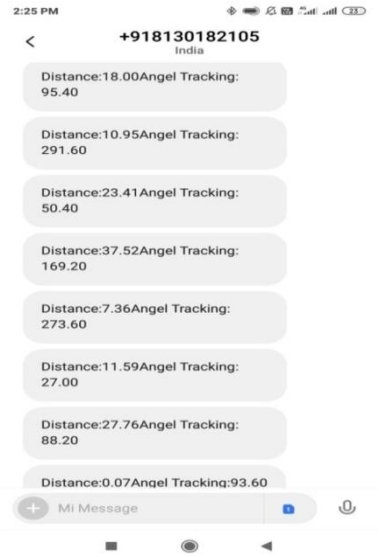


FIGURE 8: Project Designed

VII. OUTPUT OR RESULT

The distance (in cm) and angle (in degree) of the object which is detected by our model /through the SMS in the mobile (owner mobile) is:-



VIII. CONCLUSION AND FUTURE WORK

This security system is tested and implemented using ULTRASONIC RANGE, STEPPER MOTOR and GSM as an advance security over 360-degree angle in particular range. And we found systems' working is satisfactory. The systems having advanced features like its portable and low cost and standalone system. Our future work of this paper is planned to a develop in addition with some important equipment like:-

Wireless camera to help in identifying type of threat which is detected by the system and also some additional sensors like fire or gas sensors will enhance security prospects of this work when implanted with 360-degree detection.

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A Readiness Model towards Transformation a Second Generation University to an Entrepreneurial University

Morteza Borhani[1], Heydar Amiran[2], Jamshid Edalatian Shahriari[3]

Faculty Management, Islamic Azad University Central Tehran Branch, Tehran, Iran

Abstract**—** *This paper proposes a readiness model for transformation a second-generation university to an entrepreneurial organization based on influential factors and the consequences of entrepreneurial activities on local economic development. Six factors and indicators are identified and modeled based on the tutorial entrepreneurship literature. The restrictions of each factor are defined by the readiness framework and the consequences of entrepreneurial activities on local economic development are analyzed by using the proposed model. The proposed conceptual model aids policymakers in completing a much-needed assessment of the impact of organizational policies, practices, and structures on the entrepreneurial activities and transformation from second-generation universities to third-generation organizations. The proposed readiness model leads to the development of organizational interventions that facilitate successful entrepreneurial activities. The quantitative indicators of different university types are demonstrated in this study. The quantitative validation of the integrated framework suggests that university heads and policymakers can encourage and develop academic entrepreneurship by using a comprehensive systems approach for the identification, protection, and commercialization of university intellectual property.*

Keywords— Entrepreneurial universities, readiness; local economic development model, quantitative indicators.

I. INTRODUCTION

Today, the economies of corporations, countries, and successful entrepreneurial universities are deeply influenced by technological developments, short product/service life-cycles, and global competitiveness [1].In the meantime, the role of universities in the development of products/services and the commercialization of science has become crucial [2]. Various entrepreneurship initiatives are being undertaken at entrepreneurial universities to further transfer science and technologies to industries and improve the relationship between science, technology and operational activities [3]. Universities that play a critical role in the economic development of their region are called entrepreneurial universities [4]. Table 1 provides the word cloud of some selected definitions of the entrepreneurial university that are acknowledged in related literature. The development of third mission activities, i.e., technology transfer and university-industry links, the contributions to regions, new job creation and revenue generation, shaping of entrepreneurial mindsets and innovative culture in society are some of the outstanding features of definitions of the entrepreneurial university.

The intrinsic and economic capacities of the newly industrialized countries are advancing, and national universities and public research organizations are expected to become increasingly important in supporting natural companies to drive them more dynamic and industrialized [5]. The characteristics of working with universities may vary greatly depending on whether the industry partner is engaged in new or growing activities. [6]. In developed economies as well as in newly industrialized countries, the value of research, public education, and research-educational projects are of great value in playing an effective role in entrepreneurship and increasing the profits of the national economy as well as in the growth of high-tech activities.

In the medium or long term, the competition in the global economy depends on technology-based strengths [7]. This includes the ability to apply new technology to reach new successful markets, as well as develop the skill level of the workforce to develop new products. A university can play a substantial contribution to the development and institutionalization of the above-mentioned elements. Therefore, university-industry collaboration is increasingly expanding, causing market dynamics. The challenges in the global economy have made policymakers and companies expect the universities and research institutes to generate new ideas to accelerate economic innovation and development, and in fact, expect to create a new kind of university [8]. Therefore, universities are turning from the science and technology center to an ecosystem of innovation and entrepreneurship. Entrepreneurial university is a university that fulfills national and regional development goals and plays a major role in this process. The entrepreneurial university does not only think of producing human capital and ready-to-enter labor force but also pursuing its strategic goals as part of an important engine for sustainable technology development and economic growth [9].

TABLE 1
SOME DEFINITIONS OF THE ENTREPRENEURIAL UNIVERSITY

	Definition of entrepreneurial university
Urbano and Guerrero (2013)	Entrepreneurial university needs to become an entrepreneurial organization, its members need to become entrepreneurs, and its interaction with the environment needs to follow an entrepreneurial pattern'
Guerrero et al. (2014)	The nature of an entrepreneurial university is such that graduates are perceived not only as future job-seekers but also as future job-creators, and the organization and content of teaching activities reflects this conception'
Guerrero and Urbano (2012)	An entrepreneurial university could be defined as a survivor of competitive environments with a common strategy oriented to being the best in all its activities (e.g., having good finances, selecting good students and teachers, producing quality research)'
Kirby et al. (2011)	Entrepreneurial university is a natural incubator that, by adopting a coordinated strategy across critical activities (e.g., teaching, research and entrepreneurship), tries to provide an adequate atmosphere in which the university community (e.g., academics, students and staff) can explore, evaluate and exploit ideas that could be transformed into social and economic entrepreneurial initiatives'
Taylor (2012)	Entrepreneurial in the broad sense of generating a growing percentage of funding from non-state sources or linking more closely to society through third-stream activity with an industrial or commercial association'
Audretsch et al. (2012)	The role of universities is more than generating technology transfer (patents, spin-offs and start-ups), and rather, contribute and provide leadership for creating entrepreneurial thinking, actions, institutions and entrepreneurial capital'
Liu (2012)	The entrepreneurial university model originated in the process of the utility of knowledge to industry, in which substantial returns will be gained through selling knowledge'
Trippl et al. (2015)	The entrepreneurial model claims that universities promote the development of their regions by engaging in patenting, licensing and academic spin-off activities, generated from university subjects such as engineering, information technology and biotechnology, in which the knowledge produced overlaps more readily with products and processes that industry and market structures can absorb'
Etzkowitz (2016)	The entrepreneurial university is first and foremost a regional actor'

Entrepreneurial universities think and manage in a global context but operate locally as part of the regional knowledge-based economy structure. In these circumstances, entrepreneurial universities do not operate separately from industry and industry apart from knowledge [10]. The fundamental role of universities in the training of a specialist workforce has to fundamentally be changed in various countries, especially in developed countries. The first-generation universities were education-based. The purpose of these universities was to train specialized human resources. Thereafter, the first academic revolution took place in Germany at the end of the century, during which research-based universities were introduced as second-generation universities. These universities were involved in the research and production of science. Then, the second academic revolution occurred in the second half of the twentieth century after World War II, during which entrepreneurial universities emerged as the third generation to train the entrepreneurial workforce and connect with industry. In the United States, there were more than 140 entrepreneurial universities created in the 60s and 70s and reached 500 in the 1990s. Entrepreneurial universities in India, the Philippines, and Malaysia were also established in Asia. MIT, as one of the most prominent third-generation universities in the world, has established a center for training and promoting entrepreneurship among students and faculty with the aim of training managers to succeed in knowledge-based companies. Executives at the university believe that it is not just about inventing a new product, idea or technology; it is about success, commercialization of innovation [11].

The introduction of entrepreneurial university activities, as well as the reason why some universities are successful, has become an important research topic in entrepreneurship research. Extensive researches have been done to identify the factors, impacts, and consequences of university entrepreneurship activities. This article investigates the activities, effectiveness, and consequences of university entrepreneurial actions into six main factors:

1) Factors that focus on individuals and their personalities as key actors in the university's entrepreneurial currents.
2) Factors that focus on the organizational structure and configuration of the university as a key driver of entrepreneurial flows using university resources.
3) Factors that describe the culture and rewards available at the university as factors in the cultural and social development of the university's entrepreneurial activities.
4) Factors that consider external environmental impacts of university entrepreneurial practices.

5) Factors that measure the performance of university entrepreneurial activities.

6) Factors that measure the economic impact of university entrepreneurial activities.

The six research areas mentioned are not completely separate from each other and overlap in areas. This paper uses these research areas to provide a framework for evaluating the effectiveness, and consequences of university entrepreneurial actions and to explain the factors, components, and consequences of transforming a university into an entrepreneurial university. Applying the proposed framework can help policymakers to know the readiness of the university and its region to become an entrepreneurial university.

This article is structured as follows: First, the role and impact of universities' entrepreneurial transformation on the economic development of the region are examined. In Section 3, six separate research factors are introduced and their impacts of entrepreneurial universities are described in detail. Section 4 proposes a new framework for evaluating the degree of university readiness to become an entrepreneurial university, identifying the limitations and shortcomings of existing research. In Section 5, based on the literature review, the proposed theoretical framework based on the introduced factors, components, and their impacts and consequences is evaluated. The results and conclusions are presented in Section 6.

II. RELATED WORKS

The traditional mission of the second generation universities is to research and disseminate knowledge in academic societies and student communities. These universities provide Research and Development (R&D) teams and their activities lead to support patents for innovative inventions and publish high quality and state-of-the-art manuscripts. They also learn students to become skilled professionals and highly qualified personnel to play essential roles in entrepreneurial activities [12]. Universities not only provide resources, laboratories, and facilities for the development of technical abilities and outcomes of faculty members but also create an environment for students' growth to acquire explicit and implicit knowledge and tactics through learning and living in the academic environment. Some of the innovation processes of universities [13] can be summarized as:

- High-quality scientific publications that expand technology and service opportunities.
- Training of specialists, professionals, engineers and natural sciences;
- Doctoral education based on knowledge, skills, work teams, and human networks.
- Collaborating in informal networks, joint research and development projects, contract research and research activities, or exchange of explicit and implicit knowledge related agreements.

Rather than providing services and products as the primary outcome of academic and scientific research to industry, first and second-generation universities place great emphasis on education, tacit knowledge, and indirect benefits [14]. Recent researches demonstrate that entrepreneurial universities can play a greater role in regional and national economic development. Recent research shows that the attainable role of universities in regional and national economic development can be far greater than the indirect effects of traditional universities. The reasons for the importance of transforming entrepreneurial universities in regional and national economic development can be summarized as follows:

- The role of knowledge in the development of national economies and employment
- Technical advances of Information and Communication Technologies (ICT)
- The growing importance of regional high-tech clusters and entities.

The following explains the details of the importance of the transformation to Entrepreneurship University in economic development.

2.1 Increasing Share of Knowledge and Awareness in Economic Development

Today, the creation and exploitation of knowledge, especially technology-based entrepreneurial activities for the discovery of new sciences and the pursuit of new opportunities, are increasingly accepted and pursued by policymakers [15]. The growing dependence of economic development on a nation's abilities to acquire and apply technical, social and economic knowledge in the process of globalization has been accelerated. Technological progress is the prerequisite for continued high economic growth. Today, most comparative advantages are based on technical innovation and the competitive use of knowledge, and,

as in the past, abundant natural resources or cheap labor do not account for much of the competitive advantage in economic development. Indeed, economic growth is the result of the process of knowledge accumulation and technological use.

The entrepreneurial university should be considered as a key component of economic strategies that pursue economic development by providing comparative advantages based on the strengthening and exploitation of national knowledge [9][16]. This attention will provide the conditions for the development of a knowledge-based society. The rapid acceleration in the rhythm of knowledge creation and dissemination (shortening the lifespan of technologies and products) is the main reason for developing economies to focus on entrepreneurial universities. As a result of the focus and need for economic development on entrepreneurial universities, governments have recently increased the support of universities' technological and entrepreneurial developments to create knowledge-based companies and high-tech entities and the use of academic outputs, products, and services.

2.2 Effect of Engineering Research and Science on Economic Growth

Today, the world is experiencing a shift in the way people work, how organizations are structured, and how businesses compete in the aftermath of advances in information and communication technology. ICT has transformed most of the competing markets from local to global, and competing businesses may offer products and services from anywhere in the world. The need for economies to compete in such a competitive environment is to accelerate the growth of knowledge by a new generation of universities. The continuous learning process is itself one of the primary requirements to accelerate knowledge development. Therefore, it is imperative that entrepreneurial universities, which have traditionally been the centers of gathering, creating and disseminating new knowledge, should provide the conditions to enhance the competitive advantage of their areas.

2.3 The Role of Technological Clusters and Knowledge-Based Companies in Economic Development

Nowadays, universities should contribute to the development of national economies, in addition to producing and disseminating knowledge within the academic community and the indirect effects on economic development. The third-generation universities support and deployment of regional technological entities and high-tech companies by stimulating and disseminating business knowledge through the activation. One of the important aspects of entrepreneurial universities and high-tech companies in economic development is the possibility of attracting foreign direct investment into the country. From the perspective of multinational companies, the location of high value-added R&D projects is influenced by human capital and regional R&D capability [17]. Economies with high technology infrastructure and startups are better able to attract student investment from multinationals.

III. THE PROPOSED MODEL

The common elements [18] among successful entrepreneurial institutions can be summarized as:

1. Most successful entrepreneurial universities have strong top-down leadership and policies that support, accelerate, and encourage the process of entrepreneurial activity, and integrate entrepreneurial goals with traditional university academic values, thereby synergizing trends.
2. Most successful entrepreneurial universities owe their success to extensive communication and collaboration with industry in cross-cutting research projects. To this end, entrepreneurial universities have policies and procedures for entrepreneurial activities and are supported and encouraged by structures such as industrial communications offices and flexible contracting practices.
3. The sources of funding for successful entrepreneurial universities are varied, and although most of the funding for these universities is still funded by the government, funding from industry as well as private charities is available.
4. One of the requirements for successful entrepreneurial universities is to have a strong academic base and a comprehensive effort to improve their academic performance.
5. To succeed in entrepreneurial universities, it is necessary to develop an entrepreneurial culture at the university and change the culture of individuals to accept it while maintaining the core values of the institution.

The influential factors and consequences of university entrepreneurial activities can be listed in six primary research groups or domains as follows:

3.1 Scientific relationship, industrial and personality characteristics of university entrepreneurs

The entrepreneurial attributes, personality traits, motivations, disposition, and experiences of individuals play a prominent role in influencing and shaping entrepreneurial activities. The psychological model is also very effective to explain the output of service or product departure from universities. The individual's abilities, personalities, abilities, and will have a great impact on the entrepreneurial behavior of academics to succeed. The entrepreneurial behavior deters the quantity and quality of products. Academic entrepreneurs with outgoing, extroverted personalities were more likely to engage in entrepreneurial activities. Personal characteristics such as the need for achievement, the desire for independence and an internal locus of control were common in both groups. University entrepreneurs tended to be older and more scientifically experienced than "typical" high-technology entrepreneurs were. Scientific stars collaborating with firms had substantially higher citation rates than pure academic stars.

3.2 Resources and resources at the university include funding, brands, laboratories, growth centers, research centers, faculty

Although the general organizational theories of universities have concerned on the impact of environmental forces on academic entrepreneurial activities, rather than focusing on the broad economic or social forces, the organizational and human aspects of the university can be addressed and the relation between entrepreneurial activities and the level and nature of research funding; the quality of the researchers, the nature of the research within the university; and the presence of technology incubators should be excavated.

3.3 Entrepreneurial culture, policies, rules, structures, and promotion opportunities that enhance entrepreneurial activities and facilitate knowledge-based business

University entrepreneurship activities are a reflection of institutional behavior. Universities that have cultures that support commercialization have a higher level of business and higher levels of entrepreneurial activity. In contrast, academic environments that do not encourage entrepreneurship have less entrepreneurial activity. The university's social norms and expectations are the main determinants of commercialization [19]. Faculty members at some universities have greater motivation for entrepreneurial activity than their counterparts at other universities because of the inspiration provided by former university entrepreneurs at their university [20]. Faculty decisions on entrepreneurial activities are subject to social conditions. Entrepreneurial pioneers' struggle to make new academics believe that entrepreneurial activities are acceptable and desirable [21]. In contrast, academic environments do not encourage entrepreneurship to inhibit entrepreneurial activity. Academic unwillingness to engage in entrepreneurial behavior may be exacerbated by the attitudes and behaviors of senior individuals such as professors or heads of departments [22]. Local group norms are important in predicting active participation in commercialization [23].

3.4 Environmental Factors Affecting University and Academic Entrepreneurial Activities

Three broader economic factors that have the greatest impact on entrepreneurship activities in universities [24] are 1. Access to investment for the formation of advanced companies, 2. Legalization of inventions, and 3. Knowledge infrastructure in the region. National policies that allow for the invention of patents for academic inventors inhibit entrepreneurial activity and lead to anti-entrepreneurial attitudes among faculty and university administrators that do not benefit from the entrepreneurial activity of inventors [25]. Knowledge infrastructure of a region is another key environmental factor in determining entrepreneurial activities. Ease of access to critical expertise, networks and more knowledge in high-tech clusters enhances entrepreneurial activity.

3.5 Performance of side jobs, multitasking and service records

Few but growing studies have been conducted to evaluate the performance of university entrepreneurship activities. One of the performance indicators is the high survival rate of university affiliates relative to the average survival of new firms. Lower rates of failure in entrepreneurial activities at entrepreneurial universities are another indicator of performance appraisal. Studies show that new technology firms are likely to survive and continue to operate if radical technologies are exploited and if they have a broad patent. Measuring the amount of direct and indirect communication with investors is one of the indicators of performance appraisal and one of the most critical determinants of the success of technological activities that directly reduce the likelihood of product or service failure at entrepreneurial universities. A combination of academic and surrogate entrepreneurs might be the best approach for developing successful technology-based entrepreneurial activities. So, the composition of core entrepreneurs can be considered as a performance indicator for entrepreneur university.

Entrepreneurial activities have four stages including the research phase, the opportunity setting phase, the pre-reorganization phase, and the reintegration phase, as well as four critical milestones for progress to the next development stage including opportunity recognition, entrepreneurial commitment, credit threshold, and sustainability threshold. At the entrepreneurship university, indicators for evaluating their performance and success at these stages and these critical points should be defined and monitored continuously. The success of entrepreneurial activities depends on the ability of entrepreneurs to communicate with a wide range of different stakeholders such as financial institutions, research laboratories, and the customer. The breadth of university entrepreneurs' relationships and their experience in capturing market capital is another indicator of the performance evaluation of entrepreneurial universities.

3.6 Measuring the impact of university entrepreneurial activities on economic development of the region

Start-ups and entrepreneurial activities directed by entrepreneurial universities are highly effective in enhancing the economic power and market penetration of high-tech companies. They also create new job opportunities, especially for a highly educated workforce, as well as increasing economic added value and ultimately economic development [26].

IV. RESULTS AND EVALUATING

Entrepreneurial universities around the world have received much attention from scholars and policymakers, and the move towards the transformation of universities into entrepreneurial universities has been welcomed. This study examines the causes and factors behind the success of some of these third-generation universities and assesses the conditions for converting a second-generation university to an entrepreneurial university. Different perspectives are offered on why some universities are at higher levels of successful entrepreneurial activity. This section provides a framework for evaluating university readiness to become a third-generation university, based on the proposed research policy and the research methods.

According to the theory of systems and advanced modeling tools, there is a critical demand to identify systematic changes and to answer why some universities have become more relatively successful in the third generation and when a university ready to change its traditional policies to an entrepreneur university. Most of the research studies, which were done to evaluate the readiness of universities to become third generation universities and to change policies to encourage and support entrepreneurial activities, are theoretical and models that have been offered solely in expressing some relationships between events without accountability explanations [27]. Thus, further studies that can explain, from an organizational perspective, why some universities succeed in supporting and encouraging entrepreneurial activities and technology-based services/products, are still of interest to scientists and policymakers. The complex processes within institutions are required to address the different forms of entrepreneurial activities and the complex causes and patterns that lead some, but not all, academics to engage in technology-based ventures in entrepreneurial universities.

The social setting of the institution and social environment established by other faculty members in the university plays a very important role in entrepreneurial activities and the process of becoming an entrepreneur university. The difference in the number of entrepreneurial activities at different universities is a direct reflection of the degree to which the culture of cooperation made them important determinants of academic status [28]. The role of the individual personality in entrepreneurial activities should be identified and taken into account in the model or framework for measuring readiness to change to a third-generation university [29].

The needs of institutional authorities seeking to enhance entrepreneurship on campus should be taken into account in the design of the framework. The different forms of entrepreneurial activity in higher education and the roles that institutions play in start-ups should also be taken into account. Nowadays, some researchers are being conducted on the implications of entrepreneurial activities and the transformation of universities to become entrepreneurial universities in the development of the regional economy. Most of the results of these studies call for further reflection on the potential weaknesses of the innovation system of universities that have entered the third generation university phase before they are prepared. Problems with the tensions created by faculty, performance between departments and colleges within such universities have raised concerns about unsuccessful entrepreneurial activities.

Since the process of converting a traditional university into an entrepreneurial university is longitudinal, there is a need to research longitudinal structures in addition to traditional cross-sectional studies. From a methodological point of view, different methods of data collection are needed to influence the evaluation of university entrepreneurship programs as well as to assess university readiness to become a third-generation university. In preparing the data, in addition to carefully recording, documenting and explaining changes and inter-institutional variations which were made in the process of

establishing an entrepreneurial university including policies, processes, and incentives, the structural complexities, as well as the richness of universities dynamics, should be captured and analyzed.

For the reasons mentioned above, it is necessary to use quantitative and qualitative hybrid simulations to evaluate the proposed systems for modeling the process of transforming a university into a third-generation university, as well as evaluating its readiness for such change. Quantitative-based evaluation and qualitative evaluation results have been used to confirm the proposed framework of this paper. There are some limitations to the data capture and modeling of academics' viewpoints and their perception of the quality of entrepreneurial experiences that complicate the proposed framework. Thus, in addition to employing quantitative methods, extensive and rigorous research requires the use of different types of qualitative methods ranging from focus group interviews to individual interviews to explain how academics understand their experiences within their institutional framework. Fortunately, to reduce the complexity of the proposed framework, some simpler methods can be exploited to provide some of the academic entrepreneurial tendencies. Such practices allow policymakers and academics to make meaningful decisions about how prepared they are to become third-generation universities.

FIG. 1. Some of the quantitative indicators of different university types

The scientific and research productivity of universities can be exploited to determine the generation of the university. The publication and citation indices, commercial research income per academic staff and share of R&D incomes in total), as well as their funding sources (state, business and foreign), are some of the indicators to measures the university productivity [3] which were typically provided in Fig. 1. One of the distinctive indicators of potentially entrepreneurial universities is that most publication activities are related to a share of non-budgetary R&D incomes, including business and international funding sources. In these universities, the quality and quantity of publication activity (via co-publications, disclosure of research results, etc.) are enhanced in close cooperation of academic staff with businesspeople. Entrepreneurial universities have typically approached internationalization strategies (the volume of foreign-financed R&D and international publication and citation indices) and actively engaged in joint international research projects and academic exchange with foreign

universities. Promotion of entrepreneurial initiatives and engaging in technology transfer and regional innovation initiatives lead to more publication activities.

V. DISCUSSION

This section integrates the abovementioned social-psychological perspectives into a readiness framework toward the third generation university. The proposed readiness framework exploited several influence factors for the transformation of a second-generation university to a third-generation organization in the domain of entrepreneurial activities and it also quantitatively indicates consequences on local economic development due to entrepreneurial universities. This framework provides a useful organizing scheme for understanding to identify the determinants of entrepreneurial activities within universities and for explaining the determinants and consequences of entrepreneurial activities.

FIG. 2. The Readiness framework for transformation to third-generation University based on influence factors and quantitatively indicates its consequences on local economic development

The proposed readiness framework is presented in Fig. 2 based on a conceptual integration of influence factors for transformation a second-generation university to a third-generation organization and quantitatively indicates of consequences of the third-generation university on local economic development. Base on the proposed model, the readiness for a third-generation university in the local economy does not only depends on the characteristics of individual academics but also depends on variation in environments and university contexts. Four factors influence the rate of entrepreneurial activities in second-generation universities to transform into a third-generation organization:

1. Individual characteristics including academic entrepreneurs, motivations such as career experiences and faculty networking are part of the academic's reasons for engaging in entrepreneurial activity and accelerate the transformation toward third-generation university;
2. Organizational resources including faculty quality, interdisciplinary research centers, nature of research, technology transfer, resources and expertise, the process of technology transfer, the commercial orientation of research, research and development funding, type of technologies created, patent production, entrepreneurship development programs

and presence of incubators are some of the attributes of universities which have to be measured before creation a third-generation university by organizational-focused studies;

3. Institutional and cultural characteristics including leadership mission goals history and tradition and also faculty and department culture in university and proposed rewards for entrepreneurial activities are some of the broader social contexts of the university, which influence the success of transformation from a university to an entrepreneurial university.
4. Environmental factors including seed and venture capital availability, regional infrastructure and environment, university intellectual property policy and local industry characteristics are some of the external characteristics that impact readiness for the creation of a third-generation university.

The consequences of entrepreneurial activities on local economic development can be quantitatively modeled by two further indicators:

1. The development and performance of side jobs, multitasking and product/service records in the local economy;
2. The success rates of the technological developments, product/service life-cycles, and global competitiveness on the regional economy.

VI. CONCLUSION

This paper is a systematic approach to measure the readiness of second-generation universities to transform into entrepreneurial universities. The proposed framework is based on six completely different studies included influence factors and quantitative indicators of the consequences of entrepreneurial activities on local economic development. This paper argues for the existence of an underlying set of individual and contextual factors of entrepreneurial activities that need to be accepted by the local economy before initiate transforming to have a third-generation university. Also, the two other primary indicators are identified (i.e. development and performance of entrepreneurial activities and the economic impact of entrepreneurial activities) to provide a parsimonious description of the outcomes of entrepreneurial activities. The limitations of the entrepreneurial activities of the different kinds of universities are quantitatively provided by this paper. The proposed readiness framework can draw generalizations of the entrepreneurial activities and their consequences on local economic development and can help policymakers to understand how entrepreneurial universities can contribute to both their traditional functions and the added function of making the regional or national economy more competitive.

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Evidence of OH· radicals disinfecting indoor air and surfaces in a harmless for humans method

Martínez Vimbert R[1,2], Arañó Loyo M[1,2], Custodio Sánchez D[2], Garcia Raurich J[3], Monagas Asensio P[3]

[1]Emovere Natura, Biomedical Research Communications
[2]e-SHealth, Consulting health care, Parc Cientific Universitari Tecno Campus Mataró
[3]Centre de Recerca en Seguretat i Control Alimentari, de la UPC (CRESCA)

Abstract— *The development of human societies around the world has generated a very serious environmental damage that threatens human health and the survival of animals and plants due to a higher incidence of infectious diseases.*

This awareness led to the designing of an advanced harmless environmental sanitation method for the elimination of pathogenic microorganisms and volatile organic compounds (VOC's) in large air spaces and surfaces. Advanced oxidation processes (AOP) based on hydroxyl radicals ($OH^{\bullet}$) in sufficient concentrations perform biocidal functions on pathogenic microorganisms and degrade airborne organic compounds to mineral forms of harmless organic compounds.

It is a technology recognized as clean and safe and is generally carried out through solar radiation as a process initiator with photocatalyst material. The problem presented in the photocatalysis methods is its low speed, the generation of toxic degradation intermediates, deactivation of the material and the need for UV irradiation.

The increased airborne spread of pathogenic microorganisms has raised serious concerns about its threat to environmental security. However, there is no effective method to quickly eliminate these harmful microorganisms in a large air space. Compared to conventional disinfectants, $OH^{\bullet}$ radical-based oxidation processes have excellent advantages.

Keywords— advanced oxidation process, disinfection, hydroxyls radicals ($OH^{\bullet}$), infectious diseases, ozone, terpenes, VOC's.

I. INTRODUCTION

The development of human societies around the world has generated a very serious environmental damage that threatens human health and the survival of animals and plants due to a higher incidence of infectious diseases.

The atmosphere does not have a native microbiota but is a rapid and global means of dispersal for many types of microorganisms. The history of aerobiology has demonstrated until the last century the fundamental role that respiratory air pollution plays in the development of epidemics such as cholera, influenza or Legionella [1]. This respiratory air pollution together with the ease of mobility of human beings around the world has generated in this new century extremely serious respiratory syndromes for survival.

Between November 2002 and July 2003, severe acute respiratory syndrome (SARS) spread rapidly from China to 37 other countries around the world, causing 775 human deaths with an economic loss of $ 40 billion [2].

In early 2009, a new strain of H1N1 of porcine origin spread worldwide from Mexico. H1N1 was declared a flu pandemic by the World Health Organization (WHO), causing around 17,000 human deaths in early 2010[3].

In 2012 a new episode of coronavirus emerged, the MERS-CoV (Middle East Respiratory Syndrome coronavirus). The emergence of SARS-CoV in 2002 and MERS-CoV in 2012 has changed the perspective of the Coronoviridae family since the pneumonias they have caused (SARS and MERS) have mortality rates of 10% and 30% respectively, which are elevated compared to the rest of the viruses in the family [4].

In December 2019 (after 17 years) a third new coronavirus, named SARS-CoV2 (Severe acute respiratory syndrome coronavirus 2), emerged in Wuhan Hubei province, China [5]. In February 2020, it was renamed as COVID-19 and declared pandemic by the World Organization of Health (WHO). Therefore, it is very important to develop a fast and efficient method for the elimination of pathogenic microorganisms in large air spaces.

This awareness led to the designing of an advanced harmless environmental sanitation method for the elimination of pathogenic microorganisms and volatile organic compounds (VOC's) in large air spaces and surfaces. Advanced oxidation

processes (AOP) based on hydroxyl radicals ($OH^{\bullet}$) in sufficient concentrations perform biocidal functions on pathogenic microorganisms and degrade airborne organic compounds to mineral forms of harmless organic compounds [6].

The results of different studies show that $OH^{\bullet}$ radicals rapidly destroy different microorganisms with a concentration of 0.8 mg/L and a spray density of 21 $\mu L/m^2$ in 4 seconds [7]. Vital and essential cellular morphological changes in pathogenic microorganisms are also observed under a microscope when exposed to a fatal dose of $OH^{\bullet}$ radicals.

It is a technology recognized as clean and safe and is generally carried out through solar radiation as a process initiator with photocatalyst material. The problem presented in the photocatalysis methods is its low speed, the generation of toxic degradation intermediates, deactivation of the material and the need for UV irradiation.

The increased airborne spread of pathogenic microorganisms has raised serious concerns about its threat to environmental security. However, there is no effective method to quickly eliminate these harmful microorganisms in a large airspace. Compared to conventional disinfectants, $OH^{\bullet}$ radical-based oxidation processes have excellent advantages.

Currently, chlorine, alkali, and alkali-alcohol-amine are the three main types of chemical disinfectants that are widely used to eliminate microbial contamination, but they have some drawbacks. A chemical disinfectant can only selectively kill one or similar types of pathogenic microorganisms; its processing time is long, in a range of 0.5 - 1 hour due to the low chemical reaction rate and a very high lethal dosage value, which could reach 9% (v / v);the remaining chlorine intermediates imply severe secondary contamination. Finally, its lethal processing is limited to the surface of the objects, making it impossible to apply in large air spaces [8,9].

Compared to previous chemical disinfectants, advanced $OH^{\bullet}$ radical-based oxidation technology has several advantages: 1) Absence of selectivity, they can kill any pathogenic microorganism in low lethal doses due to its strong oxidative character, with an oxidation potential of 2.8 V, slightly less than fluorines (3.03 V). 2) The processing time of $OH^{\bullet}$ radicalsis very short, several seconds, because the chemical reaction rate of $OH^{\bullet}$ radicals is greater than 10^9 L $mol^{-1}second^{-1}$, which is 10^7 times greater than other oxidants' such as O_3, H_2O_2, Cl_2, etc. 3) As a green oxidant, $OH^{\bullet}$ radicals decompose into H_2O and O_2 without any residual oxidants after their biochemical reactions [10,11].

II. MATERIALS AND METHODS

2.1 Formation of $OH^{\bullet}$ radicals

Oxygen is an essential molecule for life, but due to its high reactivity it also becomes a toxic element that gives rise to the so-called *oxygen paradox*. Oxygen is basically an oxidizing molecule. The following concentration of pollutants is generally found in "clean" outdoor air (without sources of pollution): carbon dioxide, 320 ppm; ozone, 0.02 ppm, carbon monoxide, 0.12 ppm, nitric oxide, 0.003 ppm, and nitrogen dioxide, 0.001 ppm. However, these values increase significantly in urban air [12].

The $OH^{\bullet}$ radical is the most important natural oxidant in tropospheric chemistry, often called the "detergent" in the atmosphere since it reacts with many pollutants, initiating the process of cleaning them up. It also plays an important role in the elimination of greenhouse gases such as carbon dioxide, methane or ozone. Using Advanced Oxidation Processes (AOP) is attractive, among other reasons, because the contaminant is destroyed, not concentrated or transferred to the environment, a total or almost total mineralization of organic pollutants is achieved. Therefore they can be applied in the destruction of the vast majority of organic compounds, especially in non-biodegradable compounds such as organochlorines, PCBs, PAHs, etc. It is a clean and safe technology and in some processes, solar radiation can be used as the initiator.

The main problem for rapidly eliminating pathogenic microorganisms in large air spaces is how to produce the $OH^{\bullet}$ radicals with high concentration and large production. Currently, the main methods are Fenton catalysis, photocatalysis and ozone as well as their collaborative effects [13-17]. However, these technologies have some serious disadvantages: 1) The $OH^{\bullet}$ radicals rate of production is low and they are obtained at low concentration, so that the whole biochemical reaction time is long, in the range of 15 - 360 min. 2) The above-mentioned technologies are only applied to small scale experiments or applications. 3) A large number of chemical reagents such as H_2O_2, TiO_2 or $Fe^{2}+$, are necessary in the process of $OH^{\bullet}$ production, resulting in high cost and a safety problem. 4) In order to increase the $OH^{\bullet}$ radicals production, several kinds of technologies are collaborated together resulting in large-volume accessory equipment such as the bubble tower or rotating packed bed.

In previous studies, the production of a large number of $OH^{\bullet}$ radicals has been reported by ionization and dissociation of O_2 in air and H_2O in the gaseous state, using a physical method of strong electric field discharge. In this way, $OH^{\bullet}$ radicals have been successfully used in the treatment of ship's ballast water and red-tide in the ocean [18,19].

Titanium oxide is the current reference as a photocatalyst material given its high activity, relative stability, low cost and low toxicity. However, there are problems to be solved such as the low rate of photocatalysis, generation of toxic degradation intermediates, deactivation of the material and the need for UV irradiation as its band gap is not coupled with sunlight [20].

2.2 Development of a new advanced oxidation process for the decontamination of air and surfaces.

Given the described scenario, a challenge for safe and effective technological development is generated in the decontamination of air and surfaces. The technological objective is based on the milestone of achieving a method capable of producing $OH^{\bullet}$ radicals in sufficient quantities by means of an innovative system that ensures their efficacy and safety for human beings. The Wadu02® system is a device by which are active oxygen species (ROS) such as hydrogen peroxide (H_2O_2) or a terpene such as d-limonene, evaporates and reacts with an internal ozone emission below a concentration of 0.050 ppm (0.1 mg / m^3). This ozone exposure limit, established in the regulations issued by the WHO in the environmental limit values (VLA) of the year 2000 for the general public in exposures of up to 8 hours [21], is taken as an international benchmark of safety in ozone emission to obtain a constant and non-damaging production of $OH^{\bullet}$ radicals.

Wadu02®'s ozone emissions were evaluated through testing of household electrostatic air cleaners in an external laboratory [22] under the Electrostatic air cleaners standard, SUN - UL 867 and tested with a Teledyne ozone calibrator and monitor, at temperature and humidity controlled by Vaisala transducer and flow meter. The ozone emission of the Wadu02® device was certified in active mode and night mode in parameters less than 0.020ppm (0.012 - 0.015 ppm without filters and 0.015 - 0.016 ppm with filters respectively). Results were lower than all international standards regarding safety in prolonged exposures to ozone.

The production of $OH^{\bullet}$ radicals through the oxidation of H_2O_2 was evaluated under controlled conditions according to the oxidative functionality of the Wadu02® device and compared to liquid hydrogen peroxides in the purity ranges of 0.25% to 0.75%, aided by the colorimetric reaction performed on a potassium iodide test strip. The results indicate that the average oxidative capacity of H_2O_2 at 0.5% purity is equivalent to the oxidative capacity offered by the Wadu02® model devices, with a maximum production of 0.9 mg/m^3 (0.64 ppm), which is approximately 64.2% of the current workplace exposure limit (WEL) adjusted to 1.4 mg / m3 (1ppm)[23,24].

The threshold concentration for the acute irritant effects of hydrogen peroxide gas in the respiratory tract is 10 mg/m^3 (equivalent to 7 ppm) in humans, while the corresponding values for the skin are 20mg/m^3. Regarding its prolonged exposure, hydrogen peroxide has not been found to cause teratogenic or carcinogenic effects in humans. Mutagenic or chromosomal effects have also not been observed.

It was also verified as an alternative to the high natural reactivity of hydrogen peroxide, the substitution of the cartridge load with aromatic essences extracted from flowers and plants due to the biocidal role that terpenes have for their antiviral and antibacterial properties. The process of advanced oxidation was analyzed under the same conditions of low ozone emission (less than 0.02ppm) with the Wadu02® model, to compare the proven efficacy of hydrogen peroxide.

Limonene is one of the most abundant monoterpenes in nature present in essential oils extracted from the peel of citrus fruits, including the essential oils of orange and tangerine. This monoterpene is susceptible to oxidation to generate compounds with higher added value [25].

Terpenes are hydrocarbons present in essential oils that consist of more than one unit of isoprene with five carbons. Monoterpenes, most terpenes, along with sesquiterpenes and diterpenes, comprise the majority of essential oils. Due to the low molecular weight and high volatility of monoterpenes and sesquiterpenes, the use of essential oils in indoor environments can increase the levels of volatile organic compounds (VOCs) [26].

Terpenes contain one or more C=C double bonds, which interact easily with strong oxidants such as ozone, hydroxyl radicals [27-29] and nitrate radicals. Ozone is a common indoor pollutant, the general levels of which are distributed approximately 20 to 40 ppb [30,31]. The use of office machines, such as copy machines, printers and fax machines, also elevates indoor ozone concentrations [32]. The VOCs emitted through the evaporation of indoor terpene-based products may interact with ozone and generate secondary air pollutants, mostly formaldehyde and suspended particulates [33-37]. Secondary organic aerosols generated by the interaction of terpenes and ozone consist of fine and ultrafine particles [38-40]. Consequently, prior

evaluations of total limonene consumption were performed on the Wadu02® device to obtain controlled and safe evaporation.

The total consumption of d-limonene in the Wadu02® products was determined to be of the order of 0.4 g/24 h. According to the functionality of this device and the average evaporation of the measurements recorded in the laboratory, Wadu02® products emit a cloud containing d-limonene with a concentration of approximately 1.84 ppm, which in a room of $60m^2$ ($180m^3$) can give rise to a maximum concentration with a value less than 2ppb. This concentration is significantly lower than the Swedish and German OEL levels [41] (occupational exposure limits) which are 27ppm and 10ppm, respectively.

2.3 Toxicology

For the evaluation and analysis of the amounts of formaldehyde, which can be generated directly from the reaction of ozone with the structural units of C=C bonds, reports indicating that the proportions of formaldehyde formed by this mechanism during ozone-initiated reactions with terpenes represent only a small percentage of reactions to ozone were evaluated [33,34].

The main mechanism that forms formaldehyde is initiated by the reaction of ozone with the functional group C = C to generate ozonide. Subsequently, the ozonide decomposes into a carbonyl and an energy-rich (bi-radical) Criegee intermediate. Both products participate in various additional oxidation reactions to form highly reactive species such as hydroxyl radicals and stable products. These stable products can be ketones and carboxylic acids if the process has taken place in an oxidizing medium, or aldehydes and ketones if the process has taken place in a reducing medium.

The formation of stable carbonyls with low molecular weights, including formaldehyde, acetaldehyde, acetone and propionaldehyde, were observed during the gas-phase reactions of ozone with terpenes [31,33,36]. Reactive hydroxyl radicals generated from ozone reactions with terpenes played a vital role in forming indoor formaldehyde.

Several studies have indicated that indoor $OH^{\bullet}$ radicals concentrations generated by ozone reactions with unsaturated compounds were higher than those outdoors at midday or night [42-44]. $OH^{\bullet}$ radicals were responsible for 56~70% of indoor formaldehyde in reactions between ozone and 23 VOCs and ozone and terpenes [45]. Therefore, a new security objective is the evaluation of the reactions of $OH^{\bullet}$ radicals by means of terpenes and the possible contribution to obtain high levels of formaldehyde indoors and potential effects on indoor air quality [46].

2.4 Security test

Once verified that the total consumption of limonene and hydrogen peroxide does not exceed limits considered teratogenic and carcinogenic in humans and that the emission of ozone is less than what is established in international regulations, the effectiveness in reducing formaldehydes was evaluated. The advanced oxidation of limonene with Wadu02® was assessed using the SPS-KACA002-132: 2016 test method under controlled temperature and humidity conditions (21 ± 1) ºC (45 ± 5)% RH with d-limonene in the cartridge and with d- limonene in a gel [47]. The results indicate that the reduction of formaldehyde in ozonolysis reactions with emissions less than 0.020 ppm and with low emission concentrations of d-limonene with an evaporation of 0.4 g / 24 h equivalent to 1.84 ppm is significant and reaches values of 19% with gel and 41% with liquid limonene cartridge.

These results show that despite the high reactivity of d-limonene with ozone for the formation of formaldehyde, the controlled emission of ozone below 0.02ppm and the evaporation of limonene below 2ppb in a space of $60m^2$ is a safe and harmless reaction.

To validate this hypothesis, a series of experimental tests were carried out to determine the reduction of particles and air pollutants emitted by the burning of an incense stick during a 2-hour exposure to a Wadu02® air purifier, using loaded cartridges with d-limonene and H_2O_2 in a 225.72 m3 (6.6 X 6 X 5.7) volume-controlled chamber [48].

Five air quality measurements were performed under different conditions. The first lecture was determined by the initial air quality in the room, without any exposition to incense or air purifiers. The second lecture was taken after 2 hours, since half of an incense stick was burned. The third lecture was determined after the initial air quality was reached and half of an incense stick was burned, with the presence of hydrogen peroxide cartridge air purifier for two hours. The fourth lecture was taken by the same conditions as the third one but, in this case, with a D-limonene cartridge air purifier. Finally, the fifth lecture was determined by the same conditions as third and fourth measurements but, this time, with the presence of both air purifiers (D-limonene and hydrogen peroxide cartridges).

FIGURE 1. Air quality values before and after contaminating the room with the combustion of an incense stick. Comparison of the safety and efficacy of Wellis in the elimination of VOCs and formaldehyde with hydrogen peroxide and limonene.

The study shows that under these conditions, burning an incense stick generates poor air quality an average of 30 minutes after the start of combustion with a tendency to regularize after one hour and to return to the initial conditions after two hours, as the particles emitted dispersed in the air space of the room. However, formaldehyde and VOC's readings are higher than the control reading, reflecting the risk of prolonged exposure.

The results in the presence of Wadu02® purifiers regardless of the cartridge content (d-limonene or H_2O_2) maintain the initial air quality from the first half-hour of exposure, significantly reducing the values of particle matters, formaldehyde and VOCs. The efficacy in terms of the reduction of formaldehyde and VOCs, according to the use of d-limonene or H_2O_2 to carry out the emission of $OH^{\bullet}$ radicals, is not significant although H_2O_2 presents more efficient values.

This allows us to determine that the operation of the Wadu02® air purifier, based on the emission of ozone in low concentrations (< 20 ppb) and the evaporation of standardized amounts of d-limonene or H_2O_2 from the cartridge (as a result of the execution of the advanced oxidation process) is safe, harmless and effective in reducing suspended particles, VOCs and formaldehyde.

2.5 Application of OH● radicals as a broad spectrum biocide

Free radicals and ions cause irreversible alterations in macromolecules (proteins, membranes and DNA) as a consequence of the movement of electrons, resulting in a morbid effect. Reactive Oxygen and Nitrogen Species (RONS) are the most unstable and reactive, meaning these are the first ones to react with others. Within this group, the $OH^{\bullet}$ radicals are the species with a more ephemeral half-life due to its high reactivity, and therefore the most dangerous [49].

The efficacy of the concentration of $OH^{\bullet}$ radicals in the elimination of pathogenic microorganisms was studied. Under conditions of spray density of 21µL/cm^2 and at processing times of 4 seconds, a dramatic decrease in surviving cells has been reported for *S. Marcescens* at concentrations just above 0.15mg/L and almost entirely in concentrations of 0.41mg/L. In *B. subtilis*, the levels were practically undetectable at concentrations of 0.5 mg/L, whereas in *bacillus* spores the reduction was significant at levels of 0.3mg/L and practically entirely at maximum concentrations of 0.8mg/L [50].

The biocidal function of $OH^{\bullet}$ radicals is based on the advanced oxidation process, a cellular stress mechanism initiated by the "respiratory explosion" (similar to the mitocondrial) and heightened through a cascade of reactions by the release of reactive oxygen species [51-52], such as the hydrogen peroxide, which can pass through biological membranes, and the hypochlorite ion, which modifies and degrades all biological molecules.

The main effects of these reactive forms occur on membranes, lipids and sulfhydryl bonds of DNA's proteins and nucleotides [53], producing:

- Lipid peroxidation, the resulting peroxides of which initiate a catalytic chain reaction leading to further loss of unsaturated fatty acids and extensive membrane damage.
- Production of cross links between proteins, through the formation of disulfide bonds.
- Mutations in the genetic material of the pathogenic microorganism.

During the cellular oxidation process, unsaturated chains are easily attacked by $OH^{\bullet}$ radicals. The peroxidation of the fatty acids in the membranes generates peroxyl radicals ($ROO^{\bullet}$), decreasing their functionality. These radicals have a lower reactivity than the $OH^{\bullet}$ radicals and, therefore, their half-life is somewhat longer.

The presence of cell damage caused by oxidative stress provokes an antioxidant response in the cell: they try to pass electrons from one species to another until radicals are inactive and stability is restored. On the other hand, these interactions can generate cascades spreading the damage [54].

2.5.1 Lipid oxidation.

Biological membranes are made up of unsaturated fatty acid chains and are easily oxidized. $OH^{\bullet}$ radicals attack the double bonds of these structures and leave an unpaired electron in the chain that will bind to an oxygen molecule to re-stabilize, giving rise to a peroxyl radical. The presence of peroxide radicals modifies the membrane's functionality irreversibly, since it changes its spatial distribution causing instability [55]

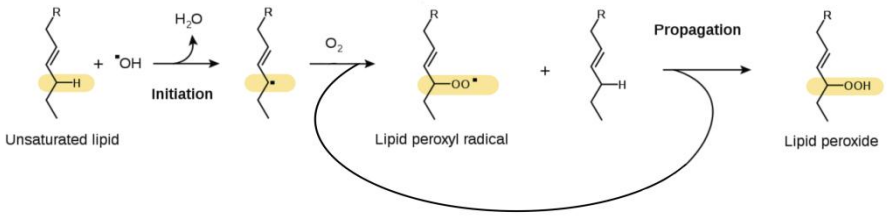

FIGURE 2: ●OH radicals attack the bonds of these structures and generate a chain with an unpaired electron, which will react with an oxygen molecule (O_2) to re-stabilize. As a product peroxyl radicals appear in the membrane, which act as positive feedback further increasing damage.

2.5.2 Protein oxidation: direct (produced by RONS) or indirect (produced by lipid peroxidation)

Free radicals cause changes in the molecular structure of amino acids by modifying their charge, which can end up breaking the polypeptide chain, fragmenting the protein.

Peroxyl radicals give rise to substances with aldehyde groups, highly reactive species that establish covalent bridges between amino acids producing intra and interprotein cross-linking. Finally, proteins lose conformation and form aggregates, leading to the decrease or inhibition of the correct functioning of the protein

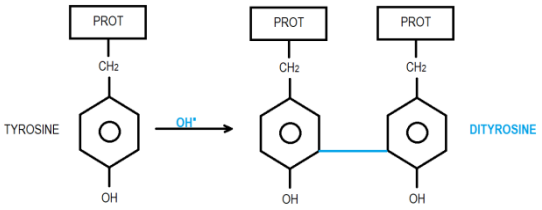

FIGURE 3. The $OH^{\bullet}$ radicals form irreversible covalent bridges between two tyrosines. The product (dityrosine) is not recognized by the kinases of the signaling pathways, meaning the information that the tyrosine had to transmit is lost. In addition, this structure is not degradable and therefore non-functional proteins with intra and intermolecular bridges accumulate.

2.5.3 Morphological changes of microorganisms.

The study by Bai et al. 2012 [50] verified the morphological changes of *B. subtilis* and *Bacillus* spores with treatment with $OH^{\bullet}$ radicals under microscopic observation in *B. Subtilis, S. Marcescens* and *Bacillus* spores.

It was clearly observed that *B. subtilis* in the form of intact cane and evenly distributed cytoplasm after treatment with $OH^{\bullet}$ radicals, greatly lost the integrity of the membrane. In the other hand, the *Bacillus* spore cells feature a tough, multi-layered outer coating that makes it impossible to quickly kill *Bacillus* spores with conventional chemical disinfectants such as chlorine, alkali and alkali-alcohol-amine. However, after treatment with $OH^{\bullet}$ radicals, the *bacillus* spores also ruptured and the round-shaped cells disappeared. Consequently, *Bacillus* spores require a higher concentration of $OH^{\bullet}$ radicals scavenging, spray density - dispersion and time. Concentration, dispersion spray density and processing time are the three important parameters for the destructive effect of $OH^{\bullet}$ radicals on microorganisms.

The demonstration that the effect of $OH^{\bullet}$ radicals on a microorganism will be with greater biocidal efficacy according to its more superficial structure (collected in previous studies) determines the need to recognize the morphological characteristics of pathogenic microorganisms from their outer layer to the interior of the specific cell [56,57].

Some microorganisms have been able to reverse this oxidative process through superoxide dismutase (SOD), a family of three metalloenzymes (FeSOD, MnSOD and CuZnSOD) with a high capacity to interact with oxidants, neutralizing them and reducing oxidative damage.

MnSOD is synthesized by *Escherichia coli* [58] after exposure to oxygen and is induced by the presence of superoxide radicals. Both SOD and catalase activity have been detected in the cytosol of microbial cells and in the periplasmic space (located between the plasma membrane and the cell wall) of the bacteria. Likewise, a protective role has been demonstrated against ROS generated in the catalase respiratory burst in *Staphylococcus aureus.* [59-61]

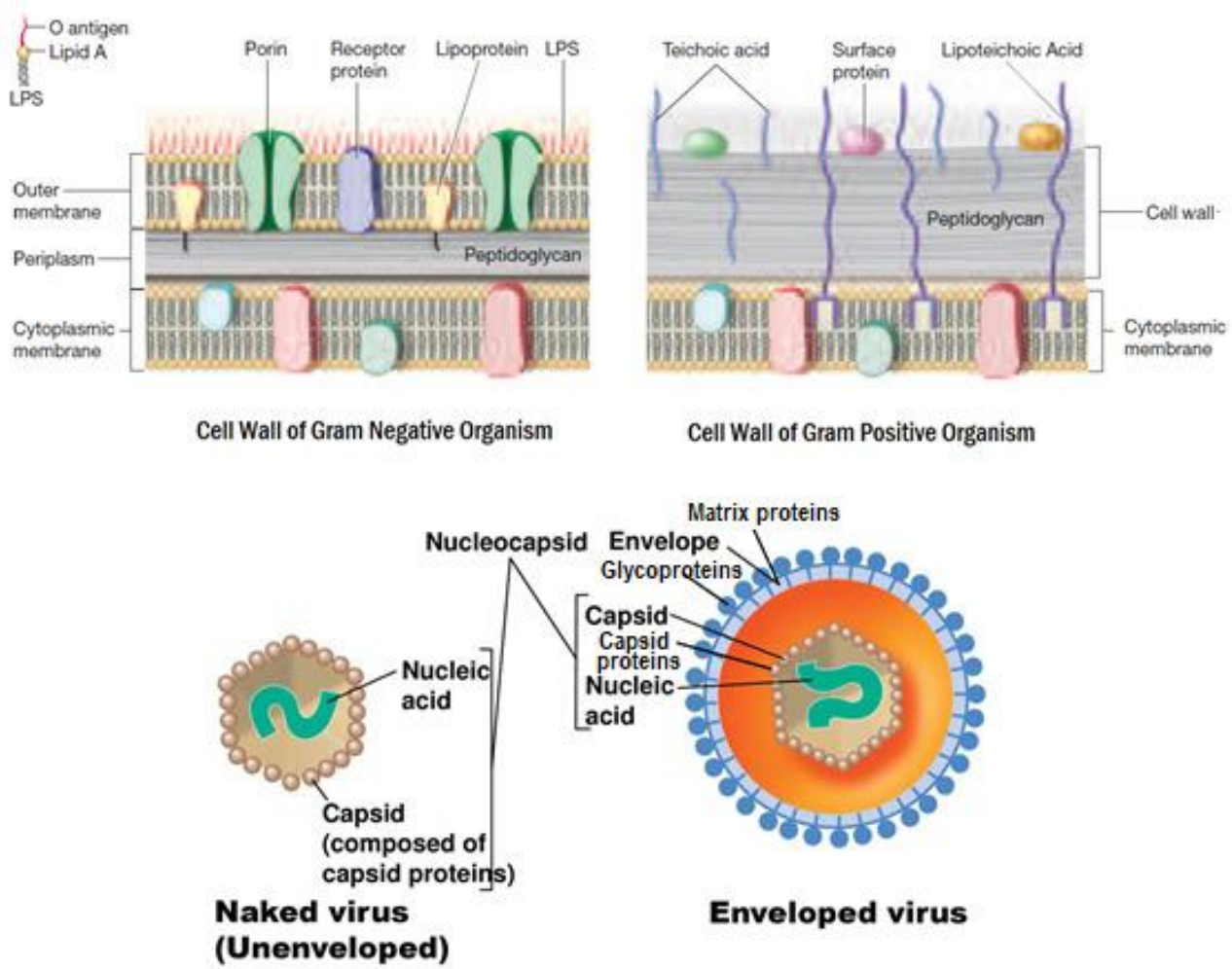

FIGURE 4: Cellular envelopes according to the type and morphology of viruses and bacteria. Adapted from Pearson education, Inc ©2015 & laboratoryinfo.com

In recent years, different laboratories, external certifiers and university research centers have developed various studies to check the biocidal efficacy of the Wadu02®, in the presence of pathogenic microorganisms in different spaces.

The results are reflected in Table 1, in which we can show that in the case of gram + and gram - bacteria the reduction reaches an average of 99.9% in the first hour of exposure to the advanced oxidation process, in both air and surfaces.

In the case of viruses, the results are observed depending on the conditions of relative humidity and the morphology of the virus. The efficacy results of Wadu02® in non-enveloped viruses indicate that in humid conditions the efficacy is less than in dry environments, averages of 99% are reached; while in enveloped viruses humidity favors the advanced oxidation process and virus elimination than in dry environments.

2.5.4 Report on stability and disinfection of 2019-nCoV

The 2019-nCoV is a new strain of coronavirus that was first detected in Wuhan City (China) in December 2019. The number of infected patients grown rapidly in recent weeks, becoming a serious public health concern. The transmission of the virus occurs mainly via respiratory droplets produced by an infected person that can land in the mouth or nose of people nearby or possibly be inhaled into the lungs. Coronaviruses are a large family of viruses common in many different species of animals, including camels, cattle, cats and bats. Rarely, animal coronaviruses can infect people, and spread among us such as with MERS, SARS and now with 2019-nCoV [62].

The new coronavirus has been classified as a *Betacoronavirus*, like MERS and SARS, both of which have their origins in bats. Coronaviruses are in the subfamily *Coronavirinae* in the family *Coronaviridae*, in the order *Nidovirales*. They are divided in 4 subgenders *Alphacoronavirus*, *Betacoronavirus*, *Deltacoronavirus* and *Gammacoronavirus*[63].

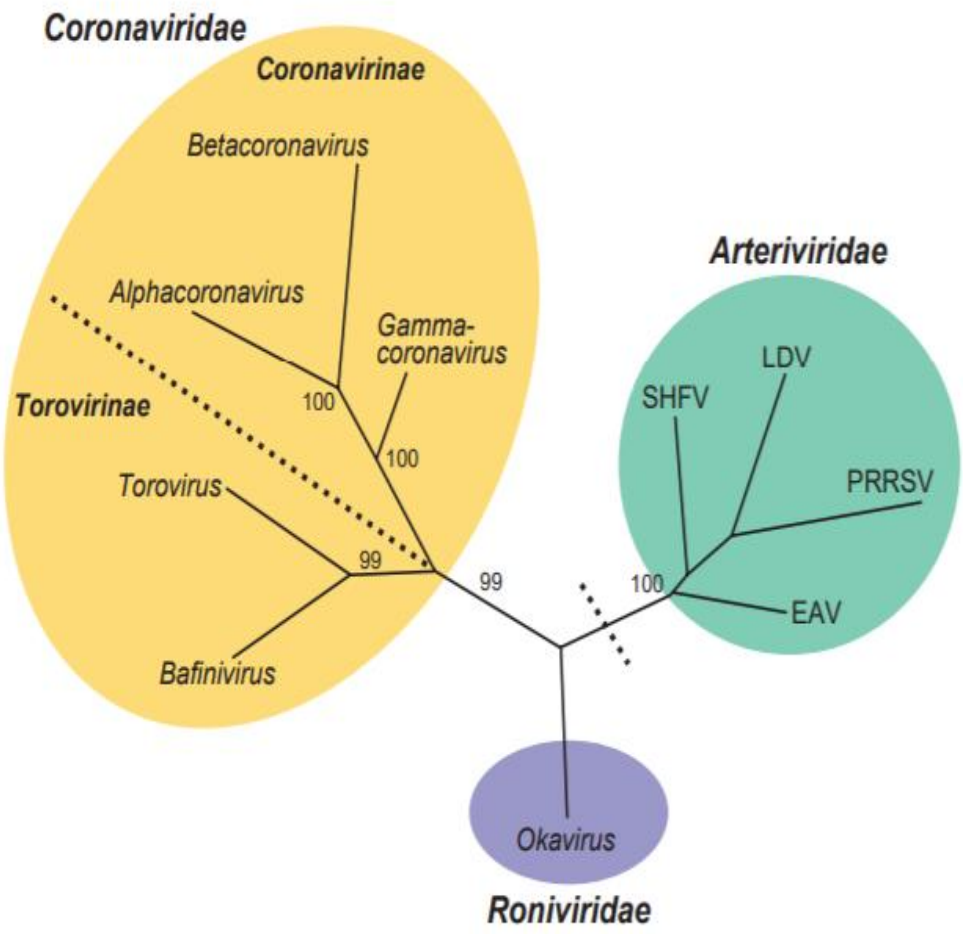

FIGURE 5: *Nidovirus* phylogeny. The Nidoviral order consists of three families: *Coronavirinae, Roniviridae and Arteriviridae* from International Committee on Taxonomy of Viruses, 2012 ©.

Based on the genetic material, these viruses are included in group IV of the Baltimore classification, as the viral particle contains only a single positive-sense stranded RNA. Therefore, the genetic material itself acts as an RNA messenger since they both are positive-sense. When translated, the RNA polymerase and the different structural proteins that form the capsid are synthesized [64].

Coronavirus' diameter is around 60-200 nm. They present a nucleocapsid with helical symmetry and a lipid sheath, that derives from the membrane of the previously infected host cell and contains glycoproteins and surface antigens. From the lipid sheath the characteristic projections of this genus arise forming a solar corona around it that is visible under a microscope and gives the family its name. Despite what might be expected, having an envelope implies that the virus is sensitive to different factors and external agents such as heat, lipid solvents, non-ionic detergents, formaldehyde, oxidizing agents and UV irradiation [63].

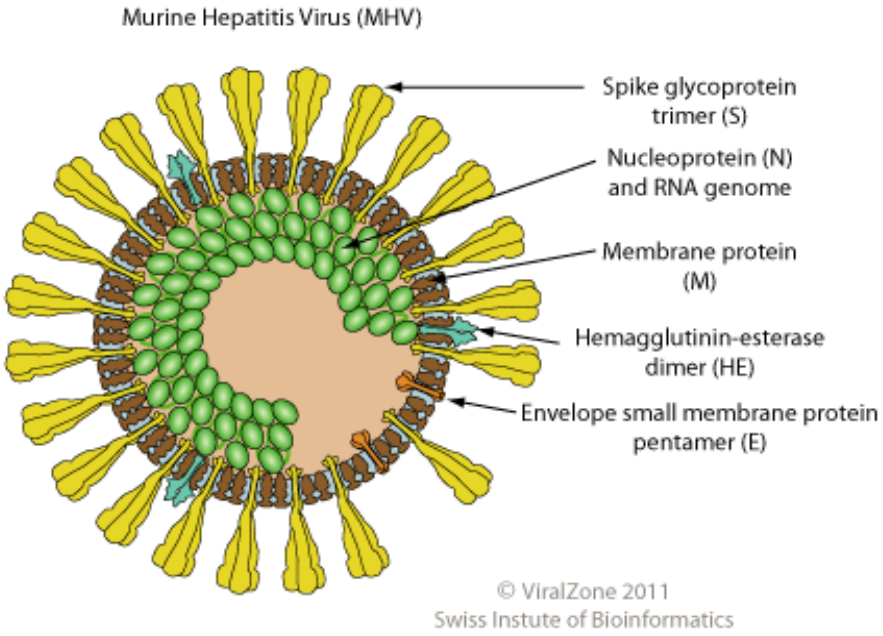

FIGURE 6: Structural proteins of *coronavirus* (from ViralZone©)

As can be seen in Figure 6, the coronavirus capsid consists of the following structural proteins:

The Spike glycoprotein (S) protrudes from the outer envelope of the virus forming the "corona" visible under a microscope. Its function is to stick to the proteins found on the cell's surface and infect them. In some cases, the S protein causes the infected cell to fuse with other adjacent cells, thus favoring the spread of the virus. The Envelope protein (E) is responsible for the formation of new viral particles and their release from the infected cell, being necessary for virus diffusion. The Membrane protein (M) is attached to the inner part of the virus membrane and causes this membrane to bend, determining the spherical shape of the virions. M also interacts with the nucleocapsid formed by the RNA of the virus and the N protein. And finally, the Nucleocapsid protein (N) is phosphorylated and binds to the viral genome during assembly.

They are viruses distributed worldwide due to their genetic diversity, their short incubation periods and the high mutation rate they present. The combination of these factors allows the pathogen to infect not just animals but also humans.

It is well known that ozone, at concentrations above 100ppm and high humidity rates, is an effective disinfection treatment especially for RNA-viruses with or without envelope [65-67]. However, high ozone concentrations may be harmful to coexist in habitable urban environments. Reactive oxygen species (ROS) including $OH^{\bullet}$ radicals, hydrogen peroxide (H_2O_2) and ozone (O_3) have been reported to enhance disinfection efficiencies of several microorganisms [68,69].

III. RESULTS

According to the results obtained with Wadu02® in viruses with similar structures to Covid-19 (RSV), we can expect that the efficacy of the device will have an expected elimination result of an average of 99 to 92% depending on the relative humidity conditions.

IV. CONCLUSIONS

The results show that the use of $OH^{\bullet}$ radicals in the advanced oxidation process produced by the Wadu02® purifier is a new, safe and effective method to quickly eliminate pathogenic microorganisms in large air spaces and surfaces.

The application of $OH^{\bullet}$ radicals in different studies has shown that their use in advanced oxidation processes, standardized as a safety measure carried out by Wadu02®, is safe, innocuous and effective in the control of pathogenic microorganisms and the elimination of suspended particles, formaldehyde and VOCs.

The evidence on the efficacy of $OH^{\bullet}$ radicals as a biocide shows that their use is endorsed for being a strong oxidant, capable of eliminating microorganisms in low concentrations (0.8 mg/L) equivalent to 10 thousandths of the dose of conventional

chemical disinfectants. Its spray density - dispersion is 22ml/cm^2 representing one thousandth of other disinfectants, its constant high reaction rate 10^9L/mol • sec in the processing of $OH^•$ radicals is shorter than 4 seconds, which is one thousandth of chemical disinfectants. Finally, the damage that has been observed to pathogens under a microscope is irreversible.

Basing our homeostatic state on the correct functioning of our internal antioxidant system and the experimental demonstration of the use of $OH^•$ radicals effectively in the disinfection of air and surfaces, we can issue a safety statement on the use of Wadu02® technology to achieve safe, effective and harmless advanced oxidation processes in humans in the purification and decontamination processes of air and surfaces.

TABLE 1
WADU02© BIOCIDE EFFICACY TEST RESULT WITH LIMONENE

Pathogen	Means of dispersion	Exposure	effectiveness %	Documented testing
Bacillus subtilis (Gram +)	Surface	1 h	99,4	Bacillus, Esch, Staph - KNU
	Air	20 min	99,6	Bacillus, Esch, Staph - KNU
Staphylococcus aureus (Gram +)	Surface	1 h	52,3	Bacillus, Esch, Staph - KNU
	Surface	4 h	99,9	Esch, Pseudo, Staphy- KCL
	Air	1 h	99,9	Bacillus, Esch, Staph - KNU
Resistant Staphylococcus aureus (MRSA) (Resistant Gram +)	Surface	4 h	99,9	Salm, Kleb, MRSA - KCL
	Air	4 h	99,9	MRSA - KCL
Pseudomonas aeruginosa (Gram -)	Surface	4 h	99,9	Esch, Pseudo, Staphy- KCL
Enterobacter species: Salmonella (Gram -)	Surface	4 h	99,9	Salm, Kleb, MRSA - KCL
Enterobacter species: Klebsiella (Gram -)	Surface	4 h	99,9	Salm, Kleb, MRSA - KCL
	Air	4 h	99,9	Klebsiella - KCL
Enterobacter species: Escherichia coli (Gram -)	Surface	1 h	99,9	Bacillus, Esch, Staph - KNU
	Surface	4 h	99,9	Esch, Pseudo, Staphy- KCL
	Air	20 min	99,9	Bacillus, Esch, Staph - KNU
Influenza virus (Enveloped)	Wet	30 min	86	Influenza A - UB
	Dry	30 min	38	Influenza A - UB
VRS -Respiratory Syncytial Virus (Enveloped)	Wet	2 h	99	VRS - UB
	Dry	2 h	92	VRS - UB
Rotavirus (Naked)	Wet	2 h	37	RoV - UB
	Dry	2 h	99	RoV - UB

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A Novel Assistive System using National Instruments LabVIEW Graphical Programming

Sumit Jha[1], Subhrajit kundu[2], Sudipa Biswas[3], Subhradeep Biswas[4], Arnab Chakraborty[5], Abhishek Malik[6]

[1]Research assistant ESL Technologies, Kolkata, India
[2,5]Applied electronics and instrumentation engineering, RCC Institute of information Technology
[3]IBM, Bangalore, India
[4]TCS, Kolkata, India
[6]ESL Technologies, Kolkata, India

Abstract*—Today health monitoring system related research has been the priority for all as pre diagnosis of any health related issue can help to save lives of many people. It involved multidisciplinary fields of research which included use of electronic sensors, biomedical diagnosis, embedded system, artificial intelligence etc. In today's busy world most people does not have time for proper medical checkup or does not have the economic support for the expenses related to it. In this paper we have proposed a novel assistive system called AHD (Automated health diagnosis) system which is cost effective, durable and easy to use. It will be very advantageous for elderly people in eliminating the excessive cost of diagnosis and unnecessary travelling to the hospital for whom regular health checkup is a priority aspect. This system will monitor patient health so that necessary medical support can be provided within appropriate time. AHD system involves uses of ECG (Electrocardiogram) signal, body vibration signal and the use of GSM technology. In case of abnormality this system will send text message to the doctor, hospital and the family members. We have used Ardunio Mega 2560 as a microcontroller, AD620 for ECG and LabVIEW as a visual programming language. This system will bridge the gap involved in the patient deteriorating health condition and health care entities.*

***Keywords*— Biomedical embedded system, ECG, AHD (Automated health diagnosis) system, Medical diagnosis, Signal Processing.**

I. INTRODUCTION

Heart is the center of human anatomy which is the paramount of all organs. Based on the analysis it is estimated that in the year 2014 27.6 million adult with diagnosed heart diseases and every year almost 614,348 people die due to heart failure [Open data from Centre of Disease Control and Prevention]. Heart disease has ranked no 1 in causes of death. Hypertension or high blood pressure [1] has increased rapidly in few decades and resulted in 92% of all deaths due to heart failure. The advancement in Medical treatment has cure for almost all heart problems if taken care at early stage. Development of biocompatible prostheses, various diagnostic and therapeutic medical instruments ranging from clinical to micro-implants and also the common imaging equipment which involves MRI, EEG, and many other biomedical [2] operations. The AHD system proposed acquires the ECG signal [3] and the body vibration signal [4] and feed it to the microcontroller. The data is acquired and analyzed in real time. However it's not only the analyzing of a human health but also the necessary action should be taken. In the case of abnormality or if the data acquired during analysis outstrip the threshold provided then the GSM 300 module [5] used here is triggered and a text message is sent about the patient abnormality to the entities provided.

II. METHODOLOGY

The AHD system comprises of three essential parts. Firstly, ECG signal and acquisition and analysis, secondly body vibration signal and thirdly the text message handling process.

2.1 ECG (Electrocardiogram)

ECG is the transthoracic elucidation [6] of the electrical activity of heart in some interval of time. The electrodes are attached to the skin of the human body and the analysis is recorded externally. It's very useful in explaining the heart condition and the need of a pacemaker if required. There are four waves generated by ECG which includes a P

wave, a QRS complex, a T wave and U wave where each of the waves is of different pattern in comparison to the other waves. These waves are the result of the Voltage vs. Time graph which is used to detect the functioning of the heart of the patient. Firstly, we have used three disposable Ag-AgCl button type surface electrodes connected to the AD 620-B instrumentation amplifier [7] with the circuit board through three individual ECG cables. The whole circuit parameters are calculated in accordance with the needed signal strength and the arduino Mega 2560 is also interfaced. Below in Fig 1 the normal healthy heart signal image has been shown and in Fig 2 the snapshot of the raw ECG signals acquisition process.

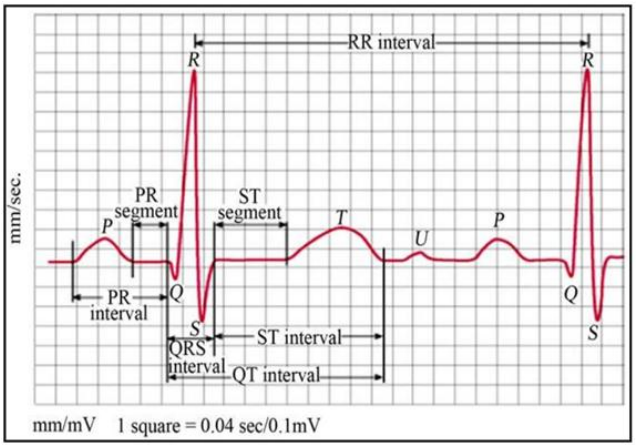

FIGURE 1: Normal healthy heart ECG signal

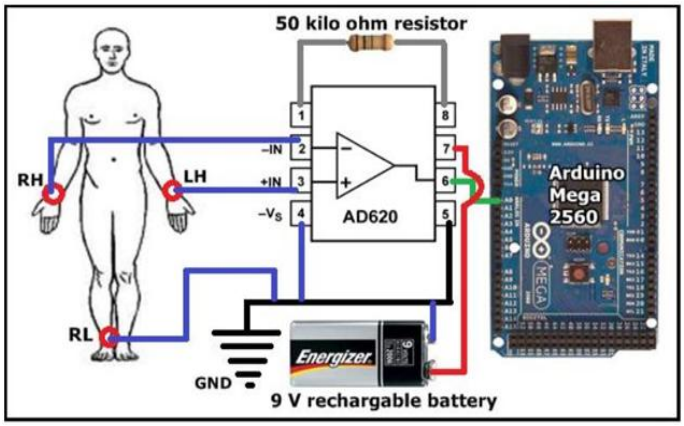

FIGURE 2: Raw ECG signal acquisition process

The ECG signal algorithm, the serial communication parameters are set via LVIFA toolkit settings. Then the real-time raw ECG signal is acquired and filtering, baseline wandering removal is done to get proper ECG signal. Now in an ECG signal, the peak amplitude value, depth voltage level and the RMS voltage are the three major factors with which we have to deal. Hence with proper analyser GUI blocks and with some logical techniques the feature extraction is done. Below in Fig3 the ECG signal collector is shown and in Fig4 the ECG signal analyser is shown.

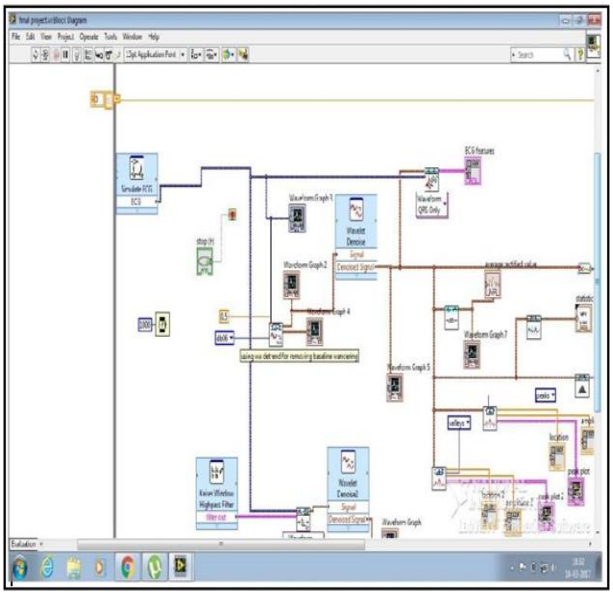

FIG 3: ECG signal collector

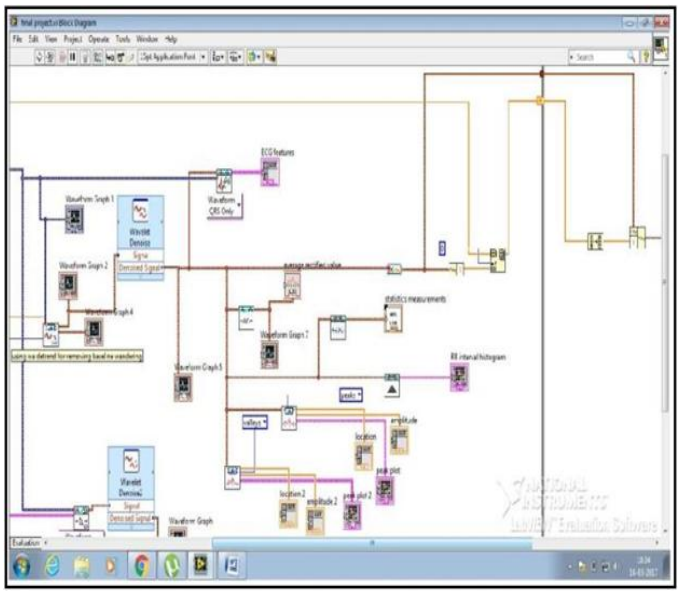

FIG 4: ECG signal analyser

In the signal analysis if the ECG parameters go beyond the threshold then the logic circuit displays abnormality and GSM module in triggered. Below in Fig5 the ECG signal output graph for normal heart condition is shown and in Fig6 the ECG signal output graph for abnormal heart condition is also shown.

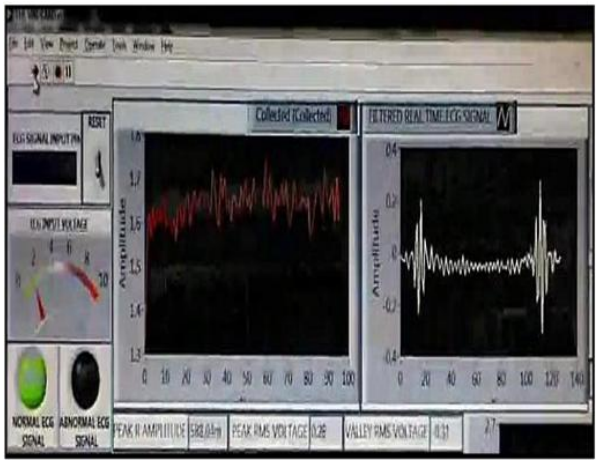

FIG 5: ECG signal output graph for normal heart condition

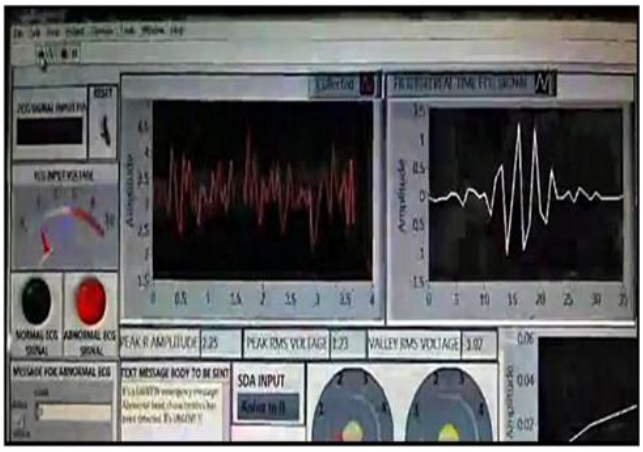

FIG 6: ECG signal output graph for abnormal heart condition

2.2 Body Vibration Signal

ADXL345 is a very tiny, lightweight and ultra-low-power, 3-axis MEMS accelerometer that measures [8] data in very high resolution (13bit) which ranges from +/-2g to +/-16g and its digital output data is acquired either by using a SPI or I^2C digital interface which ranges from 10Hz to 3200Hz. ADXL345 is very pertinent for mobile applications. It measures both the Dynamic acceleration and the static acceleration of gravity, where the dynamic acceleration is the result of the shock or mobility and the static acceleration is used in tilt sensing applications. Its other uses include activity or inactivity sensing which is detected by the presence or the absence of mobility by analyzing the acceleration detected on any axis with user-set threshold. Single and double taps are detected by Tap sensing and the descending of the device is detected by the Free-fall sensing. These functions are delineated to either of the two interrupt output pins. To lower the overall system power consumption and to minimize the host processor activity an integrated memory management system FIFO buffer is used to store data. The AI pin 1 and 2 of arduino Mega 2560 is [9] bridged with the ADXL345 supply pin, ground pin, SCL and SDA ports. The factual magnitude of the body vibration signal is retrieved from the AI pin 1 which is interfaced with SDA (Self Diagnosing Accelerometer). The analog signal retrieved is filtered and the threshold given is analogized. If the threshold exceeds the GSM module is triggered. Below in Fig7 the algorithm of body vibration signal is given and also in Fig 8 the real time body vibration signal monitoring system in labVIEW is given.

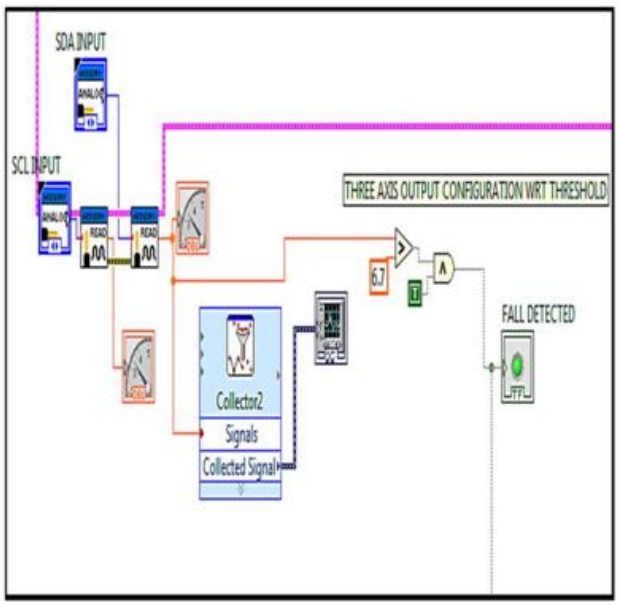

FIG 7: Algorithm of body vibration signaL

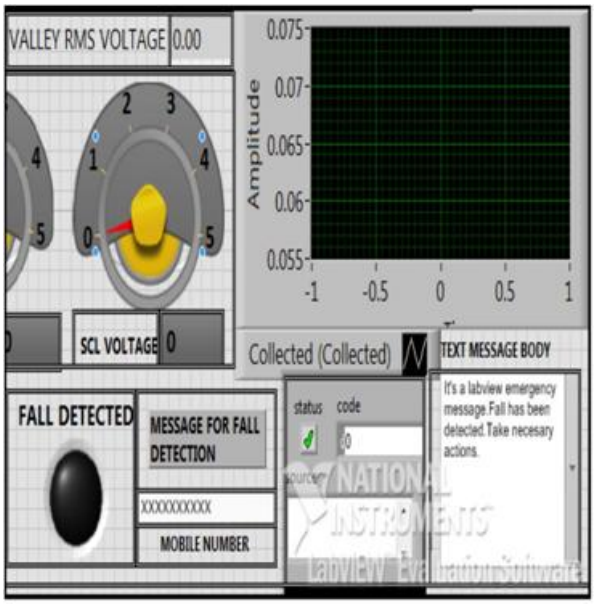

FIG 8: Real time body vibration signal monitoring system in labVIEW

2.3 Text Message Handling

The most important part of our proposed AHD (Automated heart diagnosis) system is sending the text message to the entities provided. The GSM uses AT commands in order to entrench communication between the microcontroller ATmega 2560 and the GSM 300 module. It works in the standard 1800 MHz frequency. We have used GSM 300 module [10-11] which has been interfaced with RS 232 cable with LabVIEW to get accurate output. The algorithm constructed using AT commands, and necessary baud rate for the particular text message to the entities phone number. Below in Fig 9 the text message algorithm snapshot is given.

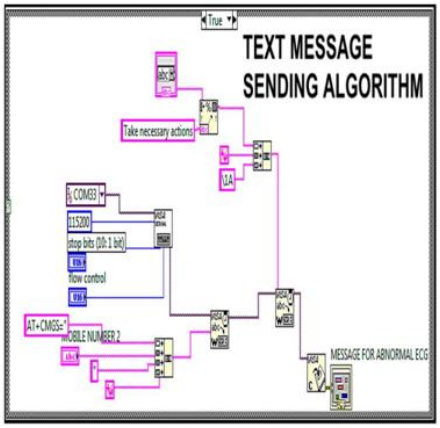

FIG 9: Snapshot of the text message algorithm

III. WORKFLOW CONTROL LOGIC

The wireless transmitter part is a small box attached to the waist of the human body which has two distinguishable signal acquisition sections one is the signal modification and the second is the transmission section. The first section consists of three electrodes which are met at a preamplifier's input junction. These electrodes acquires human heart's ECG signal and sends to the preamplifier circuit for necessary amplification. The second section consists of an accelerometer module as well as a gyroscope module to so that body vibration signals and tilting angles can also be measured along with X,Y and Z all of these three axes. Now these three signals ECG signals, vibration signal and tilt angles are sent to a microcontroller based ADC module and its digitized output signal is connected to wireless Zigbee [12] transmitter module. These are the part of the signal modification and transmission section. The wireless Trans receiver part is basically a single board RIO or SBRIO a specially designed board by National Instruments [13] for biomedical signal analysis and signal & data transfer and reception purposes. An algorithm is at first built in a VI of NI-LABVIEW and then it is dumped to SBRIO so that it can work on its own loops continuously with respect to its data acquisition via a wireless Zigbee module. This part also has a transmission section to mobile phones as an auto-forward-conditional text message. Lastly basically a mobile phone which receives an auto-forward-conditional text message from the **SBRIO** part. We would like to implement modern GSM (Global System for Mobile communication) technology for text message service. Below in Fig 10 the work flow diagram is given and also in Fig 11 the block diagram of the control logic and signal flow is given.

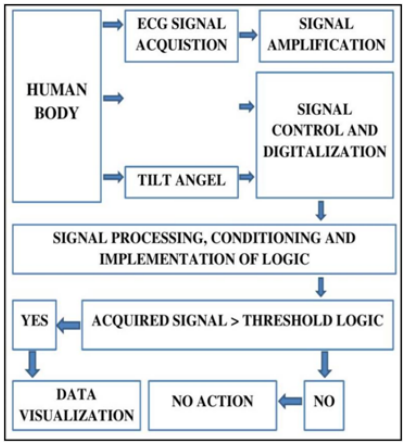

FIG 11: The block diagram of the control logic and signal flow

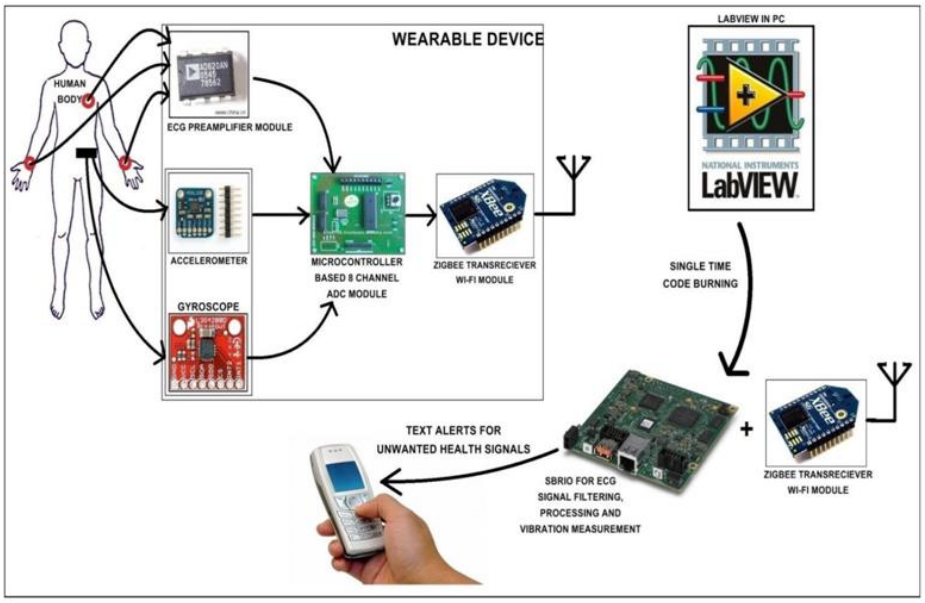

FIG 10: Workflow diagram

IV. RESULTS

The GSM algorithm of two different types for the ECG and body vibration signal has been implemented successfully in TRUE-FALSE case structure. The accumulated vales are compared continuously which consists of three different types of parameters which consists of Peak amplitude value, depth voltage and the RMS voltage with their own threshold value. If theses threshold values get exceeded then the GSM module gets triggered and text message gets initiated. We have done several tests successfully. Below in the table 1 and 2 we have shown the test results of two specific tests which we have successfully done and in Fig 11 the front view of the panel is shown.

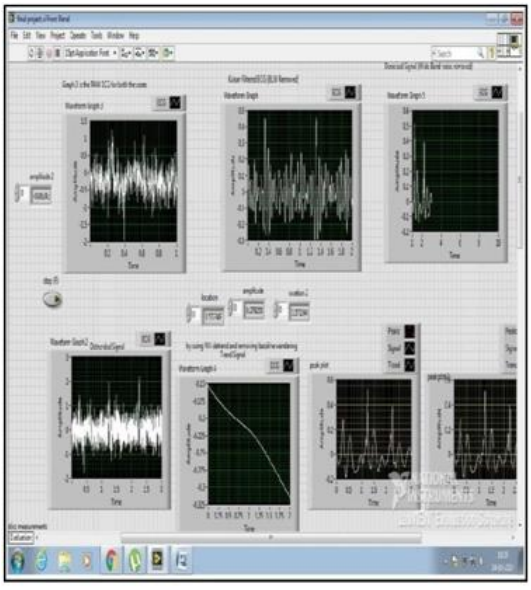

FIG 11: Front view of the panel

TABLE 1
CASE STUDY 1

Name of Parameters	Natural Voltage	Threshold Voltage	Results
Peak Voltage	+2.1 mV	+2.15 mV	+2.12 mV
Depth Voltage	-1.76 mV	-2.0 mV	-1.69 mV
RMS Peak Voltage	+1.82 mV	+2.10 mV	+1.76 mV
Body Vibration Voltage Rating	+5.80 mV	+6.7 mV	+5.93 mV

TABLE 2
CASE STUDY 2

Name of Parameters	Natural Voltage	Threshold Voltage	Results
Peak Voltage	+2.10 mV	+2.15 mV	+2.19 mV
Depth Voltage	-1.76 mV	-2.0 mV	-2.17 mV
RMS Peak Voltage	+1.82 mV	+2.10 mV	+1.96 mV
Body Vibration Voltage Rating	+5.80 mV	+6.7 mV	+6.63 mV

V. CONCLUSION

There are considerable differences in the profile of heart signals or ECG signals from one person to another so the result will also vary with differences in the ECG signal. The Most important thing that needs to be kept in mind is to fit the accelerometer perpendicular to our body to ensure to get the actual normal or abnormal tilt angle or vibration of our body.

The goal of this paper is to implement the proposed theory and making a prototype AHD (Automated health diagnosis) which will be very cost effective system, easy to use, durable with no side effects and prevent human from death and dangerous emergences which has been done successfully.

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Trapping & Harvesting Lightning Energy

Anindya Anupam

Department of Mechanical Engineering, Amity University (U.P)

Abstract*— *Energy is available in the universe in different forms. For any work to be done, energy is required. The need and scarcity of energy made the mankind for the search of different forms of energy. For centuries many scientists are in search of energy and have found many forms of renewable and non-renewable source of energy which are being used till date but the problem arises here that the sources which are non renewable (e.g: fossil fuels) are getting over day by day and it cannot be replenished. At this rate if this usage continues then by 2075 it will completely get over. Fossil fuels are given a very huge importance as mankind is completely dependent on this source of energy as 99% of transportation and automation uses fossil fuels. Due to this completion of energy mankind has started search of another source of energy that is sufficient and that can replace fossil fuels. After lots of research and analysis it has been noticed that lightening is a very huge source of energy.

***Keywords*— *Lightning Energy, Trapping and Harvesting lightning Energy, Source of Energy*.**

I. INTRODUCTION

In 1752, Electricity was discovered by Benjamin Franklin during his "Kite Experiment". Then from late 19th century many research have been done to trap and harvest the energy from lightning. Lightning contains static electricity. The characteristic of this electricity is that it strikes to a point or a small area and just for some milliseconds lightning produces 100,000,000 volts in a single strike which is a very huge amount which has the capacity of running the any country for 2-3 days. As we know H2O has a very strong bonding and for breaking this bond a huge amount of energy is required and lightning has sufficient energy for the hydrolysis of water and hydrogen is itself a tremendous energy source. Hydrolysis means ("HYDRO= WATER", "LYSIS= BREAKING"). As its known, from chemical bonding of Hydrolysis of water a large amount of energy is required as hydrogen bonding with oxygen is very strong, from the below reaction, we can analyse that:

$$[2H_2O \longrightarrow 2H_2+O_2]$$

So Energy or electricity can be used for Hydrolysis of water where hydrogen and oxygen separates. Hydrogen can be used for diff. purposes.

The main problem is of trapping the lightning energy and previously many methods have been done to trap this energy but were not successful. So, we will know the formation, characteristic of lightning and way to trap and harvest the lightning energy.

II. THEORY

Lightning:

Lightning is the discharge of electrical charges in lower clouds and it is unpredictable. Before trapping and harvesting lightning energy, first we should know how is lightning generated? Basically lightning occurs due to collision. And there are three types of collision occur i.e- IC, CC, CG. On going to the explanation part IC- intra cloud collision, CC- cloud to cloud collision, CG- cloud to ground collision. Out of these three types of collision IC and CC commonly occurs. Most important of these things is that the cloud must be warm and in condensed form, which are generally found in lower heights nearly 4-5 km above the sea level as with increase in altitude the Water droplets in clouds gets converted into ice. As per the investigation done by NASA and geographical researchers there occurs about 50-100 lightning strikes worldwide every second. Lightning are occurred during to the electrons in the clouds and the charged particles. So at that time cloud acts as negative and earth acts as positive. This is basic electrical nature that for the flow of electricity circuit must be completed and opposite terminals must be there. Then the lightning strike is produced. Single strike of lightning creates a very high

temperature in the atmosphere (~50000-60000 degrees).The repeated lightning strikes increases the resultant temperature of the atmosphere (~ 100000 degrees) then a very huge lightning strike occurs which produces more that 10 million volts.

III. EFFECTS OF LIGHTNING

Mankind has taken lightning under natural calamities as it is very disastrous because it can kill many people and destroy a area on a single strike. Everything in this universe has advantages and disadvantages. Many ways have been found for the protection from lightning. So on neglecting the disadvantages, advantages are much more. As this source has the capacity to fulfill the scarcity of energy and itself a huge amount of energy as when 'n' number generator produces electrical energy that amount of volts is produced by lightning in a single strike.

IV. WAYS OF TRAPPING LIGHTNING ENERGY

On looking to the way of trapping and harvesting lightning energy we need a device that can withstand such high voltage which is near to impossible as this high voltage will destroy the capacitor. First these high voltage current needs to convert to low voltage current. This can be done through using numbers of step down transformers. Basically step down transformers converts high voltage current to low voltage. Then after lowering the current voltage we can use capacitor for storing it.

From years people have been using the earthing process to protect their houses and buildings. Lightning current passes to the ground as this earthing process consist of earthing rod which is made of very good conducting material such as copper which is widely used in electrical industries that provides a low resistance path to flow through. As current always follows the low resistance path to flow.

V. PROBLEMS FACED BEFORE IN TRAPPING OF LIGHTNING ENERGY

Many scientists have been trying to trap the lightning energy but they could not as they faced many problems. First and foremost problem faced generally is that lightning is sporadic and due to of its static current type it just strikes to a single point and for some milliseconds which is just impossible to predict the time of occurrence of lightning as well as the place where will it occur. Secondly, current produced from lightning is of very high voltage which can just destroy on trapping it as it produces 10 million volts.

VI. MY PROPOSAL FOR THE WAY AND DEVICE FOR TRAPPING LIGHTNING ENERGY

Instead of letting the lightning energy to pass to the ground we can trap it by earthing process. On going to explanation of earthing process.

6.1 what is earthing process?

It is the process in which it consists of a earthing rod or a bar having a very small surface area made of very good conductor of electricity(copper)which in result provides a low resistance path for the lightning to pass to ground. As the current is passed to the earth so this process is named after that "Earthing Process".

6.2 *Author's Way of Trapping the Lightning Energy

6.2.1 1^Earthing Rod & Its Working

By using earthing rod of 1-2 inch of surface area, Surface area should be less as from the principle of electrostatics more positive charges gathers at the tips and attracts the negative charge in the clouds and must be made up of copper as its a very good conductor of electricity as its stated before, followed by n number of step down transformers which will decrease the high voltage current to low voltage current then it will be connected to any stored water or reservoir where water will be hydrolysed, hydrogen and oxygen is separated then after can be separately stored and at the end capacitor will be installed where electricity will be stored and can be used in many ways as well as the hydrogen. Hydrogen is very useful and a very powerful source of energy in itself but due to its scarcity as individual hydrogen is not found in atmosphere so it cannot be used but by this process it solves this problem too.

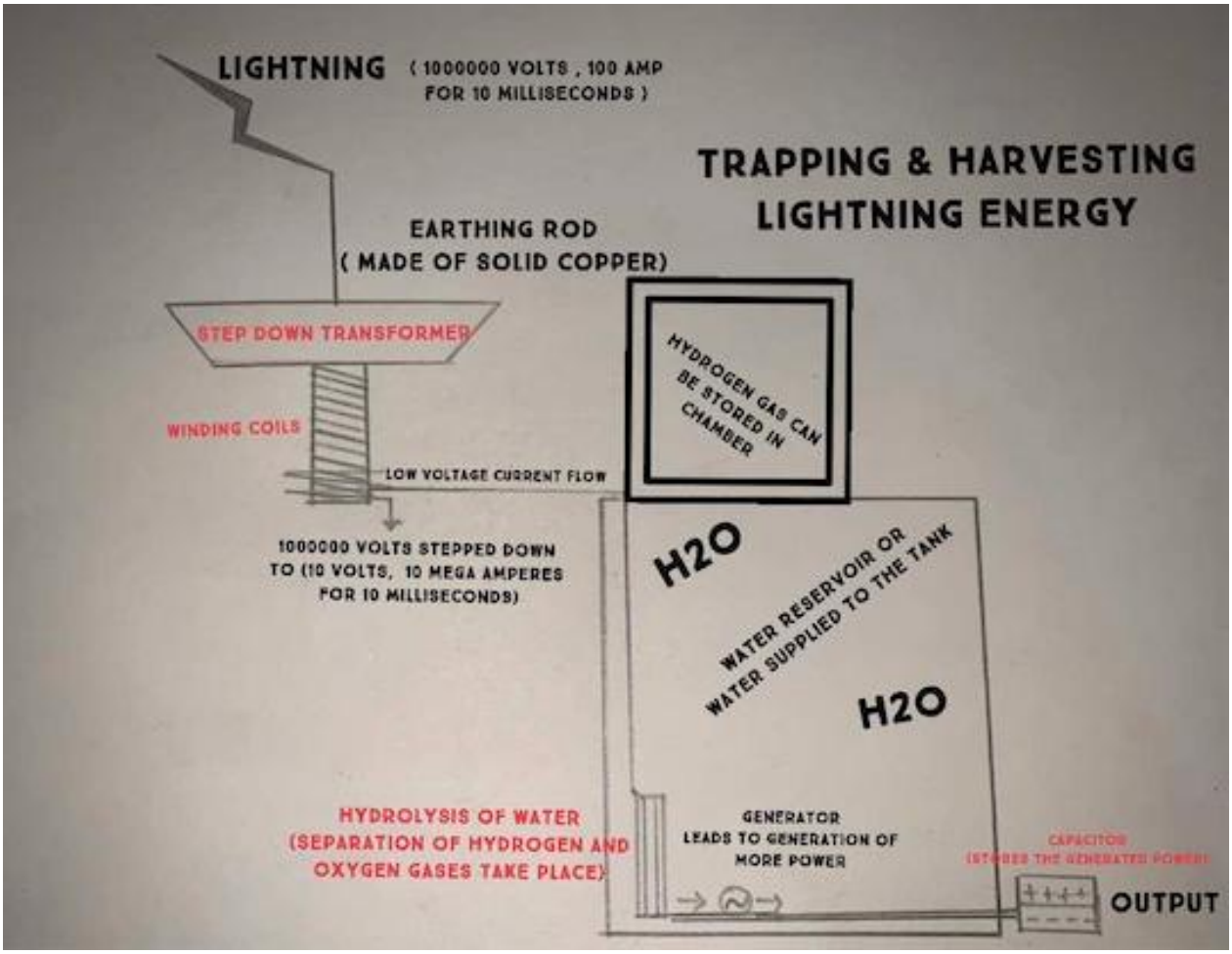

FIGURE 1: Trapping & Harvesting Lightning Energy

6.2.2 2^ Uv Laser Beams in Earthing Rod

By using uv laser in the earthing rod,

Uv laser beams have high wavelengths when on projecting the laser beam to sky/clouds there it will cause ionisation in gas molecules will occur which is necessary otherwise laser doesn't have that criteria of conducting charges, after the ionisation takes place it will create a path way for the negative charges to attract towards the positive charges present on the tip of earthing rod but the power density of the beam must be kept high during the time of operation to ionise the gases. After theses process then general harvesting process of electricity is to be done and stored and used in different purposes later on.

1.	ENERGY - 1.8 JOULES
2.	POWER OF LASER BEAM - 180 MW
3.	TIME- 10 NS
4.	RADIUS OF LASER BEAM- 100 (MU. M)
5.	INTENSITY - 10^11 W/CM SQ. TO 10^12 W/CM SQ.

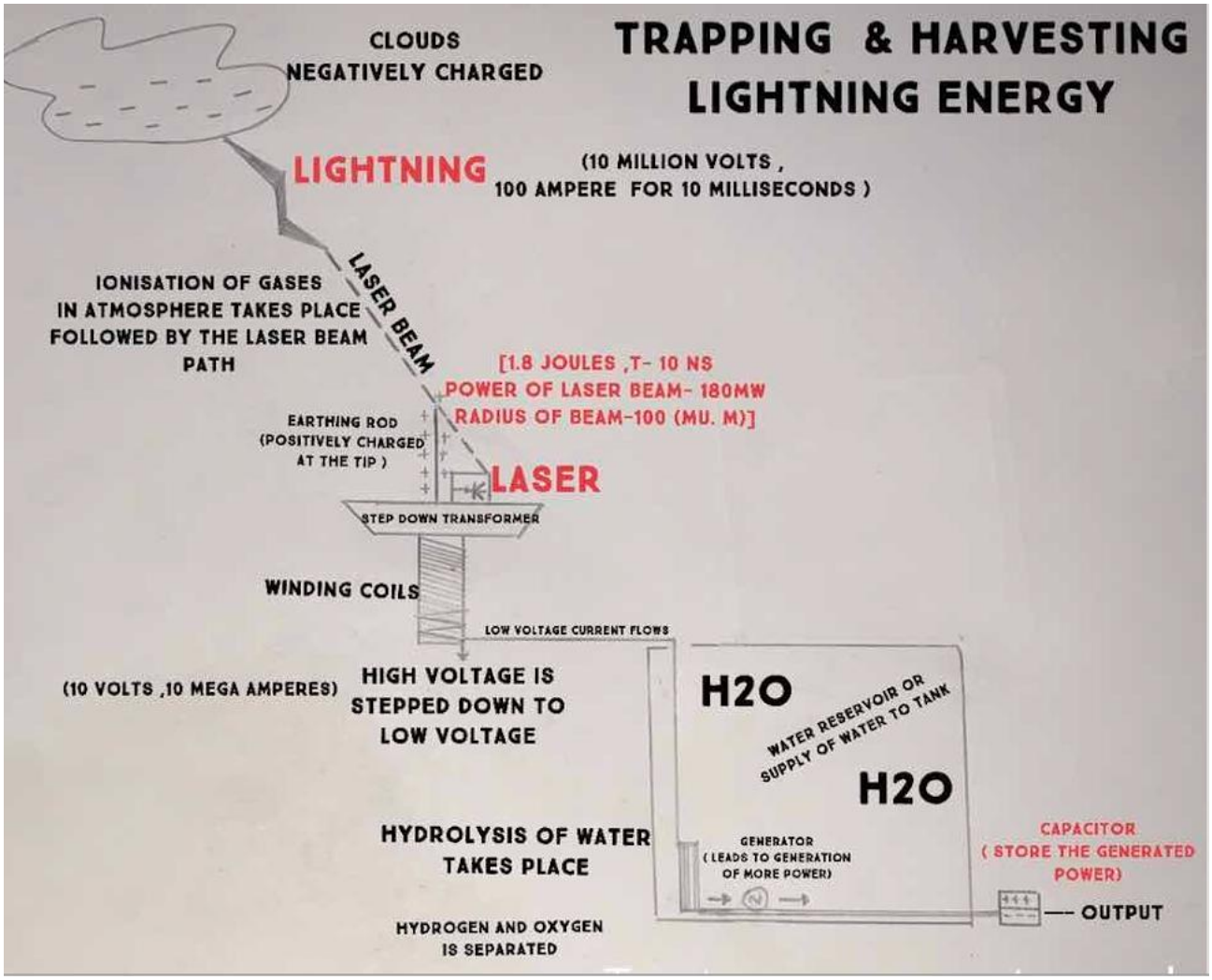

FIGURE 2: Trapping and Harvesting Lighting Energy when clouds negatively charged

VII. CONCLUSION

The search of ways of trapping and harvesting the lightning energy can be lessen to an extent and it can replace the use of fossil fuels and used in many ways, this may not be the end of search of source of energy but it can fulfill upto an huge extent.

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