ISSN 2531-2189

Volume 4, Issue 13 — January — June — 2020

Journal of Mechanical Engineering

ECORFAN®

Journal of Mechanical Engineering, Volume 4, Number 13, June-2020, is a biannually Journal edited by ECORFAN-Spain. Matacerquillas Street 38, CP: 28411. Moralzarzal - Madrid. WEB: http://www.ecorfan.org/spain/rj_ingenieria_mec.php, revista@ecorfan.org. Editor in Chief: SERRUDO-GONZALES, Javier, BsC. ISSN 2531-2189. Responsible for the last update of this issue ECORFAN Computer Unit. Imelda Escamilla Bouchán, PhD. Vladimir Luna Soto, PhD. Updated as of June 30, 2020.

Journal of Mechanical Engineering

Definition of Journal

Scientific Objectives

Support the International Scientific Community in its written production of Science, Innovation Technology in the Area of Engineering and Technology, in the Subdisciplines of pumps and equipment for handling liquids, bearings, air compressors, gears, refrigeration equipment, mechanical power transmission equipment, pneumatic equipment, equipment and industrial machinery, agricultural machinery, oil extraction machinery, printing and reproduction machinery , Mining Machinery, Hydraulic Machinery, Specialized Industrial Machinery, Nuclear Machinery, Paper Manufacturing Machinery, Machinery for the Food Industry, Material Handling Machinery, Textile Machinery, Steam Machinery, Vending and Distributor Machines, Machines, Tools and Accessories, Heating Material, Construction Material, Dies, Insoles and Gauges, Internal Combustion Engines (General), Gas Engines, Machined Operations.

ECORFAN-Mexico SC is a Scientific and Technological Company in contribution to the Human Resource training focused on the continuity in the critical analysis of International Research and is attached to CONACYT-RENIECYT number 1702902, its commitment is to disseminate research and contributions of the International Scientific Community, academic institutions, agencies and entities of the public and private sectors and contribute to the linking of researchers who carry out scientific activities, technological developments and training of specialized human resources with governments, companies and social organizations.

Encourage the interlocution of the International Scientific Community with other Study Centers in Mexico and abroad and promote a wide incorporation of academics, specialists and researchers to the publication in Science Structures of Autonomous Universities - State Public Universities - Federal IES - Polytechnic Universities - Technological Universities - Federal Technological Institutes - Normal Schools - Decentralized Technological Institutes - Intercultural Universities - S & T Councils - CONACYT Research Centers.

Scope, Coverage and Audience

Journal of Mechanical Engineering is a Journal edited by ECORFAN-México S.C in its Holding with repository in Spain, is a scientific publication arbitrated and indexed on a quarterly basis. It supports a wide range of contents that are evaluated by academic pairs by the Double-Blind method, around topics related to the theory and practice of pumps and equipment for handling liquids, bearings, air compressors, gears, cooling equipment, mechanical power transmission equipment, pneumatic equipment, equipment and industrial machinery, agricultural machinery, oil extraction machinery , printing and reproduction machinery, mining machinery, hydraulic machinery, specialized industrial machinery, nuclear machinery, paper manufacturing machinery, machinery for the food industry, material handling machinery, textile machinery, steam machinery, vending machines and distributors, machines, tools and accessories, heating material, building material, dies, insoles and gauges, internal (general) combustion engines, gas engines , mechanized operations with diverse approaches and perspectives, which contribute to the dissemination of the development of Science Technology and Innovation that allow arguments related to decision-making and influence the formulation of international policies in the Field of Engineering and Technology Sciences. The editorial horizon of ECORFAN-Mexico® extends beyond the academy and integrates other research and analysis segments outside this field, as long as they meet the requirements of argumentative and scientific rigor, as well as addressing topics of general and current interest of the International Scientific Society.

Editorial Board

Arbitration Committee

Assignment of Rights

The sending of an Article to Journal of Mechanical Engineering emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Originality Format for its Article.

The authors sign the Authorization Format for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Spain considers pertinent for disclosure and diffusion of its Article its Rights of Work.

Declaration of Authorship

Indicate the Name of Author and Coauthors at most in the participation of the Article and indicate in extensive the Institutional Affiliation indicating the Department.

Identify the Name of Author and Coauthors at most with the CVU Scholarship Number-PNPC or SNI-CONACYT- Indicating the Researcher Level and their Google Scholar Profile to verify their Citation Level and H index.

Identify the Name of Author and Coauthors at most in the Science and Technology Profiles widely accepted by the International Scientific Community ORC ID - Researcher ID Thomson - arXiv Author ID - PubMed Author ID - Open ID respectively.

Indicate the contact for correspondence to the Author (Mail and Telephone) and indicate the Researcher who contributes as the first Author of the Article.

Plagiarism Detection

All Articles will be tested by plagiarism software PLAGSCAN if a plagiarism level is detected Positive will not be sent to arbitration and will be rescinded of the reception of the Article notifying the Authors responsible, claiming that academic plagiarism is criminalized in the Penal Code.

Arbitration Process

All Articles will be evaluated by academic peers by the Double Blind method, the Arbitration Approval is a requirement for the Editorial Board to make a final decision that will be final in all cases. MARVID® is a derivative brand of ECORFAN® specialized in providing the expert evaluators all of them with Doctorate degree and distinction of International Researchers in the respective Councils of Science and Technology the counterpart of CONACYT for the chapters of America-Europe-Asia- Africa and Oceania. The identification of the authorship should only appear on a first removable page, in order to ensure that the Arbitration process is anonymous and covers the following stages: Identification of the Journal with its author occupation rate - Identification of Authors and Coauthors - Detection of plagiarism PLAGSCAN - Review of Formats of Authorization and Originality-Allocation to the Editorial Board-Allocation of the pair of Expert Arbitrators-Notification of Arbitration -Declaration of observations to the Author-Verification of Article Modified for Editing-Publication.

Instructions for Scientific, Technological and Innovation Publication

Knowledge Area

Work should be unpublished and refer to issues of Pumps and equipment for handling liquids, bearings, air compressors, gears, cooling equipment, mechanical power transmission equipment, pneumatic equipment, equipment and industrial machinery, agricultural machinery, oil extraction machinery, printing and reproduction machinery, mining machinery, hydraulic machinery, specialized industrial machinery, nuclear machinery, machinery to manufacture paper , machinery for the food industry, material handling machinery, textile machinery, steam machinery, vending machines and distributors, machines, tools and accessories, heating material, building material, dies, insoles and gauges, internal combustion engines (general), gas engines, machined operations and other topics related to engineering and technology sciences.

Presentation of Content

In volume fourth issue thirteen, as the first article we present, *Mechanical upgrade to a proposed mechanical transition ventilation*, by REYES-MARTINEZ, Roberto Alejandro, MIRANDA-PASCUAL, María Elena, ESQUEDA-ELIZONDO, José Jaime and TRUJILLO-TOLEDO, Diego Armando, with secondment at the Universidad Autónoma de Baja California, as a second article we present, *Test analysis for implementation of mechanical and robotic systems in therapy applications*, by AGUILERA-HERNÁNDEZ, Martha Isabel, ORTIZ-SIMÓN, José Luis, RAMÍREZ-AGUIRRE Miguel and ROJO-VELÁZQUEZ, Gustavo Emilio, with an appointment at Tecnológico Nacional de México-Instituto Tecnológico de Nuevo Laredo, as a third article we present, *Design of a rotational type vibration absorber*, by VÁZQUEZ-GONZÁLEZ, Benjamín, JIMÉNEZ-RABIELA, Homero and RAMÍREZ-CRUZ, José Luis, with secondment at the Universidad Autónoma Metropolitana, as fourth article we present, *Analysis of drag and lift forces for a sedan car using a rear lip spoiler*, by HORTELANO-CAPETILLO, Juan Gregorio, MARTÍNEZ-VÁZQUEZ, J. Merced, ZUÑIGA-CERROBLANCO, José Luis and RODRIGUEZ-ORTIZ, Gabriel, with secondment Universidad Politécnica de Juventino Rosas.

Content

Article

Journal of Mechanical Engineering

June 2020 Vol.4 No.13 1-9

Mechanical upgrade to a proposed mechanical transition ventilation

Mejora en la parte mecánica a una propuesta de ventilador mecánico de transición

REYES-MARTÍNEZ, Roberto Alejandro†*, MIRANDA-PASCUAL, María Elena, ESQUEDA-ELIZONDO, José Jaime and TRUJILLO-TOLEDO, Diego Armando

Universidad Autónoma de Baja California, Faculty of Chemical Sciences and Engineering, Mexico.

ID 1st Author: *Roberto Alejandro, Reyes-Martínez* / **ORC ID:** 0000-0003-2210-2692, **Researcher ID Thomson:** AAN-2895-2020, **CVU CONACYT ID:** 21470

ID 1st Coauthor: *María Elena, Miranda-Pascual* / **ORC ID:** 0000-0002-9469-3383, **CVU CONACYT ID:** 455846

ID 2nd Coauthor: *José Jaime, Esqueda-Elizondo* / **ORC ID:** 0000-0001-8710-8978, **Researcher ID Thomson:** I-2941-2017, **CVU CONACYT ID:** 90966

ID 3rd Coauthor: *Diego Armando, Trujillo-Toledo* / **ORC ID:** 0000-0003-1482-8581, **Researcher ID Thomson:** M-2770-2018, **CVU CONACYT ID:** 232755

DOI: 10.35429/JME.2020.13.4.1.9

Received January 10, 2020; Accepted June 30, 2020

Abstract

Due to the contingency situation that has been generated in various parts of the world and the declaration of a pandemic carried out by the World Health Organization against the Sars-CoV-2 virus, various people, educational institutions and companies are carrying out the development of mechanical ventilators that can meet the need for this equipment in their countries. This paper shows experiences obtained in the design and construction of a transitional mechanical ventilator that allows compliance with the minimum requirements that doctors and healthcare professionals consider when a person is piped. Also, it helps in the seek to comply the regulations that the federal government agency elaborates with the purpose of reviewing the existing proposals for open source mechanical ventilators. It also contains the technical requirements that are need to be covered by the designers. These regulations cover the feasibility for replicating the ventilators proposed, based on certain factors that will be described in this paper. Once the ventilators have been tested, its improvement is carried out from the mechanical part, considering the electrical element to be used, in order to obtain a transitional mechanical ventilator that could be easily replicated with national suppliers.

COVID-19, Ventilator, Transition

Resumen

Debido a la situación de Contingencia que se ha generado en diversas partes del mundo y a la declaración de Pandemia llevada a cabo por la Organización Mundial de la Salud ante el virus Sars-CoV-2, diversas personas, instituciones educativas y empresas están llevando a cabo el desarrollo de ventiladores mecánicos que pueden cubrir la necesidad de estos equipos en sus países. Este trabajo presenta una parte fundamental de la construcción de una propuesta de ventilador mecánico de transición que permita poder cumplir con los requerimientos mínimos que los médicos consideran cuando una persona es entubada buscando cumplir con la normatividad del organismo federal, para ello se hace uso de una revisión de las propuestas existentes de ventiladores mecánicos de código abierto, de los requerimientos técnicos a cubrir y de la factibilidad de réplica del mismo, con base a ciertos factores que se describirán en el artículo y una vez probado se lleva a cabo la mejora del mismo desde la parte mecánica considerando el elemento eléctrico a utilizar, con la finalidad de obtener un ventilador mecánico de transición que pudiera replicarse de manera simple con proveeduría nacional.

COVID-19, Ventilador, Transición

Citation: REYES-MARTÍNEZ, Roberto Alejandro, MIRANDA-PASCUAL, María Elena, ESQUEDA-ELIZONDO, José Jaime and TRUJILLO-TOLEDO, Diego Armando. Mechanical upgrade to a proposed mechanical transition ventilation. Journal of Mechanical Engineering. 2020. 4-13:1-9.

* Correspondence to the Author (Email: roberto@uabc.edu.mx)

† Researcher contributing as first author.

Introduction

Due to the outbreak of a new coronavirus (SARS-CoV-2) identified as the etiological agent of pneumonia (COVID-19) in China, according to data from the publication of the Pan American Health Organization (2020, March 3) An identification was carried out among the patients who maintained similar symptoms and through a study published by the Center for Disease Control and Prevention of China in February of this year, it was identified that the spectrum of the disease was distributed in 81% of mild cases (cases of non-pneumonia and mild pneumonia), 14% of severe cases (dyspnea, respiratory rate greater than 30 / min, blood oxygen saturation less than 93%, PaO_2 / FiO_2 ratio less than 300, and / or pulmonary infiltrates greater than 50% within 24–48 hours), and 5% of patients in critical condition, with respiratory failure, septic shock and / or multi-organ dysfunction or failure.

According to the world health organization (WHO January 2020), it has been identified that the implementation of supportive therapies, including those that supply oxygen, has helped people with severe manifestations of COVID-19. Being the SARS-CoV-19 coronavirus identified as a virus with a very high contagion rate according to the WHO, it is estimated that it is from 1.4 to 2.5, although there are other estimates that manage it between 2 and 3, which means that each An infected person can infect 2 or 3 more people, but there may be people called “supercontagators” that can infect up to 16 people as indicated (Sarukhan, 2020) of the Barcelona Global Health Institute.

Based on the data that the WHO reports as of April 26, 3,200,000 people have been infected in the world and according to the information mentioned above, 14% of the people, that is, 448,000 could fall into the consideration of serious and require oxygen support.

According to the PAHO, some of the essential elements for oxygen supply that are approved by WHO are presented in Table 1:

Paper	Description
Mechanical ventilators	ISO10651-4: Lung ventilators that support a person in the breathing process.
Non-invasive ventilation (BiPAP)	It is a form of temporary respiratory support for patients who have shortness of breath that manage the Positive Airway pressure of two levels.
Portable ventilator	System with certain characteristics reduced to those of a mechanical ventilator.

Table 1 Oxygenation equipment considered for COVID-19 supportive treatment
Source: Own elaboration

Although mechanical ventilation is not really a therapeutic process, it is the most used technique for the management of critical patients who require support for the respiratory process.

The evolution of this process of keeping a person alive can be said to come from the glory days of the Egyptians, passing through Hippocrates according to his treatise on air (Ya, 2005), later in the year 175 After Christ Galen generated a first device based on bellows to supply air and so followed several scientists, such as Andreas Vesalius, Leonardo da Vinci, Robert Hooke, Robert Boyle, Torsten Thunberg and many more, who allowed to develop what today is known as a mechanical ventilator. For a further description of the evolution of a ventilator, see the work of Neri, *et al* (2013).

Mechanical ventilation is a life-support treatment that began to be widely used in 1950 due to a polio epidemic in Europe (Gutiérrez, 2011). This process is supported by supplying air and oxygen through a machine, facilitating gas exchange and respiratory work in patients with respiratory failure. The mechanical ventilator (MV), by generating a pressure gradient between two points (mouth / airway - alveolus) produces a flow for a certain time, which generates a pressure that has to overcome the resistance to flow and the properties elastic bands of the respiratory system obtaining a volume of gas that enters and then leaves the system.

Generally, this type of device is found in the Intensive Care Units (ICU) of hospitals and is used to treat various conditions that require the support of the respiratory system, its use is restricted to specialist doctors such as intensivists, who know of certain models and brands, these equipments cover different ventilation situations and have a very high cost.

The COVID-19 pandemic has led to an increased use of mechanical ventilators, to support patients who require the use of them for between 7 to 21 continuous days. Faced with this situation and considering that almost half a million people may need to use a VM, the amount of equipment installed in hospitals is exceeded, so the need for support equipment that meets the needs of a serious COVID-19 patient, It has been an area of opportunity that various educational institutions, entrepreneurs and companies have tried to take advantage of to carry out the generation of low-cost VMs that could be considered as mechanical ventilators or transitional mechanical ventilators that can be more similar to ventilators non-invasive better known as BiPap.

These transition VMs have generally been developed as so-called open source products and what is sought with this process is that they could be replicated quickly anywhere in the world, having the opportunity to increase their production based on the need. existing. Generally, for their construction, they require the use of 3D printers for the development of parts, low-cost electronic elements such as generic microcontrollers and the use of numerical control machines (CNC) for parts where 3D printers are not the best option.

A work on the state of the art of mechanical ventilators (Pham et al, 2017) allows identifying their main characteristics, their advantages and disadvantages, as well as alternatives in their development.

Among the open source VMs there are different principles of operation, one of them is based on the flow of air through a turbine and its regulation through the management of pressure and flow sensors.

Likewise, there is another operating principle based on AMBU bags where the automation of the respiratory rate and air volume is sought as in the first commercial ventilators, the above is done by compressing the bag by electrical-mechanical means such as levers cranks, cams and connecting rods in conjunction with direct current electric motors, servo motors or stepper motors and with speed reduction mechanisms such as gears, endless screws, etc.

The project carried out in this work is related to the update of the mechanical part of an open source ventilator that handles the operating principle through AMBU bag, based on an existing proposal and that is fairly easy to achieve with the materials and equipment available at the faculty, and that its mechanical principle is related to the use of a cam and a lever, but when developing and testing it did not meet the technical volume requirements that a VM should have, so they were carried out changes in the dimensions of the cams and levers and not reaching the appropriate volume levels, it was necessary to evolve to another mechanical principle based on a crank rod, thus updating the mechanical principle of the reference ventilator, identifying that said proposal did not it met one of the signals to be measured essential for a MV and this signal can only be carried out by means of a mechanical action, likewise, the proposal was presented to a group of doctors who made observations for the mechanical structure, which would allow a device easy to handle by the medical team.

To explain this update in detail, the following sections are used, the first one puts into context the basic characteristics of a VM, the next one adds the characteristics of an AMBU bag-based ventilator, one more section describes the open source ventilator for reference, the following presents the implementation of the proposal and the evidence obtained, following the conclusions section and finally the references section.

Characteristics of a mechanical ventilator

A mechanical ventilator must have the ability to provide medical gas (air-oxygen mixtures) to the patient by controlling the variables of volume, pressure, flow, and respiratory rate.

In addition to conditioning the gas through filters, a temperature and humidity variation system and through non-invasive or invasive mechanical ventilation devices.

MV must have the ability to monitor the patient's ventilation and respiratory mechanics, as well as offer alarms when conditions other than those expected are present. According to Gutiérrez, F (2011) the characteristics that an ideal mechanical ventilator should have are those described in Table 2.

No	Features
1	High capacity (volumes, pressures, flows)
2	Versatile (modes, clinical context, patient demand)
3	insurance
4	Easy to use
5	Accepted by patients
6	Cheap

Table 2 Ideal characteristics of a mechanical ventilator
Source: Gutiérrez, F., Mechanical Ventilation.

Mechanical ventilators such as those shown in Figure 1, are compact equipment that has a programming panel on the front, as well as a visualization system through a screen, where the ventilation modes are programmed, as well. It has data acquisition sockets, while in the back are generally the electronic system, pneumatic and gas mixing system, electrical connections and medical gases, as well as the equipment's cooling system. (Ramos, L. & Vales, S., 2012).

Latest generation ventilators

Figure 1 Types of ventilators
Source: Biomedical engineering course, Universidad de la República Montevideo Uruguay

The main variables that should be considered to observe in the VMs are:

Tidal or Tidal Volume, Respiratory Rate, Sensitivity, Inspiratory Flow, I: E Ratio, Inspiratory Time, and Peak Inspiratory Pressure.

The ranges that should be considered in each of them can be seen in the following Table.

Variable	Rank	Units
Tidal volume	200-600	ml
Breathing frequency	12-24	rpm
Sensitivity	-0.5 a 3 1-5	cmH_2O Pressure l/min flow
Inspiratory flow	7-12	l/min
I: E ratio	1:1, 1:2, 1:3	------
Inspiratory time	10-35	min^{-1}
Inspiratory pressure	10-30	cmH_2O

Table 3 List of important variables in Mechanical ventilators. Mechanical Ventilation art font

The above variables should also be considered in open source ventilators regardless of their purpose being transitional use.

Characteristics of an Open Source Mechanical Ventilator (AMBU bag)

An open source mechanical ventilator (OSMV) is one that provides the code to replicate it, as well as the licensing for others to freely reproduce it. The development of these ventilators is mainly managed in two ways, the first is that design communities make proposals, in the same community improvements are made that are shared and are free for anyone; the second path follows the process of the first, but the information that permeates is incomplete to be able to replicate it.

In the context of OSMV, the existing literature is very poor, there is some research on low-cost ventilators of portable systems but without enough information to be reproduced, however there are works that can be useful documents for open source designers (Kerechanin, C. , et al, 2004).

There are low-cost VM concepts that have been developed and prototyped, under the principle of a pump and air regulator that allows the use of hospitals' gas mixing systems and that have allowed the creation of sensors through 3D printers. (Fuchs, P., et al, 2017; Powelson, S., 2010).

ISSN-2531-2189

June 2020 Vol.4 No.13 1-9

Another low-cost Ventilation proposal is to use an AMBU bag. Changes in the way of compression of the AMBU bag through an electrical-mechanical system of a pivoting arm pushed by an electric motor improves the traditional compression proposal (Husseini, A, et al, 2010).

Mkaram Shabid's studies have shown good characteristics compared to that of a conventional commercial VM (Shahid, M., 2019). By automating the AMBU bag, it is possible to regulate the respiratory rate and the volume of air, as in the first MV, as well as to regulate the relationship between inspiration and expiration, and the PEEP ratio. The Shahid system has two modes: 1) mandatory ventilation (old models) and 2) assisted ventilation (in most current systems). The device has knobs that control the tidal volume, respiratory rate, I: E ratio and inspiratory pressure, however it does not have all the elements: blueprints, code, etc., necessary to qualify as open source devices, however it is a good document for those OSMV developers based on AMBU exchange.

Likewise, as of February of this year, given the situation in Italy, different communities were created on the Internet for the development of open source projects, in particular in the development of mechanical ventilators, as is the case of Project Open Air. , AIR (innovative breathing aid forum), RepRap, Air Collective in Bulgaria, #EngineersAssemble among others.

Of all the proposals available at the start of the project, an analysis was made and the proposal of the A.I.R.E. community was considered. called Respirator23 promoted by the team called Resistance, to be replicated at the University, given the infrastructure and equipment available at the faculty.

Characteristics of the Mechanical Ventilator Respirator23 Open Source (ambu bag)

The low-cost, open source mechanical ventilator called Respirator23 is based on the Jackson-Rees system that consists of an anesthetic circuit that modifies the Mapleson D circuit with a reservoir bag that incorporates an escape mechanism for the exit of exhaled gases, such as shown in Figure 2.

Figure 2 Jackson-Rees system
Source: DCD products

This system consists of an AMBU-type bag as a reservoir element for the fluids, in addition to having connectivities by valves that allow air flow to the reservoir and later when compressing it, the fluid exits through another part of the circuit, sending the gas mixture to patient.

A team of Spaniards from different areas and with knowledge of medicine, biotechnology, 3D printing, mechanics, electronics, computing and industrial design created a working group called ReesistenciaT, which tried to carry out a mechanical ventilator design with minimal materials and automate the process of compression of an AMBU bag as Husseini did, but taking it to the open source level for rapid replication given the needs of ICUs in Europe and possibly throughout the world, the above was done within the Coronavirus group Makers, with the possibility that their proposal could be replicated anywhere in the world in the face of the COVID-19 pandemic.

Its mechanical design in its first proposals, of which the replica was carried out, consisted of the following 3D printed elements: A cam, a rocker made of 2 pieces that are joined with a bearing that comes into contact with the cam and It pivots on an M8 screw that anchors it to the structure of the box, and in its final part it is fixed to a blade with two M5 screws. In addition, it has a 3D printed bed that houses Jackson Rees' breathing balloon. All elements were made available in open source for reproduction on the web, as 3D files, like the example shown in Figure 3.

ISSN-2531-2189

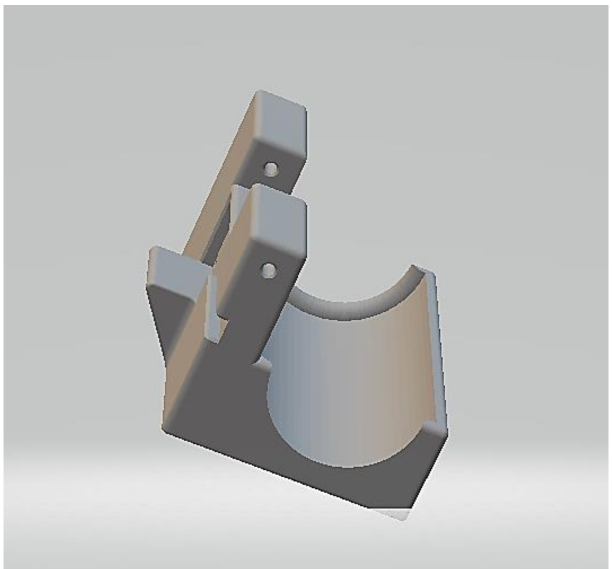


Figure 3 Respirator AMBU base 23
Source: Images respirator 23

Making some modifications over the weeks, your latest VMCA update is shown in Figure 4.

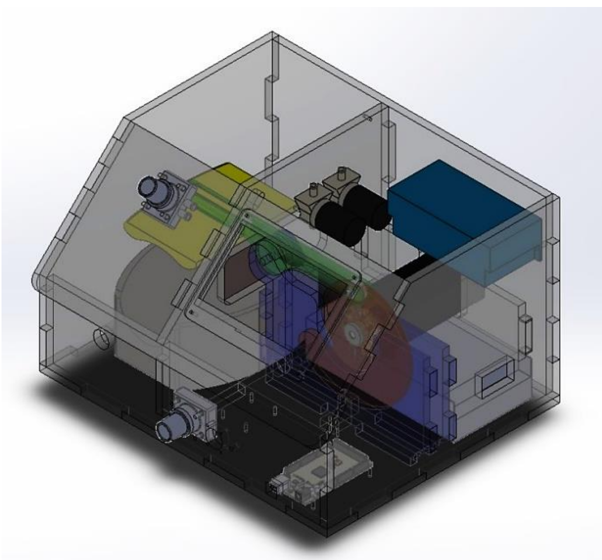


Figure 4 Respirator 23
Source: Images respirator 23

Implementation of the mechanical proposal

Based on the information from the Respirator23 and considering that all the mechanical part could be developed with the equipment that is in the school, the corresponding files were downloaded, and the following parts developed:

In 3D printer:

- Thrust part (shovel).
- Two arms that join the thrust with a bearing (rocker).
- PortaAmbu (bed).
- Two pieces in the form of a bearing.

In numerical control machine.

- Cam (in acrylic and wood).
- Two pieces that make up the rocker arm and motor support.

Likewise, the following elements were acquired: a 10 mm steel shaft, a bearing for skid, two 6/32 10 mm screws with nuts, an 8/32 10 mm screw with nut, the above in order to make the system is more robust and easier to acquire. All components can be seen in the assembled system in Figure 6.

Figure 5 Assembled Proposal of Respirator 23
Source: Own elaboration

The first test was done without printing the base of the AMBU bed called Base_23, because when viewing the Figure in the 3D printing software (see Figure 6), an overlap with the AMBU bed identified as balloon-support was identified in the shared documents for 3D printing.

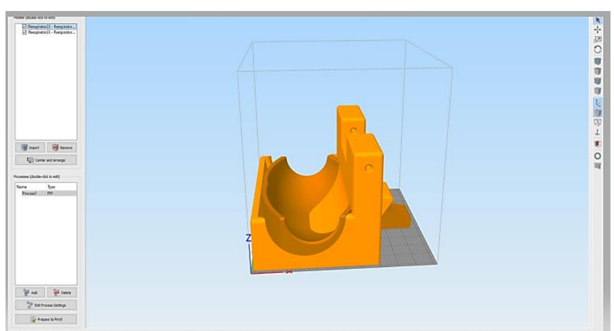


Figure 6 Overlap of Respirator 23 parts
Source: Own elaboration

ISSN-2531-2189

When carrying out the first tests of operation in terms of compression, as shown in Figure 7, it was identified that it made some compression of the AMBU bag, but it was until a lung simulator was put that it was possible to identify that it did not tidal volume requirements were met with Respirator 23 proposal.

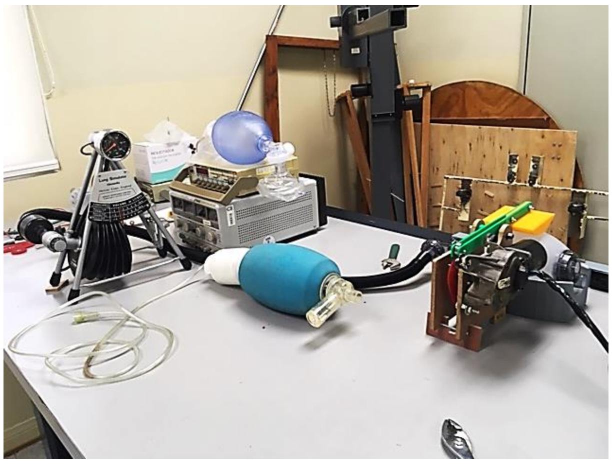


Figure 7 System with lung simulator
Source: Own elaboration

As identified alternatives, the first one used was the modification of the electrical system (motor), with the results shown in Table 4.

Type of motor	Speed (RPM)	Maximum torque Kgf-cm	Volume (ml)	Current (A)
DC 12V with gear	81	4.41	100	0.6 (no more)
DC 12V without gear	150	----	70	2.9
DC 12V Planeta-rio	84	93.6	250	4.9
Window Elevator	45	122.4	250	4.7
Wiper washer	64	183.5	300	4.2

Table 4 Respirator system test results23
Source: Own elaboration

From this test it was identified that the windscreen wiper and window lifter motors were the best option, they were tested on changing the cam, maintaining the profile of the original cam and making changes to it, but without significant changes. .

With this last change, it was identified that the motor required a greater current to reach the tip of the cam, for which a change was proposed in the mechanical design of the AMBU bag compression process, for which the force required to push 600 ml of the AMBU bag, starting from the pushing force:

$$F_E = P_e V_c \quad (1)$$

Where FE is the force of the thrust, Pe the specific weight that relates the density of the air and the AMBU and VC the volume that is displaced.

Being the density of the air and the AMBU defined as:

$$P_e = (\rho_{aire} + \rho_{AMBU}) * g \quad (2)$$

And if the density of the air is 1,225 kg / m3 and that of the AMBU, being silicone, 276 kg / m3 and the acceleration of gravity is 9.81m / s2, then the specific weight is:

$$P_e = (1.225 + 276) * 9.81 = 2{,}719.57\ kg/m^2s^2$$

Since you want to displace 600 ml, this is 0.0006 m^3, so the force of the thrust is:

$$F_E = 2{,}719.5 * 0.0006 = 1.631\ kgm/s^2$$

Equivalent to 15.86 N and 94.33 kgfcm

Then, calculating the force required (from the motor) to push a force of 15.86 N, considering the separation between the pushing force and the rocker (S1 = 9 cm) and between the force of the motor and the rocker (S2 = 12 cm) you have:

$$F_M = \frac{F_E * S_1}{S_2} = \frac{15.86*9}{12} = 11.89N \quad (3)$$

For the motors that have to compress the AMBU, an FM = 3.6 N is required, then the relationship between distances is:

$$\frac{S_1}{S_2} = \frac{F_M}{F_E} = \frac{3.6\ N}{15.86\ N} = 0.226 \quad (4)$$

So, if you keep the same distance between the rocker arm and the thrust, the distance between the engine and the rocker would be:

$$S_2 = \frac{9}{0.226} = 39.82\ cm \quad (5)$$

Which would complicate the placement of the components.

For this reason, it was proposed to change the way of compressing the AMBU bag, considering a transmission through a crank-rod system like the one presented in Figure 8.

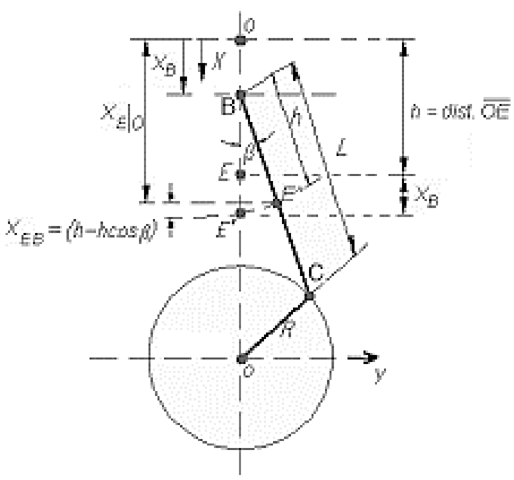


Figure 8 Crank-crank system
Source: Universidad Nacional de la Plata

Considering a crank of r = 4 cm and a crank of l = 20 cm, we have a relationship λ = 0.2 and the distance to travel through the thrust system defined by:

$$x = r * (1 - \cos\alpha) + l(1 - \sqrt{1 - \lambda^2 sin^2\alpha}) \quad (6)$$

It would be from 0 to 8 cm.

The torque required for the motor would be obtained by:

$$M = F * r[\sin\alpha + \frac{\lambda}{2}\sin 2\alpha] \quad (7)$$

Considering a required thrust force of F = 15.86 N, the torque required for the motor is:

$$M = 15.86 * 0.04m * [\sin 90 + \frac{0.2}{2}\sin 180] = 0.6344\ Nm$$

This is easily achieved with any of the wiper and window lifter motors, as presented in Table 6 in a test developed with a wiper motor.

Bag	Separation (cm)	Volume (ml)	Current (A)
Green	4	680	2.4
blue	4	640	1.8
Gray	3	600	1.9
Ambu	3	700	2.1

Table 5 Connecting rod-crank system test results
Source: Own elaboration

The final system being tested, like the one presented in Figure 9.

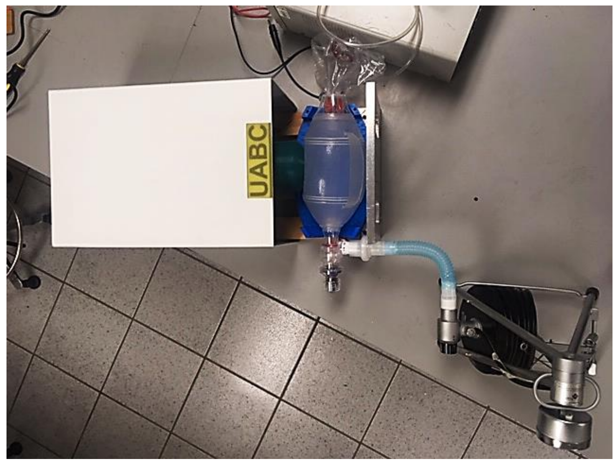


Figure 9 Crank-rod end system with lung simulator
Source: Own elaboration

Acknowledgement

The support received from the Autonomous University of Baja California and the Faculty of Chemical Sciences and Engineering to support financially and with work spaces in times of contingency is appreciated.

Conclusions

In this work, a proposal to modify the mechanical part of an Open Source Mechanical Ventilator has been presented, so that it complies with the ranges in the variables to be measured, it was identified that the basic proposal of a rocker lever did not cover the parameters to be measured. measure if not the energy capacity was greatly increased, for this, possible alternatives that are validated with their implementation are analyzed until the one that reduces the energy values and complies with the volume values is found, considering the same compression principle of an AMBU bag. The proposal can be improved if other compression alternatives are studied that were not touched on in this work.

References

Al Husseini, A.,Lee, H., Negrete, J., (2010) Design and prototyping of a low-cost portable mechanical ventilator, pp 1-9, Transactions of the ASME-W Journal of Medical Devices, 4(2).

Fuchs, P., Obermeier, J., Kamysek, S., Degner, M., Nierath, H., Ewald, H., Schwarz, J., Becker, M. (2017) Safety and applicability of a pre-stage public access ventilator for trained laypersonds: a proof of principle study, pp 1-8 , BMC Emerg Med, 17(37).

Gutiérrez, F., (2011) *Ventilación Mecánica*, pp 87-107, Acta Médica peruana, 28(2) Lima abr/jun 2011.

Kerechanin,C., Cutchis, P., Vincent, J., Smith, D., Wenstrand, D., (2004) *Development of field portable ventilator systems for domestic and military emergency response*, pp 214-222, John Hopkins Apl Tech Digest, 25(3).

Neri, R., Zacarías, J., (2013). Cap. 1 Historia de la Ventilación Mecánica, pp 1-9, México, Editorial Alfil.

Organización Mundial de la Salud OMS (2020). Documentación: Clinical management of severe acute respiratory infection when novel coronavirus (nCoV) infection is suspected: interim guidance, 25 January 2020. Recuperado el 1 de mayo de 2020, de https://apps.who.int/iris/handle/10665/330854 License: CC BY-NCSA 3.0 IGO)

Organización Panamericana de la Salud PAHO (2020). Documentación: Especificaciones técnicas de dispositivos médicos para la gestión de casos de COVID-19 en los servicios de salud OPS/PHE/IM/Covid-19/20-001, pp 1-3, (recomendaciones interinas, 3 de marzo del 2020). Recuperado el 1 de mayo de 2020, de https://iris.paho.org/handle/10665.2/51980

Pearce, J., (2020) *A review of open source ventilators for COVID-19 and future pandemics [version 2; peer review: 2 approved]*, pp 1-27, F1000 Research Open for Science. Recuperado el 1 de mayo de 2020, de https://f1000research.com/articles/9-218

Pham, T., Brochard, L., Slutsky, A., (2017) Mechanical Ventilation: State of the Art, Mayo Clin Proc., pp 1382-1400 recuperado de: http://dx.doi.org/10.1016/j.mayocp.2017.05.004

Powelson, S., (2010) *Design and prototyping of a low-cost portable mechanical ventilator*, MIT, ingeniería mecánica, Tesis de licenciatura.

Ramos, L., Vales, S., (2012) Fundamentos de la Ventilación Mecánica, pp 69-80, España, Marge Médica Books.

Ringegni, P., (2018) *Mecanismos y Elementos de Máquinas-Mecanismos y Sistemas de Aeronaves*, pp 3, Argentina, Universidad Nacional de La Plata. Trabajo de Clase.

Shahid, M., (2019) *Prototyping of Artificial Respiration Machine Using AMBU Bag Compression*, International Conference on Electronics, Information, and Communication (ICEIC), pp 1-6, IEEE.

Sarukhan, A., (2020). Un nuevo coronavirus, una nueva epidemia, muchas incógnitas, Instituto de Salud Global de Barcelona recuperado el 1 de mayo de 2020, de https://www.isglobal.org/coronavirus

Ya, Abdala (2005) Historia y Evolución de la Ventilación Mecánica, pp 199-198, CONAREC.

Test analysis for implementation of mechanical and robotic systems in therapy applications

Análisis de pruebas para implementaciones de sistemas mecánicos y robóticos en aplicaciones de terapia

AGUILERA-HERNÁNDEZ, Martha Isabel†*, ORTIZ-SIMÓN, José Luis, RAMÍREZ-AGUIRRE, Miguel and ROJO-VELÁZQUEZ, Gustavo Emilio

Tecnológico Nacional de México- Instituto Tecnológico de Nuevo Laredo, Mexico.

ID 1st Author: *Martha Isabel, Aguilera-Hernández* / **ORC ID:** 0000-0001-8127-190X, **Researcher ID Thomson:** S-4724-2018, **CVU CONACYT:** 19115

ID 1st Co-author: *José Luis, Ortiz-Simón* / **Researcher ID Thomson:** S-7037-2018, **CVU CONACYT ID:** 289883

ID 2nd Co-author: *Miguel, Ramírez-Aguirre* / **ORC ID:** 0000-0002-9780-0666

ID 3rd Co-author: *Gustavo Emilio, Rojo-Velázquez* / **ORC ID:** 0000-0002-7792-1436, **Researcher ID Thomson:** S-4724-2018, **CVU CONACYT ID:** 26367

DOI: 10.35429/JME.2020.13.4.10.15 Received January 15, 2020; Accepted June 30, 2020

Abstract

This article presents the results of tests performed on the mechanical system of wheeled robots, so they can be implemented as therapy instruments for people with different capacities (ASD). The results displayed show the robot's behavior following a trajectory and its dependence on operator handling. In this way, results can be extrapolated about the importance of design for the development of mechanical systems that can be reliable to be implemented as therapy tools.

Wheeled Robots, Therapy, Trajectory following

Resumen

En este artículo, se presentan los resultados de las pruebas realizadas al sistema mecánico de robots con ruedas, con la finalidad de que puedan ser implementados como instrumentos de terapia para personas con capacidades diferentes (TEA). Se muestran los resultados en los cuales se analizó el comportamiento del robot para realizar una trayectoria y su dependencia del manejo del operador para realizarla. De esta manera, se pueden extrapolar resultados acerca de la importancia del diseño para la elaboración de sistemas mecánicos que puedan ser confiables para implementarse como herramientas de terapia.

Robots con ruedas, Terapia, Seguimiento de trayectoria

Citation: AGUILERA-HERNÁNDEZ, Martha Isabel, ORTIZ-SIMÓN, José Luis, RAMÍREZ-AGUIRRE, Miguel and ROJO-VELÁZQUEZ, Gustavo Emilio. Test analysis for implementation of mechanical and robotic systems in therapy applications. Journal of Mechanical Engineering. 2020. 4-13:10-15.

* Correspondence to the Author (Email: maguilera@hotmail.com)
† Researcher contributing as first author.

Introduction

Lately, robotics has taken a leading role in various applications due to its multidisciplinary nature. One of them is health. According to the World Health Organization, one in 160 children has autism spectrum disorder. This disorder is characterized by the presence of alteration of social behavior, communication and language at a certain level.

Studies have been carried out in which it has been identified that children with this disorder can coexist socially in a predictive environment (Pérez, 2019). This environment can be provided by the use of activities that involve robotic prototypes. Robots by their programming can have predictive behaviors and create an environment with these characteristics. Mechanical prototypes have been developed (Tejada, 2018), which consists of a pedaling system, which was focused on helping the autistic child to improve his concentration when performing tasks such as drawing, painting or writing. The child was pedaling at the time of the activity. The results have shown that this type of device helps to establish a better environment for the development of activities. This article is focused on the realization of robotic prototypes that are used in activities that create a predictive environment in which the autistic child's concentration can be encouraged to improve their skills. In development, the characteristics of the designed prototypes are presented. The results section shows the graphs showing the tests carried out on the prototypes so that they can be used as support in therapy. Finally, the conclusions of this work are presented.

Development

The prototypes consist of mobile robots with wheels controlled by a joystick via bluetooth. These have been programmed to follow a predefined trajectory. The user can select the autonomy option or manual control with joystick in the prototype. Three different types of prototypes were designed and tests were carried out to verify the repeatability in tracking the trajectory autonomously. The two options are placed since the robotic prototypes are to be used as a game tool to promote dexterity in autistic children and their level of concentration when controlling it manually. All prototypes have an ultrasonic sensor that detects obstacles, in this way the robot will not collide with the obstacle.

This is to promote a predictive environment that allows the user to interact with the environment without it being disturbed.

The tests were conducted on mobile robotic prototypes that differ in design, one has four wheels, with a motor on each wheel. The second has two controllable wheels and a castor wheel that serves to balance its movement. The third has rails for its movement. At this point, it is important to highlight that it is taken into account that the implementation of prototypes can be carried out at an economic cost. In this way, families or institutions do not have to make a burdensome or unattainable outlay to be able to incorporate play dynamics in autistic children. The main contribution of this work is to promote the use of robotic prototypes that are economically accessible, as well as the ease of implementation. The promotion of these has been sought as part of the mechatronic engineering program of our institution. Graduates of this institution will have the necessary experience to carry out the implementation of robotic prototypes that can be used mainly by health institutions dedicated to this type of specialized care in children with different levels of autism

The diagram of the first prototype is shown in figure 1, which consists of a mechanical structure with four wheels, with optical sensors for line tracking and ultrasonic sensors for the detection of an obstacle. The control system is carried out by means of the Arduino microcontroller and bluetooth communication is carried out by integrating the HC-05 module.

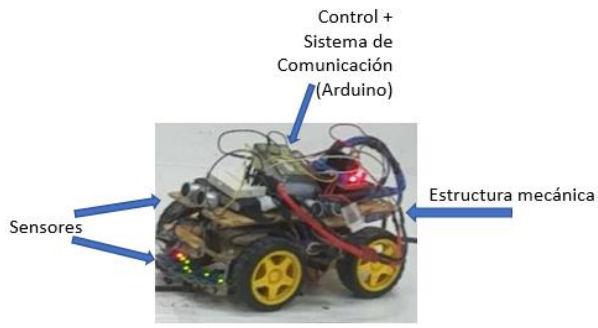


Figure 1 Description of Prototype 1

The prototype in Figure 1 is designed with four wheels and a motor on each wheel. It has a front differential control which allows the speed to be programmed on each wheel, leaving the steering to the front. The movement to the left or right with respect to the robot is obtained by the speed difference between the two front wheels. The route circuit, shown in Figure 3, consists of a black line in which trajectories were included in which the robot has to make 90-degree turns and other more closed 45-degrees. The obstacles were implemented with plastic boats filled with sand, to give them stability and the robot does not knock them down, in case there is physical contact with them.

For manual control a video game joystick was added. This was done to be easy for the child to use. The joystick's enabled options were only four: forward, backward, turn left and turn right. Acrylic and wood are the materials used in the prototypes.

Acrylic provides a firm, smooth, resistant base and does not show deformation or sagging when the temperature changes. Wood, meanwhile, was used, since in the implementation of the prototypes it has been tried to include reusable materials, this in order to help the environment.

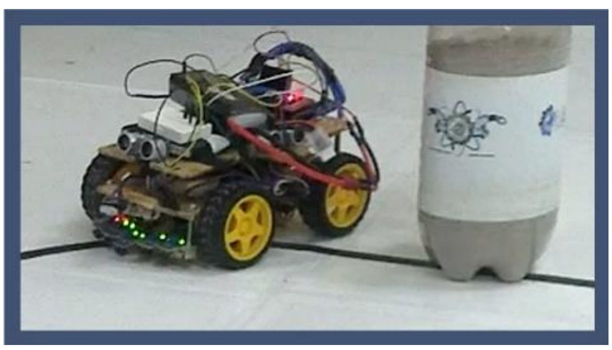


Figure 2 Prototype 1 dodging an obstacle

Figure 3 Test track example

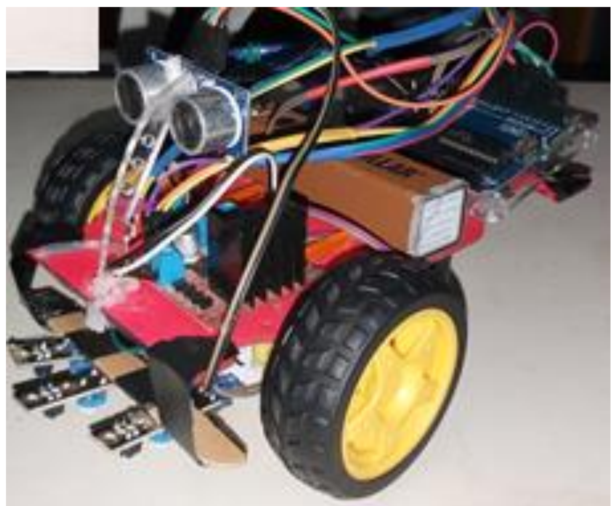


Figure 4 Prototype 2

Prototype 2, shown in Figure 4. It has two front wheels with differential control and a castor wheel at the rear for stability. Like Prototype 1, it has optical sensors for line tracking and an ultrasonic sensor for obstacle detection. Figure 5 shows the second prototype on its way autonomously.

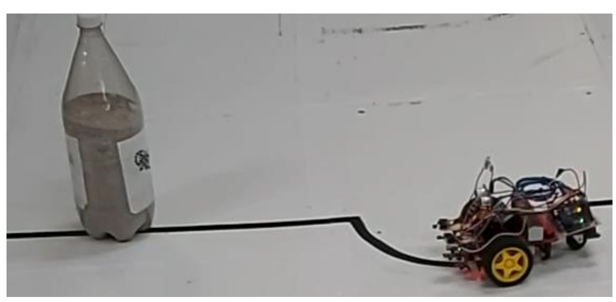


Figure 5 Prototype Tour 2

ISSN-2531-2189

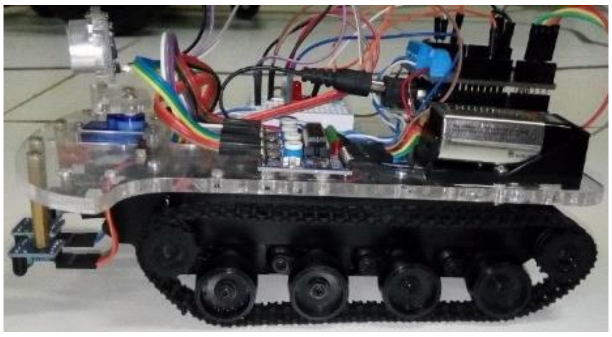


Figure 6 Prototype 3

Figure 6 shows the prototype that has rails as a mechanical part for its movement. It has two motors which allow differential control for the movement of the prototype.

The general concept of the project consists in the realization of prototypes, based on sustainable development, which contain a sensory system that allows them to carry out their journey on a trajectory. These prototypes will be used as support systems in therapy for the development of skills and adaptability in children with autism. Mechanical systems made by our institution in therapies have already been implemented (Tejada, 2018), these prototypes are considered an addition to these systems.

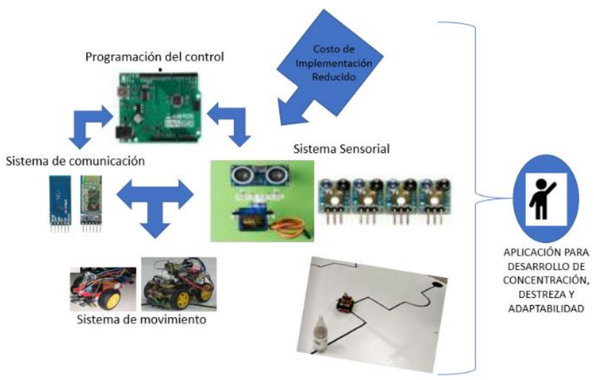


Figure 7 General Project Concept

Results

Table 1 shows the average time results autonomously. These data serve as the basis for obtaining the repeatability of the prototypes and assessing their potential for failure. In the activity, the prototypes are manipulated by the caregivers, the autistic child manipulates the remote control, which has the options of manual or autonomous. Graphs 8, 9 and 10 show the comparison of the data when the robot performs the trajectory for and against the hands of the clock.

These data check the repeatability of the trajectory following in the presence of obstacles.

ROBOT	Average travel time clockwise (seconds).	Average travel time counterclockwise (seconds).
#1	50.9	51.7
#2	58	59.1
#3	61.3	62.6

Table 1 Average time required by the prototype to finish the tour autonomously

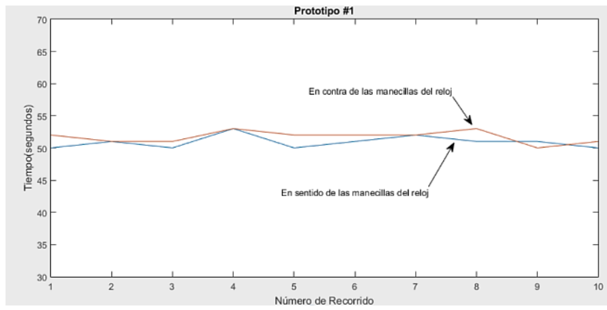


Figure 8 Prototype # 1 walkthrough comparison

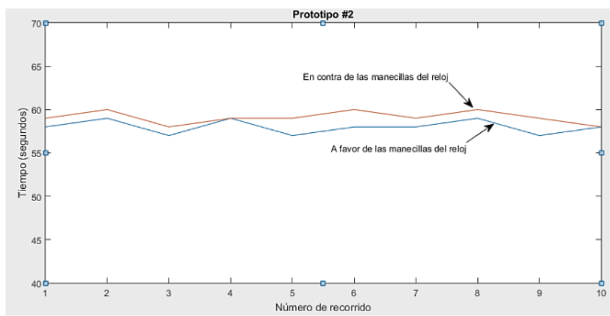


Figure 9 Prototype ride comparison # 2

A test was carried out to verify that if the prototypes manage to attract the attention of the autistic child to establish a game dynamic. It must be recognized that the role of the caregiver (Vela, 2015) is an essential point for the activity to be carried out. He patiently explains to the child what the activity-game is about, and the results showed that it was possible to capture attention and even make several tours.

In the caregiver's experience, he indicated that afterwards the child was able to make a trace indicating the path followed by the robot. That is, the child did not trace the black path, but rather that of the robot. This point still requires study within the activities that can be carried out with these prototypes. In this test, time was not recorded, since the objective was to analyze whether the prototypes managed to attract the child's attention in a therapy session.

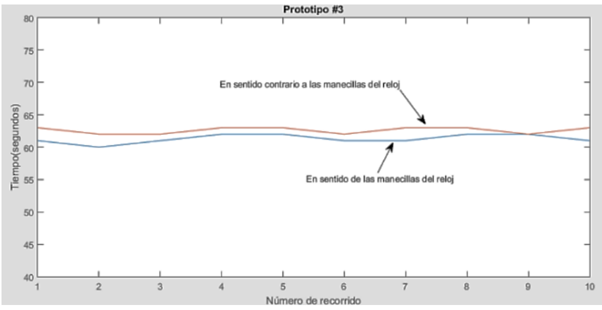


Figure 10 Prototype # 3 walkthrough comparison

In addition, a repeatability study is presented with a larger robotic prototype # 4. The repeatability studies shown are presented in Figure 9.

Figure 11 Robotic prototype # 4

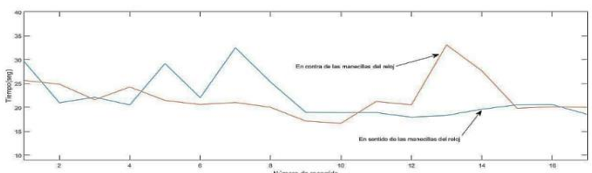


Figure 12 Prototype 4 repeatability study.

Although this prototype was not included in the test carried out with the infant, it is expected that it could be part of a set of prototypes that are available to people focused on giving therapy to autistic children, so that they can include them as part of their activities . The realization of covers for the prototypes is contemplated. These will be made with recycled material, plastic bottles will be used to cover the electronic part of the prototypes. Covers will be differently shaped to attract children's attention.

Acknowledgments

This work is part of the ITNLA-CA-2 project for Strengthening academic bodies of the National Technological Institute of Mexico.

Conclusions

Robotic prototypes were implemented with a sensory and communication system focused on being support in activities focused on the development of skills in autistic children. The prototypes have two modes, manual and autonomous. In this way, it is intended that the activities with these prototypes take place in a predictive environment. The prototypes were developed to be low-cost and based on sustainable development. In this way, they can be used by therapists in low-budget institutions. The role of the caregiver-therapist remains decisive so that the incorporation of the prototypes in the activities can be carried out successfully. It is planned to expand the study of the impact of the incorporation of a greater number of robotic prototypes in various activities focused on the therapy of children with autism.

References

Aguilera, Ortiz, & Rojo (2017). Proyecto de Aplicación de Control Difuso para Apoyo Didáctico en Clases relacionadas a Mecatrónica. Revista de Docencia e Investigación educativa, 3(8), 8-21. http://www.ecorfan.org/spain/researchjournals/Docencia_e_Investigacion_Educativa/vol3num8/Revista_de_Docencia_e_Investigacion_Educativa_V3_N8_2.pdf

Bonilla, M. D., & Chaskel, M. D. (2018). Trastorno del espectro autista. CCAP, 15(1), 19-27. https://scp.com.co/wp-content/uploads/2016/04/2.-Trastorno-espectro.pdf

Building Robota, a Mini-Humanoid Robot for the Rehabilitation of Children With Autism 2007, Aude Billard, Ben Robins, Jacqueline Nadel, Kerstin Dautenhahn 10.1080/10400435.2007.10131864 Assistive Technology

Erazo Santander, O. A. (2016). Elementos para la comprensión del trastorno de espectro autista. Poiésis,31,51. https://doi.org/10.21501/16920945.2076

Perspectives on Mobile Robots as Tools for Child Development and Pediatric Rehabilitation 2007, François Michaud, Tamie Salter, Audrey Duquette, Jean-François Laplante 10.1080/10400435.2007.10131863 Assistive Technology

S.P. Gaskill and S.R.G. Went. Safety issues in modern applications of Robots, 1996, Reliability Engineering and System Safety, 53(3):301 – 307 10.1016/S0951-8320(96)00053-1

Tejada-Velásquez, y., Aguilera-Hernández, m., & Ortiz-Simón, j. l. (2018). Sistema de pedaleo dinámico para concentrar la atención de niños con trastorno de espectro autista. Revista de Investigación y Desarrollo, 4(11), 6–10. http://www.ecorfan.org/spain/rj_investigacion_d_xi.php

Vela Baizabal, C., & Granados Ramos, D. E. (2015). Interacción en niños con trastorno del espectro autista. Revista de Enfermería Neurológica, 14(1), 37–44. https://doi.org/10.37976/enfermeria.v14i1.203

Warren, J., Adams, J., & Molle, H. (2011). Arduino Robotics (Technology in Action) (1st ed.). Apress.

Article
Journal of Mechanical Engineering
June 2020 Vol.4 No.13 16-22

Design of a rotational type vibration absorber

Diseño de un absorbedor de vibraciones tipo rotacional

VÁZQUEZ-GONZÁLEZ, Benjamín†*, JIMÉNEZ-RABIELA, Homero and RAMÍREZ-CRUZ, José Luis

Universidad Autónoma Metropolitana, Azcapotzalco Unit, Division of Basic Sciences and Engineering, Department of Energy, Mexico.

ID 1st Author: *Benjamín, Vázquez-González* / **ORC ID:** 0000-0002-9030-5662, **Researcher ID Thomson:** S-2417-2018, **CVU CONACYT ID:** 25749

ID 1st Co-author: *Homero, Jiménez-Rabiela* / **ORC ID:** EfLkjm13091998, **Researcher ID Thomson:** S-2299-2018, **CVU CONACYT ID:** 123386

ID 2nd Co-author: *José Luis, Ramírez-Cruz* / **ORC ID:** 0000-0003-0762-2630, **Researcher ID Thomson:** G-3405-2019, **CVU CONACYT ID:** 921268

DOI: 10.35429/JME.2020.13.4.16.22

Received January 20, 2020; Accepted June 30, 2020

Abstract

Mechanical vibration absorbers are mechanical subsystems capable of developing an oscillatory movement, which dynamically compensates for the vibratory motion developed by a mechanical system of interest, which is affected by an action that can produce a movement that directly affects it in a non-desirable way. The system of interest is called the primary system and the absorber is called the secondary system. The way in which both systems interact establishes the conditions in which absorption will take place. Traditional absorbers are made up of systems coupled by means of an elastic element, they can also have viscous type coupling and very complex couplings can be presented by elastic and viscous type combinations. The objective of the present work is to design a rotational type vibration absorber, in which the interaction between both mechanical systems is developed by contact by rotation without sliding and elastic coupling. Euler-Lagrange equations are used to obtain the mathematical model of the system. One of the main characteristics of the rotary absorber is that the absorber can be designed to achieve small amplitudes of the displacement of its center of mass, but large displacements. Results are presented in numerical simulation.

Linear systems, Vibrations absortion, Tuning

Resumen

Los absorbedores de vibraciones mecánicas son subsistemas mecánicos capaces de desarrollar un movimiento oscilatorio, que compensa dinámicamente el movimiento vibratorio que desarrolla un sistema mecánico de interés, el cual se ve afectado por una acción que puede producir un movimiento que incida directamente sobre él de manera no deseada. El sistema de interés se denomina sistema principal y al absorbedor se le denomina sistema secundario. La forma en que ambos sistemas interactúan establece las condiciones en las que la absorción se desarrollará. Los absorbedores tradicionales se conforman por sistemas acoplados por medio de un elemento elástico, también pueden tener acoplamiento de tipo viscoso y se pueden presentar acoplamientos muy complejos por combinaciones elásticas y de tipo viscoso. En el presente trabajo se tiene por objetivo diseñar un absorbedor de vibraciones tipo rotacional, en el que la interacción entre ambos sistemas se desarrolla por contacto por rotación sin deslizamiento y acoplamiento elástico. Se utilizan las ecuaciones de Euler-Lagrange para obtener el modelo matemático del sistema. Una de las principales características del absorbedor por rotación, es que el absorbedor puede ser diseñado para alcanzar pequeñas amplitudes del desplazamiento de su centro de masa, pero grandes desplazamientos. Se presentan resultados en simulación numérica.

Sistemas lineales, Absorción de vibraciones, Sintonización

Citation: VÁZQUEZ-GONZÁLEZ, Benjamín, JIMÉNEZ-RABIELA, Homero and RAMÍREZ-CRUZ, José Luis. Design of a rotational type vibration absorber. Journal of Mechanical Engineering. 2020. 4-13:16-22.

* Correspondence to the Author (Email: bvg@correo.azc.uam.mx)
† Researcher contributing as first author.

Introduction

Vibration absorbers are devices designed and used to reduce the vibratory effects that occur or act in any system, machine or element thereof, these vibrations can be harmful due to the repetitive effect, which can cause failure in materials or wear in the elements of the machines.

Carter mentions that the studies on vibration absorbers began with the developments made by Den Hartog, and the coupling between two masses joined by means of an elastic device or spring was considered.

One of the later studies was the one carried out by Roberson, which sought to extend the bandwidth of the action of the absorber of this type.

It has also been sought to extend Den Hartog's results to larger systems, Bulent and Royston, present the results of their work.

Huang and Lin, present in their study four types of absorbers in order to improve the absorption capacity.

Harik and Issa have continued to search for optimal parameters.

In the present work, an alternative configuration is proposed that consists of evaluating the absorption by means of direct contact by rotation without sliding, which occurs between two elements of a vibratory system, it also includes elastic interaction between both bodies.

The dynamic coupling that exists between the elements of the vibratory system is the condition that allows the absorption of vibrations or the tuned energy exchange, this means that there is a correlation between the movement of each body.

For the present case, dynamic coupling consists of the mutual interaction of accelerations and displacements, together with the participation of an element of the system that allows the dynamic tuning of movements, and this favors the flow of mechanical energy, which produces that the actions that are applied directly to the primary system, indirectly affect the secondary or absorber system.

Rotational absorber

Figure 1 shows a diagram that illustrates the position of each of the elements of the mechanical system. It is a forced two-degree-of-freedom system. The excitation is harmonic and the system has no damping, the primary system is designated by m_1, the absorber is designated by m_2.

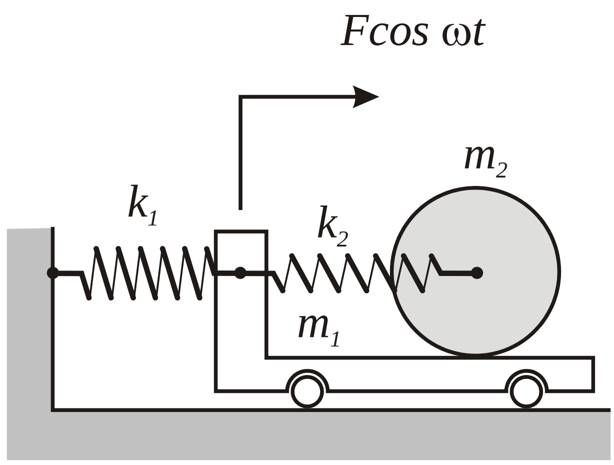


Figure 1 Scheme illustrating the configuration of the primary system, represented by m1 and its absorber, represented by m_2

The movement of the platform or primary system is of the oscillatory type, there is an external force that directly affects said platform, which is of the harmonic type F (t) = F cos ωt, where F represents the magnitude of the force expressed in Newtons and it is constant. ω corresponds to the angular frequency of the excitation movement, which is expressed in rad/s. The platform induces an oscillatory movement to the absorber, which also oscillates, in this case a rotational oscillation develops. The objective is to determine the parameters m_2 and k_2, in such a way that although the force acts directly on the platform, it moves as little as possible and the cylinder or disk absorbs all the movement energy, reducing the movement in the main system.

Unlike the typical vibration absorber, defined by two bodies that are joined by means of a spring, and each body moves with respect to the same fixed reference, the present system has the characteristic of establishing couplings defined by the relative position between them. bodies, in turn there is also an elastic coupling, due to the spring k_2, which joins both bodies.

ISSN-2531-2189

The problem is of particular interest because because the absorber is of the rotational type, it is possible to determine many relationships between m_2 and k_2, but the form of absorber is very important, because many rotational absorbers can be established because a free parameter is the radius r of the cylinder or absorber. With the above, it is possible to have a long relative displacement between both bodies, but a small displacement of the center of mass of the absorber, the present absorber has the characteristic of being compact.

Dynamic model of the rotational absorber

In Figure 2, the diagram that identifies the variables of the movement is presented.

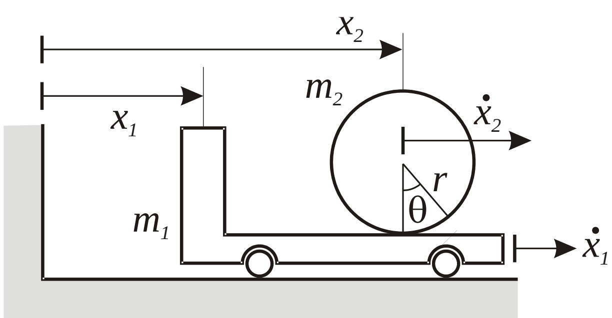


Figure 2 This Figure illustrates the position and velocity variables of the elements of the mechanical system

The displacement of the cylinder when rotating is quantified by the relation,

$$s = r\theta \tag{1}$$

On the other hand, the relative movement between both bodies is quantified with the relation,

$$s = x_2 - x_1 \tag{2}$$

so,

$$\theta = \frac{x_2 - x_1}{r} \tag{3}$$

and drifting in time, it turns out

$$\dot{\theta} = \frac{\dot{x}_2 - \dot{x}_1}{r} \tag{4}$$

The previous variables are necessary to determine the kinetic energy T of the system, that is,

$$T = \frac{1}{2}m_1\dot{x}_1^2 + \frac{1}{2}m_2\dot{x}_2^2 + \frac{1}{2}I\left(\frac{1}{2}\frac{(\dot{x}_2 - \dot{x}_1)}{r}\right)^2 \tag{5}$$

Where I represents the moment of inertia of the disk or cylinder.

The potential energy V of the system is,

$$V = \frac{1}{2}k_1x_1^2 + \frac{1}{2}k_2(x_2 - x_1)^2 \tag{6}$$

The Lagrangian L is determined by the expression, L = T - V, resulting,

$$L = \frac{1}{2}m_1\dot{x}_1^2 + \frac{1}{2}m_2\dot{x}_2^2 + \frac{1}{4}m_2(\dot{x}_2 - \dot{x}_1) - \frac{1}{2}k_1x_1^2 - \frac{1}{2}k_2(x_2 - x_1)^2 \tag{7}$$

The Euler-Lagrange equations for this system, without dissipative terms and with external excitation are,

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_1}\right) - \left(\frac{\partial L}{\partial x_1}\right) = \frac{\partial \Pi}{\partial \dot{x}_1} \tag{8}$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_2}\right) - \left(\frac{\partial L}{\partial x_2}\right) = 0 \tag{9}$$

Where,

$$\Pi = F(t)\dot{x}_1 \tag{10}$$

From this last expression the excitation term is determined,

$$\frac{\partial \Pi}{\partial \dot{x}_1} = F(t) = F\cos\omega t \tag{11}$$

By developing the partial and total derivatives of equations (8) and (9), together with expression (11), the following dynamic equations result,

$$\left(m_1 + \frac{1}{2}m_2\right)\ddot{x}_1 - \frac{1}{2}m_2\ddot{x}_1 + (k_1 + k_2)x_1 - k_2x_2 = F\cos\omega t \tag{12}$$

$$\frac{3}{2}m_2\ddot{x}_2 - \frac{1}{2}m_2\ddot{x}_1 + k_2x_2 - k_2x_1 = 0 \tag{13}$$

4Solution of the system of dynamic equations

In this section the system of dynamic equations of the primary system and its absorber is solved.

Since the system is excited by a harmonic function, the following solutions are proposed,

$$x_1 = A\cos\omega t \tag{14}$$

$$x_2 = B\cos\omega t \tag{15}$$

Where A and B correspond to the amplitudes of the oscillatory motion of the primary and secondary system, respectively.

ISSN-2531-2189

VÁZQUEZ-GONZÁLEZ, Benjamín, JIMÉNEZ-RABIELA, Homero and RAMÍREZ-CRUZ, José Luis. Design of a rotational type vibration absorber. Journal of Mechanical Engineering. 2020

The second derivatives in time of equations (14) - (15) are,

$$\ddot{x}_1 = -\omega^2 A\cos\omega t \quad (16)$$

$$\ddot{x}_2 = -\omega^2 B\cos\omega t \quad (17)$$

By substituting the equations, from (14) to (17), in equations (12) - (13), the following algebraic system of equations results,

$$\left((k_1 + k_2) - \left(m_1 + \tfrac{1}{2}m_2\right)\omega^2\right)A + \left(\tfrac{1}{2}m_2\omega^2 - k_2\right)B = F \quad (18)$$

$$\left(-\tfrac{3}{2}m_2\omega^2 + k_2\right)B + \left(\tfrac{1}{2}m_2\omega^2 - k_2\right)A = 0 \quad (19)$$

The system of equations (18) - (19) can be written in matrix form, the result is the following,

$$\begin{bmatrix} (k_1 + k_2) - \left(m_1 + \frac{1}{2}m_2\right)\omega^2 & \frac{1}{2}m_2\omega^2 - k_2 \\ \frac{1}{2}m_2\omega^2 - k_2 & -\frac{3}{2}m_2\omega^2 + k_2 \end{bmatrix}\begin{bmatrix} A \\ B \end{bmatrix} = \begin{bmatrix} F \\ 0 \end{bmatrix} \quad (20)$$

Although the system of equations is simple, the solutions are extensive and the information content is useful in designing the absorber.

The solution of the system of equations (20) is as follows,

$$A = \frac{(3m_2\omega^2 - 2k_2)F}{\Delta} \quad (21)$$

$$B = \frac{(m_2\omega^2 - 2k_2)F}{\Delta} \quad (22)$$

Where

$$\Delta = (3m_1m_2 + m_2^2)\omega^4 - (3k_1m_2 + 2k_2m_1 + 2k_2m_1)\omega^2 + 2k_1k_2 \quad (23)$$

Vibration absorber design

The design of the absorber is carried out from equation (21), since it is intended that the amplitude is as low as possible, the dynamic parameters of the absorber can be chosen for this purpose. The design in this way is done by imposing the following condition,

$$A = \frac{(3m_2\omega^2 - 2k_2)F}{\Delta} = 0 \quad (24)$$

Where does it come from,

$$3m_2\omega^2 - 2k_2 = 0 \quad (25)$$

Since F≠0 and ω is a known parameter, which corresponds to the frequency of the movement that is printed on the primary system.

In this way, we have the following expression,

$$m_2 = \frac{2k_2}{3\omega^2} \quad (26)$$

This will reduce the amplitude of the primary system for the mass m2 previously determined, and for the excitation frequency ω with any arbitrarily proposed value of k2.

Expression (26) defines the tuning parameters between the primary system and its absorber.

As mentioned in the introduction of this work, the tuning parameter corresponds to the speed of movement of both bodies, so knowing the value of this parameter, it will be allowed that before an action on the primary system, the movement of the absorber compensates said action with its own movement, reducing the action on the primary, resulting in a decrease in the amplitude of its movement.

Equations in state space

The system of dynamic equations (12) - (13) can be written in the state space according to the following change of variables,

$$\dot{x}_1 = \dot{y}_1, \dot{y}_1 = y_2, \dot{x}_2 = \dot{y}_3, \dot{y}_3 = y_4$$

$$\begin{bmatrix} \dot{y}_1 \\ \dot{y}_2 \\ \dot{y}_3 \\ \dot{y}_4 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ -\frac{3k_1 + 2k_2}{a} & 0 & \frac{2k_2}{a} & 0 \\ 0 & 0 & 0 & 1 \\ \frac{2k_2m_1 - k_1m_2}{b} & 0 & -\frac{2k_2m_1}{b} & 0 \end{bmatrix}\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{3F\cos\omega t}{a} \\ 0 \\ \frac{F\cos\omega t}{a} \end{bmatrix} \quad (27)$$

Where, $a = 3m_1+m_2$ y $b = 3m_1m_2+m^2_2$

This way of expressing the dynamic system of equations, allows to carry out numerical simulations to determine the responses in time, both of the primary system and its absorber.

ISSN-2531-2189

Results in numerical simulations

This section presents the results of the experiments in numerical simulation of the vibratory mechanical system. Two cases can be distinguished. The first corresponds to the performance of the vibratory system under general conditions, that is, without determining the parameters of the absorber or tuning. Numerical simulations were performed using the Runge-Kutta-Fehlberg 2/3 method, according to Vázquez et al.

To illustrate the above, consider the following numerical values,

m_1= 1.5 kg	m_2= 0.3 kg	k_1 = 200 N/m
k_2 = 1000 N/m	F = 6 N	ω = 10 rad/s

Table 1 General parameters of the vibratory mechanical system

The results are described in the following figures.

In Figure 3, the development in time of the primary system is shown, after a certain time, an approximate permanent amplitude of x1 = 0.3064 m is reached, for the data in Table 1.

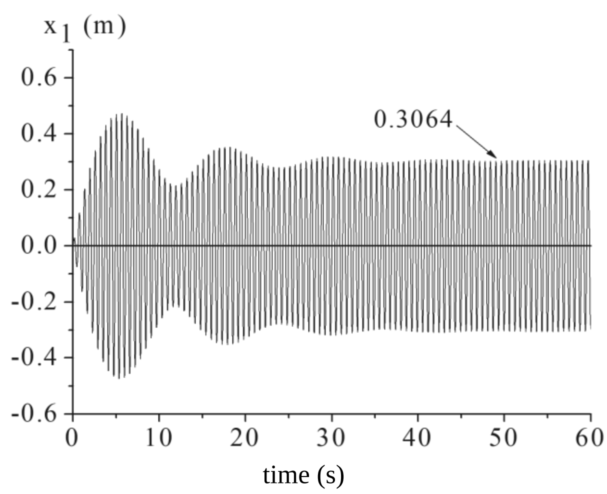


Figure 3 Response in time of the primary system for the data in Table 1, an approximate value of x1 = 0.3064 m is reached

Figure 4 shows the performance over time of the secondary system for the parameters of Table 1, in which the tuning condition is not considered.

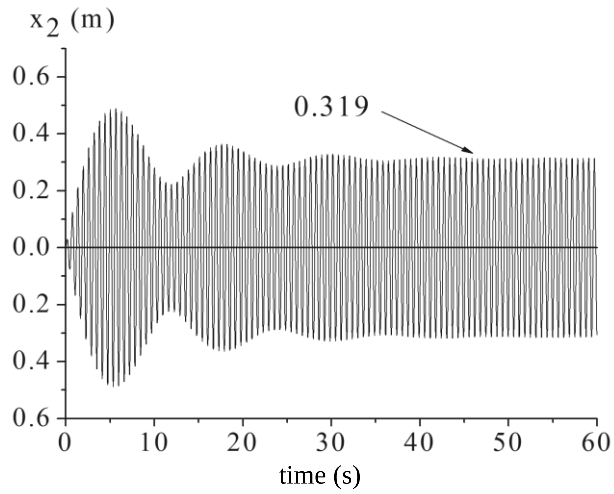


Figure 4 Absorber time response for the data in Table 1, an approximate value of x2 = 0.319 m is reached

In this case, it is observed that a sample of the amplitude reaches a value x2 = 0.319 m.

The previous simulations are presented to observe the performance of the system as a whole, each subsystem reaches particular values, however, the tuning condition defines minimum values of the primary system.

Note the proportion of the displacements in relation to the magnitude of the applied force.

The evaluation of the amplitudes using the solutions (21) - (22) for the numerical values of Table 1, reports the following values: A = -0.31484 m and B = -0.32473 m, which are consistent with the results in simulation.

Now the tuning condition defined by equation (26) is considered, that is, the calculation of m2 is performed, for the excitation frequency □ and preserving the value of k2, in order to preserve the values of the initial parameters, without However, there is the possibility to propose some other value arbitrarily.

The results are shown in the following Table.

m_1= 1.5 kg	m_2= 6.6667 kg	k_1 = 200 N/m
k_2 = 1000 N/m	F = 6 N	ω = 10 rad/s

Table 2 Design parameters of vibration absorber

ISSN-2531-2189

Figure 5 shows the performance over time of the primary system for the values in Table 2, it is observed that in a period, the amplitude decreases continuously, an arbitrary measurement reports a value of x1 = 0.0017 m, which represents a significant reduction in relation to the previous general case.

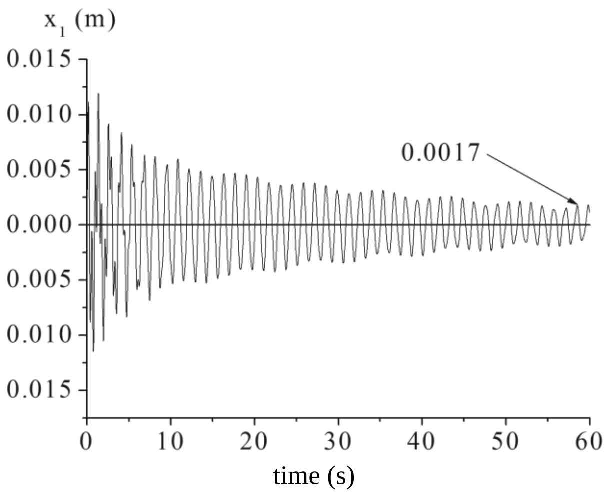


Figure 5 Response in time of the primary system for the data in Table 2, an approximate value of x1 = 0.0017 m is reached

Figure 6 shows the development in time of the absorber for the values in Table 2, the amplitude of its movement is also much smaller in relation to the general case, however, the value of the mass is quite high in relation with the mass in Table 1, but it must be considered that it was decided to conserve the value of the spring constant k2. This means that you have the freedom to also modify the value of said elastic parameter, which can lead to obtaining smaller values of the absorber mass.

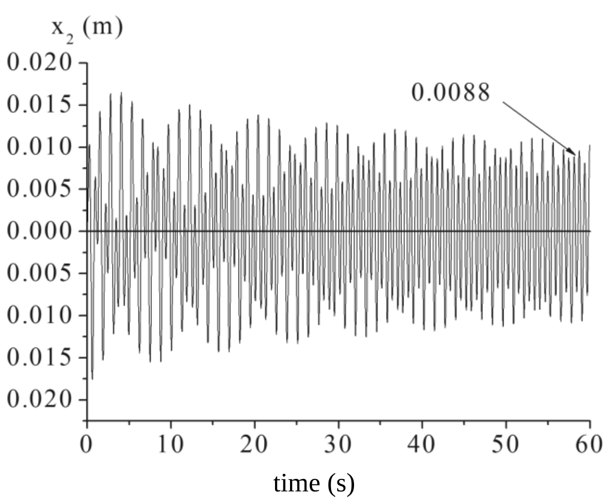


Figure 6 Absorber time response for the data in Table 2, an approximate value of x2 = 0.0088 m is reached

Again, using the expressions that allow determining the amplitude (21) - (22), the following results are obtained for the values of Table 2, A = -6.7500 × 10^{-8}, and B = 0.0089999 m.

The simulation results are also consistent with the expected values in the case of the absorber, however, it is important to note that, from the algebraic point of view, the amplitude of the primary system should be strictly A = 0, which does not result, as an effect of numerical calculation.

In each case, the negative sign refers to the direction of movement, the significant value being the magnitude.

It is convenient to make a precision between secondary system and absorber, the absorber is defined when the secondary system is determined with the parameters defined by the tuning condition (26) and presented in Table 2.

The previous results allow us to observe the decrease in the amplitude of the movement of the primary system, note that the body does not stop, it develops an oscillatory movement of very low amplitude, in turn, the amplitude of the oscillation of the secondary system is also low in relation with the overall performance, in this way it can be confirmed that the rotational absorber has fulfilled its function.

Note also that the envelope of the graph of Figure 5 is like the behavior of the damped movement, considering that the present system is undamped, in the sense of the way in which over time, the amplitude of the movement it is reducing.

Acknowledgments

The authors are grateful for the institutional support of the Universidad Autónoma Metropolitana and the Azcapotzalco Unit, in particular the Division of Basic Sciences and Engineering and the Department of Energy.

Conclusions

In this work the parameters of a rotational vibration absorber have been determined. The rotational vibration absorber has the characteristic of being compact because the absorption movement is developed by direct contact in the main system and its primary system. Compared to the general performance, the vibration absorption is significant, a high value of the absorber mass produces a considerable reduction in the amplitude of the primary system, because the mechanical energy to maintain the movement of the absorber is also high. From the tuning condition it is possible to arbitrarily propose parameters that allow the flow of mechanical energy efficiently. The rotational vibration absorber still has the advantage of being able to establish the dimension of the absorber, because it is possible to obtain a small body of great mass.

References

Harik R. F, Issa J. S. (2015) Design of a vibration absorber for harmonically forced damped systems, Journal of Vibration and Control, 21(9). 1810-1820.

Mehmet Bulent Ozer, Thomas J. Royston. (2005) Extending Den Hartog's Vibration Absorber Technique to Multi-Degree-of-Freedom Systems. Journal of Vibration and Acoustics, 127(4), 341-350.

Robert E. Robertson. (1952) Synthesis of a nonlinear dynamic vibration absorber. Journal of the Franklin Institute 254 (3), 205 - 220.

Shyh-Chin Huang, Kao-An Lin. (2014) A New Design of Vibration Absorber for Periodic Excitation Shock and Vibration - Hindawi Publishing Corporation, 2014, 1 - 11.

Vázquez González Benjamín, Jiménez Rabiela Homero, Ramírez Cruz José Luis, Bravo Acosta Adrian Gustavo. (2019) Algunos errores numéricos en la respuesta del estado estable de sistemas mecánicos vibratorios, Revista de Ingeniería Mecánica, ECORFAN-Spain, 3 (12), 1 – 9.

W. J. Carter, F. C. Liu. (1961) Steady-State Behavior of Nonlinear Dynamic Vibration Absorber. Journal of Applied, Mechanics, March 1961, 67 - 70.

Article **Journal of Mechanical Engineering**
June 2020 Vol.4 No.13 23-31

Analysis of drag and lift forces for a sedan car using a rear lip spoiler

Análisis de fuerzas de arrastre y sustentación para un auto sedan usando alerón trasero tipo labio

HORTELANO-CAPETILLO, Juan Gregorio†*, MARTÍNEZ-VÁZQUEZ, J. Merced, ZUÑIGA-CERROBLANCO, José Luis and RODRIGUEZ-ORTIZ, Gabriel

Universidad Politécnica de Juventino Rosas, Mexico.

ID 1st Author: *Juan Gregorio, Hortelano-Capetillo /* **ORC ID:** 0000-0002-3702-4853, **CVU CONACYT ID:** 347496

ID 1st Co-author: *J. Merced, Martínez-Vázquez* / **ORC ID:** 0000-0002-6230-3846, **CVU CONACYT ID:** 93450

ID 2nd Co-author: *José Luis, Zúñiga-Cerroblanco* / **ORC ID:** 0000-0003-0493-8197, **CVU CONACYT ID:** 208410

ID 3rd Co-author: *Gabriel, Rodriguez-Ortiz /* **ORC ID:** 0000-0002-3615-1973, **CVU CONACYT ID:** 48565

DOI: 10.35429/JME.2020.13.4.23.31 Received January 25, 2020; Accepted June 30, 2020

Abstract

In this research, aerodynamic tests were carried out using Solidworks Flow Simulation software on a Sedan-type car, implementing different sizes of lip-type spoilers at the rear to obtain the results of the drag and lift coefficients produced by movement. of the air regardless of the design at the rear of the car and analyze if there was improvement in aerodynamics. Analyzing the results, it is obtained that the aerodynamics of the car is improved when a lip-type spoiler is fitted, the lift forces were reduced, whereas the drag forces remained constant for all the different designs.

Drag coefficient, Lift coefficient, Aerodynamics

Resumen

En esta investigación se realizaron pruebas aerodinámicas mediante el uso del software Solidworks Flow Simulation en un automóvil tipo Sedan, implementando diferentes tamaños de aleron tipo labio en la parte trasera para obtener los resultados de los coeficientes de arrastre y de sustentación que se producen mediante el movimiento del aire independientemente del diseño en la parte trasera del auto y analizar si hubo mejora en la aerodinámica. Analizando los resultados se obtiene que se mejora la aerodinámica del automóvil cuando se le pone un alerón tipo labio, se redujo las fuerzas de sustentación, en cambio las fuerzas de arrastre se mantuvieron constante para todos los diferentes diceños.

Coeficiente de arrastre, Coeficiente de sustentación, Aerodinámica

Citation: HORTELANO-CAPETILLO, Juan Gregorio, MARTÍNEZ-VÁZQUEZ, J. Merced, ZUÑIGA-CERROBLANCO, José Luis and RODRIGUEZ-ORTIZ, Gabriel. Analysis of drag and lift forces for a sedan car using a rear lip spoiler. Journal of Mechanical Engineering. 2020. 4-13:23-31.

* Correspondence to the Author (Email: jhortelano_ptc@upjr.edu.mx)
† Researcher contributing as first author.

Introduction

The ailerons have different configurations and sizes, in some cases they are already assembled from the factory. When the car is in motion, it creates a flow of air that surrounds the body and is usually trapped at the bottom, which creates an upward pressure in the front, reducing the forces on the tires against the ground. To solve this aerodynamic problem is to relieve the pressure by implementing the ailerons at the rear, in this way, the flow of air passes under the wing that will have a speed greater than the air that passes over it creating a downward force called lift. There are 2 methods to perform the aerodynamic tests and obtain the drag and lift forces:

- Wind tunnel.

- CFD (Computational Fluid Dynamics) techniques.

Using a wind tunnel, it simulates in a real way the air currents that are generated at different speeds against the vehicle that remains static. On some occasions smoke is used to be able to observe turbulence clearly. Using the method in CFD is the use of computers as tools to solve the equations of fluid dynamics, having the advantage of being able to see the current lines, vortices, pressure fields around the vehicle, etc.

In automotive aerodynamics, its main objective is to decrease drag and lift coefficients for fuel economy, this phenomenon allows the car conditions to be faster using the same power. Howell et al [1] and Okada et al [2] took the dynamic movement of the vehicle into account to consider stability problems, whereas Aschwanden et al [3] carried out the measurements in a wind tunnel. Studies on car designs to improve aerodynamics have been advancing all the time, because aerodynamic performance is directly related to fuel consumption and environmental impact.

Scale experiments carried out in a wind tunnel are the most common methods for investigating the aerodynamics of vehicles [3, 4, 5, 6, 7, 8]. Some researchers implemented some devices such as spoilers, ailerons or fins; to improve aerodynamics [9, 10, 11, 12, 13], other authors investigated the impact on the deflectors horizontally [14, 10].

Some studies carried out to improve aerodynamics are in the rear diffuser, located under the bodywork modifying the angles and the shape of the spacers to affect the flow formed by the air speed [15, 16, 17]. Some researchers Gilhauset al. [18], J. R. Callister et al. [19], F. R. Bailey et al. [20], H. Taeyoung et al. [21], S. Y. Cheng et al. [22], S. M. Rakibul Hassan [23], Rubel et al. [24], D. E. Aljure et al. [25], Krzysztof Kurec et al. [26], Vignesh S. et al. [27], Mario et al. [28], Emil Ljungskog et al. [29], among others, used CFD techniques to obtain numerical results of the cars by making modifications to the design.

Mathematical and numerical model

In this work, several tests were carried out in CFD to reproduce the aerodynamic behavior for the different models with the implementation of a spoiler. Figure 1 shows the steps to solve a problem using CFD.

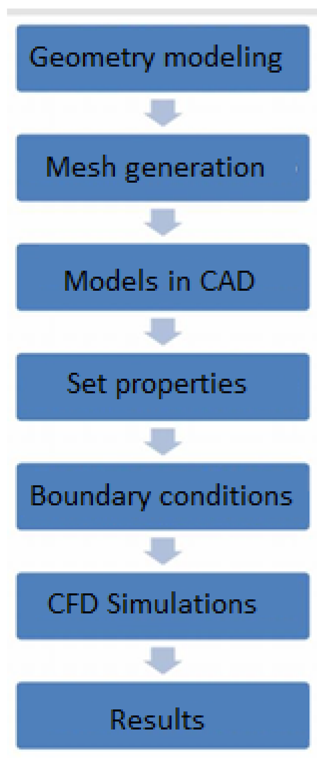


Figure 1 Steps for simulation in CFD
Source: Self-made

A sedan car was designed without any implement in Solidworks, as shown in Figure 2, the dimensions are 4.63 m long, 1.74 m wide and 1.36 m high, giving a frontal area of 2.36 m^2.

ISSN-2531-2189

Journal of Mechanical Engineering
June 2020 Vol.4 No.13 23-31

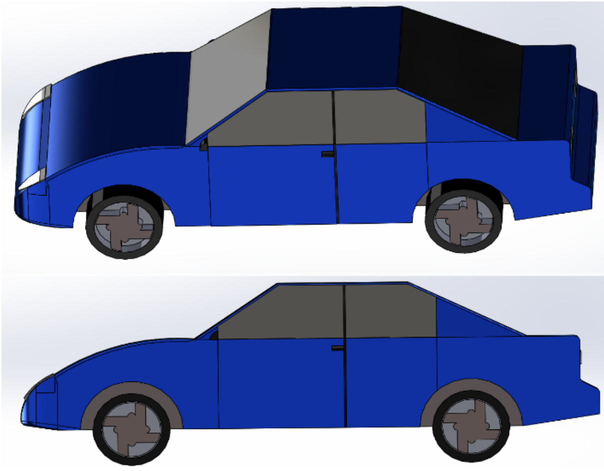


Figure 2 Normal Design
Source: Own elaboration in Solidworks

Figure 3 shows an example of the lip-type spoiler placed at the rear of the car to improve aerodynamics by reducing drag and lift forces.

Figure 3 Design of a lip type spoiler
Source: Own elaboration in Solidworks

6 different models of lip-type spoilers were designed for the rear of the car, in order to improve the aerodynamics of the Sedan car. Figure 4 shows the dimensions of the spoilers that were placed at the rear.

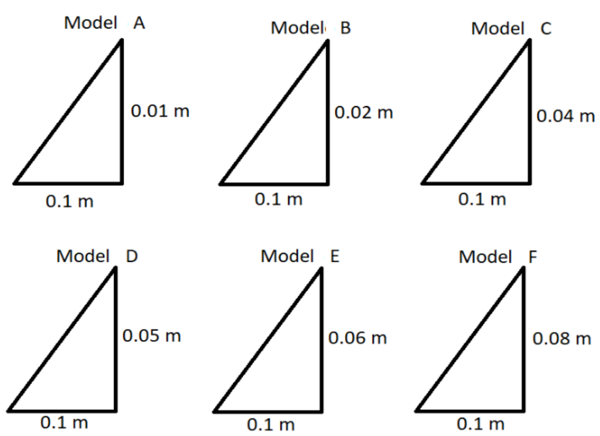


Figure 4 Lip type aileron dimensions
Source: Own elaboration in Solidworks

Figure 5 shows the design of Model A with the dimensions of the base of 0.1 m and height 0.01 m.

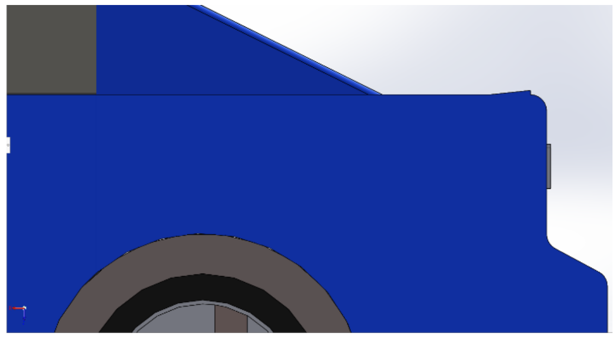


Figure 5 Lip type spoiler Model A design
Source: Own elaboration in Solidworks

Figure 6 shows the design of Model B with the dimensions of the base of 0.1 m and height 0.02 m.

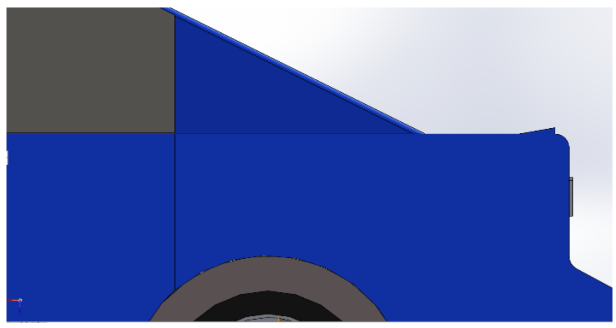


Figure 6 Lip type spoiler Model B design
Source: Own elaboration in Solidworks

Figure 7 shows the design of Model C with the dimensions of the base of 0.1 m and height 0.04 m.

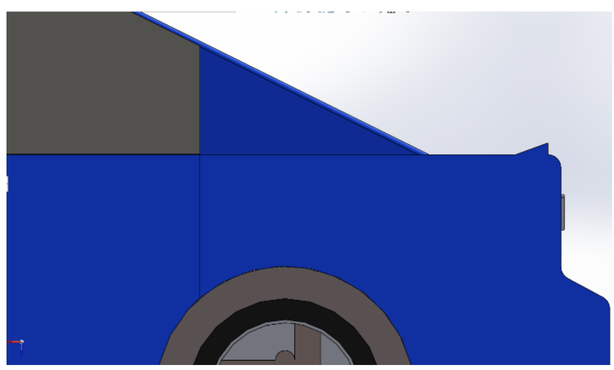


Figure 7 Lip-type spoiler Model C design
Source: Own elaboration in Solidworks

Figure 8 shows the design of Model D with the dimensions of the base of 0.1 m and height 0.05 m.

ISSN-2531-2189

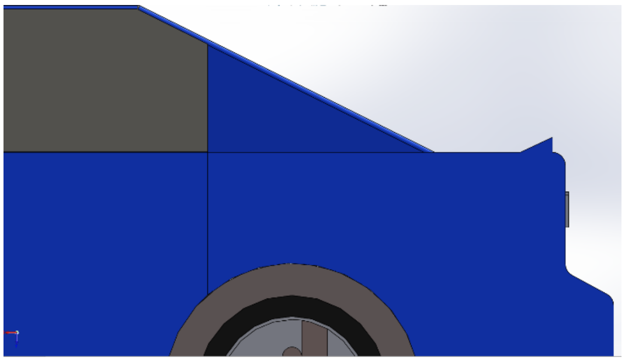


Figure 8 Lip type spoiler Model D design
Source: Own elaboration in Solidworks

Figure 9 shows the design of Model E with the dimensions of the base of 0.1 m and height 0.06 m.

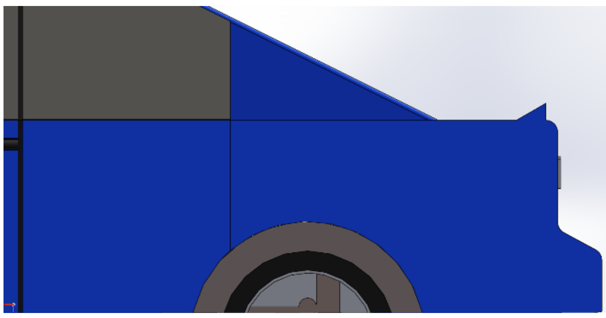


Figure 9 Lip type spoiler Model E design
Source: Own elaboration in Solidworks

Figure 10 shows the design of Model F with the dimensions of the base of 0.1 m and height 0.08 m.

The CFD software in Solidworks has the techniques of numerical solution for finite elements using a mesh in the geometry in the fluid region. While the mesh is finer, more computing capacity is required.

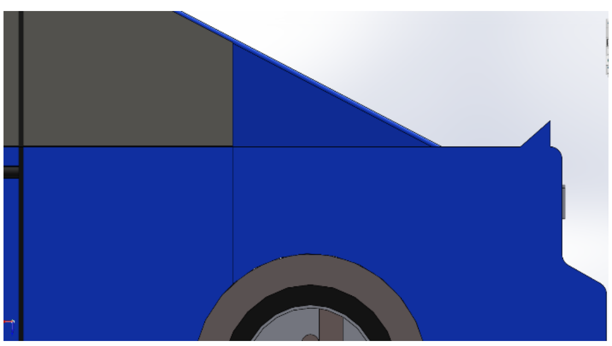


Figure 10 Lip type spoiler Model F design
Source: Own elaboration in Solidworks

For this case study, a volumetric mesh is used that is formed using hexahedral cells as shown in Figure 11 in a control volume, it is generally used for external aerodynamics due to its ability to correctly define the area where the wake is formed due to the separation of the boundary layer returning to the turbulent fluid.

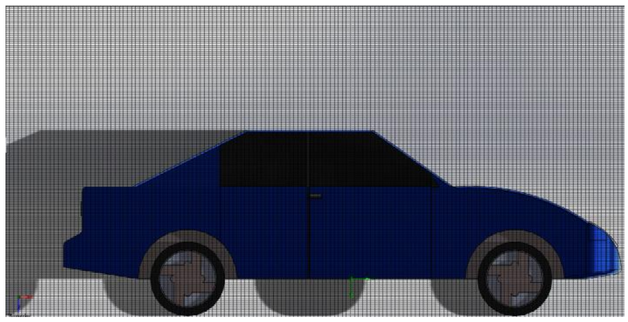


Figure 11 Control volume with 5744807 cells in the mesh
Source: Own elaboration in Solidwork

The aerodynamic study that presents the flow developed around the vehicle requires a mathematical presentation, which in turn is transformed into an algorithm for its solution. This mathematical presentation is summarized in a set of conservation equations for mass, momentum, and the k-ε turbulence model.

The continuity equation is represented by [30]:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \qquad (1)$$

The Navier Stokes equations are expressed as follows [30]:

$$\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right) = \rho g_x - \frac{\partial P}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right) \qquad (2)$$

$$\rho\left(\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z}\right) = \rho g_y - \frac{\partial P}{\partial y} + \mu\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2}\right) \qquad (3)$$

$$\rho\left(\frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + v\frac{\partial w}{\partial y} + w\frac{\partial w}{\partial z}\right) = \rho g_z - \frac{\partial P}{\partial z} + \mu\left(\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2}\right) \qquad (4)$$

For turbulent flows, the Standard k-modelo [31] model applies:

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_i}(\rho k u_i) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_k}\right)\frac{\partial k}{\partial x_j}\right] + G_k + G_b - \rho\varepsilon - Y_m + S_k \qquad (5)$$

$$\frac{\partial}{\partial t}(\rho\varepsilon) + \frac{\partial}{\partial x_i}(\rho\varepsilon u_i) = \frac{\partial}{\partial x_j}\left[\left(\mu + \frac{\mu_t}{\sigma_\varepsilon}\right)\frac{\partial \varepsilon}{\partial x_j}\right] + C_{1\varepsilon}\frac{\varepsilon}{k}(G_k + C_{3\varepsilon}G_b) - C_{2\varepsilon}\rho\frac{\varepsilon^2}{k} + S_\varepsilon$$

In these equations, Gk represents the generation of turbulent kinetic energy due to average velocity gradients. Gb is turbulent kinetic energy generation due to buoyancy. Ym represents the contribution of fluctuating dilation in compressible turbulence at all dissipation rates. C1ε, C2ε and C3ε are constants. Σε and σε are the turbulent Prantl numbers for k and ε respectively. Sk and Sε are user-defined source terms. The turbulent viscosity μt is calculated as follows:

$$\mu_t = \rho C_\mu \frac{k^2}{\varepsilon} \quad (6)$$

The parameters of thesome constants are:

$C_{1\varepsilon}$=1.44, $C_{2\varepsilon}$=1.92, C_μ=0.09, σ_k=1.0, σ_ε=1.3

To calculate the drag coefficient, equation (7) is used, where Fx is the drag force (N), ρ is the air density (kg/m^3), v is the air speed (m / s) and A is the frontal area of the car [30], for this study the area is 4.63 m^2.

$$Cd = \frac{Fx}{(1/2)\rho v^2 A} \quad (7)$$

The lift force as perceived from its inception is normal to the ground. Unlike the drag force which has the opposite direction to the direction of the vehicle. Equation (8) shows the calculation of the lift force, where Fy is the lift force:

$$Cl = \frac{Fy}{(1/2)\rho v^2 A} \quad (8)$$

For the analysis of this work, air is used at a speed of 125 km/h at different mesh numbers (495989, 2050308, 2971043, 3840774 and 5744807), the air density is 1.2 kg/m^3 and the viscosity is 1.8x10 -5 Pa.s. With the results of the simulations, it is intended to know the drag and lift forces, then calculate the coefficients to know the best aerodynamic model with the spoiler implemented at the rear that reduces these forces compared to normal models.

Results

The results obtained through the simulations carried out in Solidworks Flow Simulation at different types of meshing (a coarse mesh to a fine mesh) were the drag and lift forces.

Figure 12 shows the drag force results of all the lip-type aileron models proposed to improve aerodynamics. Making a comparison with the finest mesh of 5744807 cells, the normal car registered a force of 560.13 N and the model F registered 579.8 N. When the height increases in each model of the lip type aileron, the Drag Force increases.

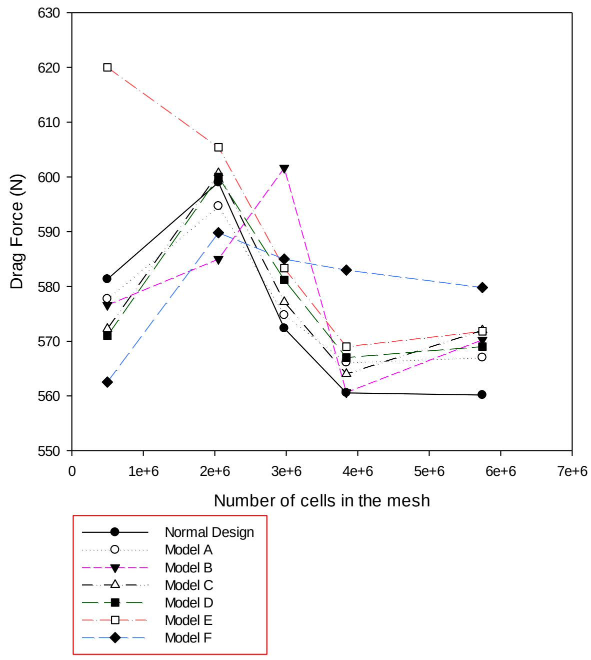


Figure 12 Drag Forces Results with a mesh refinement at 125 km/h
Source: Self made

Figure 13 shows the lift forces for each model. Comparing the results with the mesh of 5744807, the normal model registered a force of 407.34 N and the model F of 226 N. It is observed that the lift forces decrease as the height in the aileron increases.

With the results obtained from the drag and lift forces through the simulations, the drag and lift coefficients were calculated with a mesh of 5744807 cells. Figure 14 and Table 1 show the results and the percentages of the drag coefficients for all the models. Comparing the results of the coefficients and the percentages the difference is minimal, with the implementation of the ailerons the drag coefficients increase in a range of 1,222-3,598%.

ISSN-2531-2189

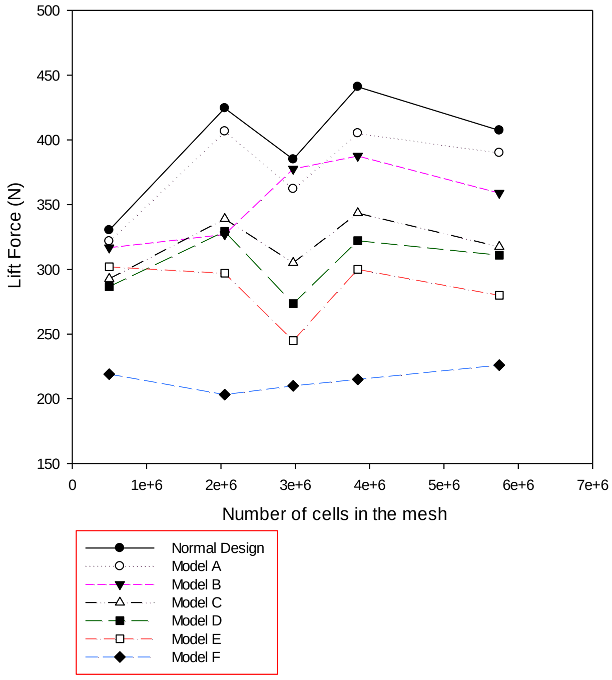


Figure 13 Results of the Support Forces with a mesh refinement at 125 km/h
Source: Self-made

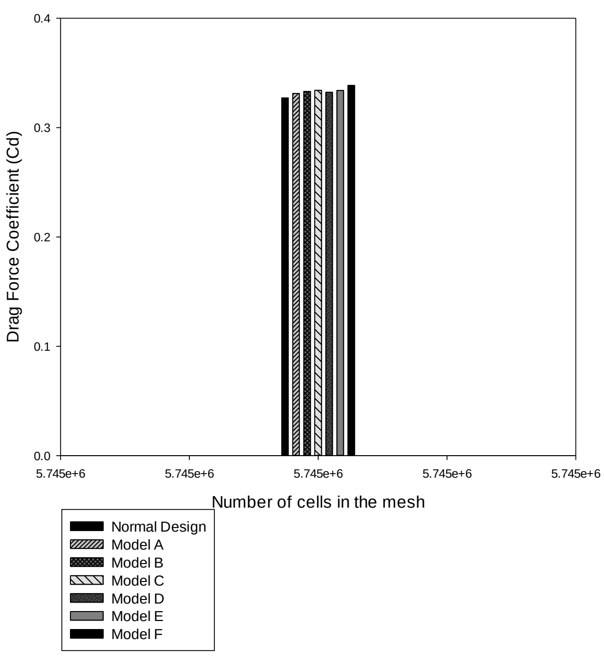


Figure 14 Results of the Drag Coefficients with 5744807 cells in the mesh at 125 km/h
Source: Self-made

Meshed	Normal Car	Model TO	Model B	Model C	Model D	Model E	Model F
	Drag Coefficient						
5744807	0.327	0.331	0.333	0.334	0.332	0.332	0.338
% Increase		1.222	1.803	2.115	1.579	2.079	3.598

Table 1 Results of the reduction percentages of the drag coefficients
Source: Self-made

Figure 15 and Table 2 show the results of the lift coefficients with a mesh of 5744807 cells. It is observed that the coefficients of the models decrease as the height of the aileron increases. With the F model it is possible to reduce the lift coefficient up to 44.52%. The normal car registered a value of 0.238 and it was reduced to 0.132.

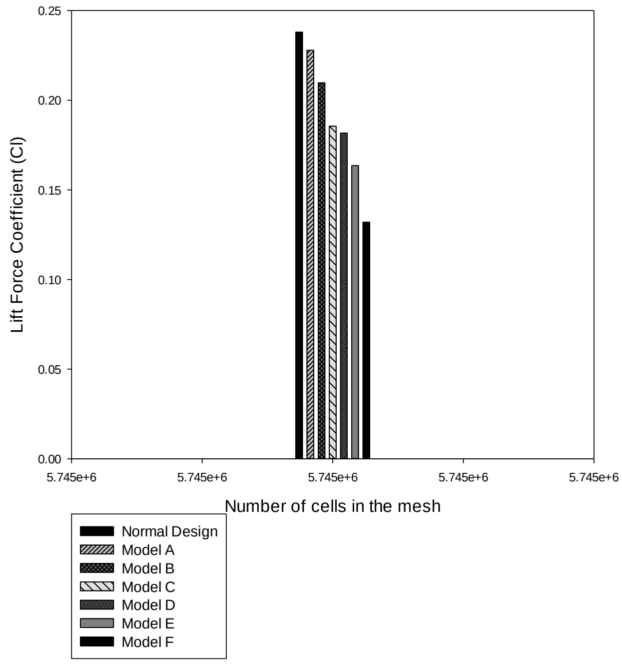


Figure 15 Results of the Support Coefficients with 5744807 cells in the mesh at 125 km/h
Source: Self-made

Meshed	Normal Car	Model TO	Model B	Model C	Model D	Model E	Model F
	Coefficient of Support						
5744807	0.238	0.228	0.21	0.185	0.181	0.163	0.132
% Reduction		4.25	11.86	22.05	23.65	31.26	44.52

Table 2 Percentages of reduction of lift coefficients
Source: Self-made

Figures 14, 15, 16, 17, 18 and 19 show the speed contours for the proposed models of lip-type ailerons implemented in the rear simulated at the speed of 125 km / h. The formation of wakes formed by vortices at low speeds is observed that cause the pressure to decrease and the detachment of the turbulent boundary layer takes place at a farther distance, therefore this effect causes the lift forces to decrease.

ISSN-2531-2189

Figure 14 Results of the velocity contours of Model A with 5744807 cells in the mesh
Source: Own elaboration in Solidworks

Figure 15 Results of the velocity contours of Model B with 5744807 cells in the mesh
Source: Own elaboration in Solidworks

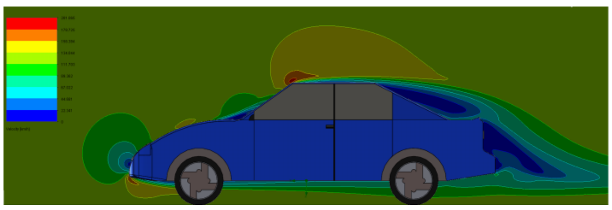


Figure 16 Results of the velocity contours of Model C with 5744807 cells in the mesh
Source: Own elaboration in Solidworks

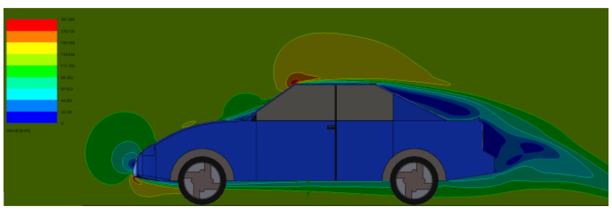


Figure 17 Results of the velocity contours of Model D with 5744807 cells in the mesh
Source: Own elaboration in Solidworks

Figure 18 Results of the velocity contours of Model E with 5744807 cells in the mesh
Source: Own elaboration in Solidworks

Figure 19 Results of the velocity contours of Model F with 5744807 cells in the mesh
Source: Own elaboration in Solidworks

Conclusions

By implementing the different models of ailerons at the rear of the car, it is possible to reduce the lift coefficient up to 44.5% with the F model (0.1 m base with 0.08 m height), with the same model F the drag coefficient increases. up to 3.5% which is not highly recommended to increase this force. Using a spoiler attachment on a normal car improves aerodynamics and provides greater stability when cornering or on a normal path on the road. Therefore, these coefficients are affected by the design and dimensions of the car.

On the part of the computer equipment, while the mesh is finer, the longer it will take to solve the simulation and the results will be more exact to reality depending on the characteristics of the computer.

References

[1] Howell J., Le Good G., 1999. *The influence of aerodynamic lift on high-speed stability*. SAE paper No. 1999-01-0651.

[2] Okada Y., Nouzawa T., Nakamura T., Okamoto S., 2009. *Flow structure above the trunk deck of Sedan-Type vehicles and their influence on high-speed vehicle stability first report: On-road and wind tunnel studies on unsteady flow characteristics that stabilize vehicle behavior*. SAE paper No. 2009-01-0004.

[3] Coleman S. A; Baker C. J; 1990. *High sided road vehicles in cross wind*. Journal Wind Engineering Industrial Aerodynamic. 36, 1383-1392.

[4] Coleman S. A; Baker C. J; 1994. *An experimental study of the aerodynamic behavior of high sided lorries in cross wind*. Journal Wind Engineering Industrial Aerodynamic.53, 401-429.

[5] Baker J. C; 1991. *Ground vehicles in high cross wind. 1. Steady aerodynamic forces*. Journal Fluids Structure. 5, 69-90.

[6] Baker J. C; 1991. *Ground vehicles in high cross wind. 2. Steady aerodynamic forces*. Journal Fluids Structure. 5, 91-111.

[7] Quinn A. D; Sterling M; Robertson A. P; Baker J. C; 2007. *An investigation of the wind induced rolling moment on a commercial vehicle in the atmospheric boundary layer.* Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering. 221, 1367-1379.

[8] Cheli F; Corradi R; Sabbioni E; Tomasini G; 2011. *Wind tunnel test on heavy road vehicles: cross wind induced loads Part 1.* Wind Engineering Industrial Aerodynamic. 99, 1000-1010.

[9] Beaudoin J. F; Aider J. L; 2008. *Drag and lift reduction of a 3D bluff body using flaps.* Experiment in Fluids. 44 (4), 491.

[10] Fourrié G; Keirsbulk L; Labraga L; Gilliéron P; 2011. *Bluff body drag reduction using a deflector.* Experiment in Fluids. 50 (2), 385-395.

[11] Hanfeng W; Yu Z; Chao Z; Xuhui H; 2016. *Aerodynamic drag reduction of an Ahmed body based on deflectors.* Journals Wind Engineering Industrial Aerodynamic. 148, 34-44.

[12] Grandemage M; Mary A; Gohlke M; Cadot O; 2013. *Effect on drag of the flow orientation at the base separation of a simplified blunt road vehicle.* Experiment in Fluids. 54 (5), 1529.

[13] Urquhart M; Sebben S; Sterken L; 2018. *Numerical analysis of a vehicle wakes with tapered rear extensions under yaw conditions.* Journal Wind Engineering Aerodynamic. 179, 308-318.

[14] Littlewood R. P; Passmore M; 2010. *The optimization of roof trailing edge geometry of a simple square back.* (No. 2010-01-0510) (SAE Technical Paper).

[15] J. P. Howell. *The influence of ground simulation on aerodynamic of simple car shapes with an underfloor diffuser.* Conference on vehicle aerodynamics. Royal Aerodynamic Society. 1994.

[16] Cooper K. R; Bertenyi T; Dutil G; Syms J; Sovran G. 1998. *The aerodynamics performance of automobile underbody diffuser.* SAE Technical Paper 980030.

[17] Xingjun Hu; Rui Zhang; Jian Ye; Xu Yan; Zhiming Zhao; 2011. *Influence of different diffuser angle on sedan aerodynamic characteristics.* Physics Procedia. 22. 239-245.

[18] Gilhaus, R. Hoffmann. *"Directional Stability, Aerodynamic od Road Vehicles, in: W.H. Hucho (Ed), SAE International, Warrendale. PA, 1998.*

[19] J.R. Callister, A.R. George, *Wind Noise, Aerodynamics of Road Vehicles,* in: W.H. Hucho (Ed.), SAE International, Warrendale, PA, 1998.

[20] F.R. Bailey, H.D. Simon, *Future Directions in Computing and CFD,* AIAA Paper 92-2734, 1992.

[21] H. Taeyoung, V. Sumantran, C. Harris, T. Kuzmanov, M. Huebler, T. Zak, *Flow-field simulations of three simplified vehicle shapes and comparisons with experimental measurements,* SAE Transactions 106 (1996) 820835.

[22] S. Y. Cheng; M. Tsubokura; Y. Okada; T. Nouzawa; T. Nakashima; D. H. Doh; 2013. *Aerodynamic stability of road vehicles in dynamic pitching motion.* Journal Wind Engineering and Industrial Aerodynamics. 122 (2014), 146-156.

[23] S. M. Rakibul Hassan, Toukir Islam, Mohammad Ali, Md. Quamrul Islam. "*Numerical Study on Aerodynamic Drag Reduction of Racing Cars*". Procedia Engineering 90 (2014) 308-313.

[24] Rubel Chandra Das, Mahmud Riyad, *"CFD Analysis of Passenger Vehicleat Various Angle of Rear End Spoiler".* Procedia Engineering 194 (2017) 160-165.

[25] D. E. Aljure; J. Calafell; A. Baez; A. Oliva; 2018. *Flow over a realistic car model: Wall modeled large eddy simulations assessment and unsteady effects.* Journal Wind Engineering Industrial Aerodynamics. 174 (2018), 225-240.

[26] Krzysztof Kurec, Michal Remer, Tobiasz Mayer, Sylwester Tudruj, Janusz Piechna. "*Flow control for a car-mounted rear wing"*. International journal of Mechanical Sciences. Volume 152 (2019) 384-399.

[27] Vignesh S; Vikas Shridhar Gangad; Jishnu V; Maheswarreddy; Amal Krishna; Yagna S. Mukkamala; 2019. *Windscreen angle and hood inclination optimization for drag reduction in cars.* Procedia Manufacturing. 30 (2019), 685-692.

[28] Mario Rüttgers; Junshin Park; Donghyun You; 2019. *Large-eddy simulation of turbulent flow over the DrivAer fastback vehicle model.* Journal Wind Engineering Industrial Aerodynamics. 186 (2019), 123-138.

[29] Emil Ljungskog; Simone Sebben; Alexander Broniewicz; 2020. *Inclusion of the physical wind tunnel in vehicle CFD simulations for improved prediction quality.* Journal Wind Engineering Industrial Aerodynamics. 197 (2020), 104055.

[30] Introduction to Fluid Mechanics, Sixth Edition, (2003). Robert W. Fox, Alan T. MacDonald, Philip J. Pritchard.

[31] V. Yakhot and L. M. Smith. *The renormalization group, the ε-expansion and derivation of turbulence models.* Journal of Scientific Computing, Vol. 7, no. 1, pp. 35-61, 1992.

[[Title in Times New Roman and Bold No. 14 in English and Spanish]

Surname (IN UPPERCASE), Name 1st Author†*, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor

Institutional Affiliation of Author including Dependency (No.10 Times New Roman and Italic)

International Identification of Science - Technology and Innovation

ID 1st Author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1st author: (Scholar-PNPC or SNI-CONACYT) (No.10 Times New Roman)

ID 1st Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1st coauthor: (Scholar or SNI) (No.10 Times New Roman)

ID 2nd Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 2nd coauthor: (Scholar or SNI) (No.10 Times New Roman)

ID 3rd Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 3rd coauthor: (Scholar or SNI) (No.10 Times New Roman)

(Report Submission Date: Month, Day, and Year); Accepted (Insert date of Acceptance: Use Only ECORFAN)

Abstract (In English, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In English)

Indicate 3 keywords in Times New Roman and Bold No. 10

Abstract (In Spanish, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In Spanish)

Indicate 3 keywords in Times New Roman and Bold No. 10

Citation: Surname (IN UPPERCASE), Name 1st Author, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor. Paper Title. Journal of Mechanical Engineering. Year 1-1: 1-11 [Times New Roman No.10]

---

* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

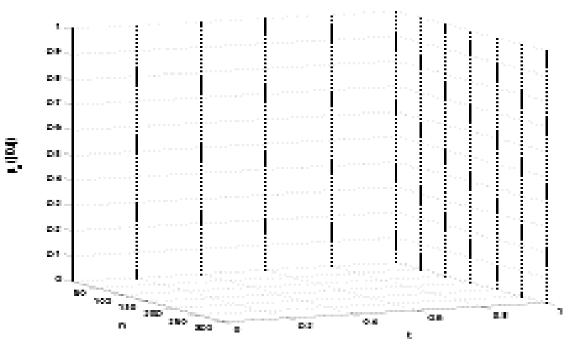
[Title No.12 in Times New Roman, single spaced and bold]

Products in development No.12 Times New Roman, single spaced.

Including graphs, figures and tables-Editable

In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

[Indicating the title at the bottom with No.10 and Times New Roman Bold]



Graphic 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

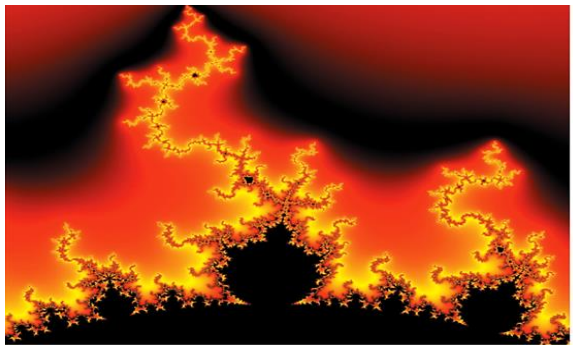


Figure 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

Table 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

Each article shall present separately in **3 folders**: a) Figures, b) Charts and c) Tables in .JPG format, indicating the number and sequential Bold Title.

For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \qquad (1)$$

Must be editable and number aligned on the right side.

Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources

Acknowledgment

Indicate if they were financed by any institution, University or company.

Conclusions

Explain clearly the results and possibilities of improvement.

ISSN 2531-2189

References

Use APA system. Should not be numbered, nor with bullets, however if necessary numbering will be because reference or mention is made somewhere in the Article.

Use Roman Alphabet, all references you have used must be in the Roman Alphabet, even if you have quoted an Article, book in any of the official languages of the United Nations (English, French, German, Chinese, Russian, Portuguese, Italian, Spanish, Arabic), you must write the reference in Roman script and not in any of the official languages.

Technical Specifications

Each article must submit your dates into a Word document (.docx):

Journal Name
Article title
Abstract
Keywords
Article sections, for example:

1. Introduction
2. Description of the method
3. Analysis from the regression demand curve
4. Results
5. Thanks
6. Conclusions
7. References

Author Name (s)
Email Correspondence to Author
References

Intellectual Property Requirements for editing:

-Authentic Signature in Color of Originality Format Author and Coauthors

-Authentic Signature in Color of the Acceptance Format of Author and Coauthors

Reservation to Editorial Policy

Journal of Mechanical Engineering reserves the right to make editorial changes required to adapt the Articles to the Editorial Policy of the Journal. Once the Article is accepted in its final version, the Journal will send the author the proofs for review. ECORFAN® will only accept the correction of errata and errors or omissions arising from the editing process of the Journal, reserving in full the copyrights and content dissemination. No deletions, substitutions or additions that alter the formation of the Article will be accepted.

Code of Ethics - Good Practices and Declaration of Solution to Editorial Conflicts

Declaration of Originality and unpublished character of the Article, of Authors, on the obtaining of data and interpretation of results, Acknowledgments, Conflict of interests, Assignment of rights and Distribution.

The ECORFAN-Mexico, S.C. Management claims to Authors of Articles that its content must be original, unpublished and of Scientific, Technological and Innovation content to be submitted for evaluation.

The Authors signing the Article must be the same that have contributed to its conception, realization and development, as well as obtaining the data, interpreting the results, drafting and reviewing it. The Corresponding Author of the proposed Article will request the form that follows.

Article title:

– The sending of an Article to Journal of Mechanical Engineering emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Format of Originality for its Article, unless it is rejected by the Arbitration Committee, it may be withdrawn.

– None of the data presented in this article has been plagiarized or invented. The original data are clearly distinguished from those already published. And it is known of the test in PLAGSCAN if a level of plagiarism is detected Positive will not proceed to arbitrate.

– References are cited on which the information contained in the Article is based, as well as theories and data from other previously published Articles.

– The authors sign the Format of Authorization for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Spain considers pertinent for disclosure and diffusion of its Article its Rights of Work.

– Consent has been obtained from those who have contributed unpublished data obtained through verbal or written communication, and such communication and Authorship are adequately identified.

– The Author and Co-Authors who sign this work have participated in its planning, design and execution, as well as in the interpretation of the results. They also critically reviewed the paper, approved its final version and agreed with its publication.

– No signature responsible for the work has been omitted and the criteria of Scientific Authorization are satisfied.

– The results of this Article have been interpreted objectively. Any results contrary to the point of view of those who sign are exposed and discussed in the Article.

Copyright and Access

The publication of this Article supposes the transfer of the copyright to ECORFAN-Mexico, SC in its Holding Spain for its Journal of Mechanical Engineering, which reserves the right to distribute on the Web the published version of the Article and the making available of the Article in This format supposes for its Authors the fulfilment of what is established in the Law of Science and Technology of the United Mexican States, regarding the obligation to allow access to the results of Scientific Research.

Article Title:

Name and Surnames of the Contact Author and the Coauthors	Signature
1.	
2.	
3.	
4.	

Principles of Ethics and Declaration of Solution to Editorial Conflicts

Editor Responsibilities

The Publisher undertakes to guarantee the confidentiality of the evaluation process, it may not disclose to the Arbitrators the identity of the Authors, nor may it reveal the identity of the Arbitrators at any time.

The Editor assumes the responsibility to properly inform the Author of the stage of the editorial process in which the text is sent, as well as the resolutions of Double-Blind Review.

The Editor should evaluate manuscripts and their intellectual content without distinction of race, gender, sexual orientation, religious beliefs, ethnicity, nationality, or the political philosophy of the Authors.

The Editor and his editing team of ECORFAN® Holdings will not disclose any information about Articles submitted to anyone other than the corresponding Author.

The Editor should make fair and impartial decisions and ensure a fair Double-Blind Review.

Responsibilities of the Editorial Board

The description of the peer review processes is made known by the Editorial Board in order that the Authors know what the evaluation criteria are and will always be willing to justify any controversy in the evaluation process. In case of Plagiarism Detection to the Article the Committee notifies the Authors for Violation to the Right of Scientific, Technological and Innovation Authorization.

Responsibilities of the Arbitration Committee

The Arbitrators undertake to notify about any unethical conduct by the Authors and to indicate all the information that may be reason to reject the publication of the Articles. In addition, they must undertake to keep confidential information related to the Articles they evaluate.

Any manuscript received for your arbitration must be treated as confidential, should not be displayed or discussed with other experts, except with the permission of the Editor.

The Arbitrators must be conducted objectively, any personal criticism of the Author is inappropriate.

The Arbitrators must express their points of view with clarity and with valid arguments that contribute to the Scientific, Technological and Innovation of the Author.

The Arbitrators should not evaluate manuscripts in which they have conflicts of interest and have been notified to the Editor before submitting the Article for Double-Blind Review.

Responsibilities of the Authors

Authors must guarantee that their articles are the product of their original work and that the data has been obtained ethically.

Authors must ensure that they have not been previously published or that they are not considered in another serial publication.

Authors must strictly follow the rules for the publication of Defined Articles by the Editorial Board.

The authors have requested that the text in all its forms be an unethical editorial behavior and is unacceptable, consequently, any manuscript that incurs in plagiarism is eliminated and not considered for publication.

Authors should cite publications that have been influential in the nature of the Article submitted to arbitration.

Information services

Indexation - Bases and Repositories

LATINDEX (Scientific Journals of Latin America, Spain and Portugal)
RESEARCH GATE (Germany)
GOOGLE SCHOLAR (Citation indices-Google)
REDIB (Ibero-American Network of Innovation and Scientific Knowledge- CSIC)
MENDELEY (Bibliographic References Manager)
HISPANA (Information and Bibliographic Orientation-Spain)
UNIVERSIA (University Library-Madrid)

Publishing Services

Citation and Index Identification H
Management of Originality Format and Authorization
Testing Article with PLAGSCAN
Article Evaluation
Certificate of Double-Blind Review
Article Edition
Web layout
Indexing and Repository
ArticleTranslation
Article Publication
Certificate of Article
Service Billing

Editorial Policy and Management

38 Matacerquillas, CP-28411. Moralzarzal –Madrid-España. Phones: +52 1 55 6159 2296, +52 1 55 1260 0355, +52 1 55 6034 9181; Email: contact@ecorfan.org www.ecorfan.org

Site Licences

03-2010-032610094200-01-For printed material, 03-2010-031613323600-01-For Electronic material,03-2010-032610105200-01-For Photographic material, 03-2010-032610115700-14-For the facts Compilation, 04-2010-031613323600-01-For its Web page, 19502-For the Iberoamerican and Caribbean Indexation, 20-281HB9- For its indexation in Latin-American in Social Sciences and Humanities,671-For its indexing in Electronic Scientific Journals Spanish and Latin-America,7045008-For its divulgation and edition in the Ministry of Education and Culture-Spain,25409-For its repository in the Biblioteca Universitaria-Madrid,16258-For its indexing in the Dialnet,20589-For its indexing in the edited Journals in the countries of Iberian-America and the Caribbean, 15048-For the international registration of Congress and Colloquiums. financingprograms@ecorfan.org

Management Offices

38 Matacerquillas, CP-28411. Moralzarzal –Madrid-España.

Journal of Mechanical Engineering

"Mechanical upgrade to a proposed mechanical transition ventilation"
REYES-MARTINEZ, Roberto Alejandro, MIRANDA-PASCUAL, María Elena, ESQUEDA-ELIZONDO, José Jaime and TRUJILLO-TOLEDO, Diego Armando
Universidad Autónoma de Baja California

"Test analysis for implementation of mechanical and robotic systems in therapy applications"
AGUILERA-HERNÁNDEZ, Martha Isabel, ORTIZ-SIMÓN, José Luis, RAMÍREZ-AGUIRRE Miguel and ROJO-VELÁZQUEZ, Gustavo Emilio
Tecnológico Nacional de México- Instituto Tecnológico de Nuevo Laredo

"Design of a rotational type vibration absorber"
VÁZQUEZ-GONZÁLEZ, Benjamín, JIMÉNEZ-RABIELA, Homero and RAMÍREZ-CRUZ, José Luis
Universidad Autónoma Metropolitana

"Analysis of drag and lift forces for a sedan car using a rear lip spoiler"
HORTELANO-CAPETILLO, Juan Gregorio, MARTÍNEZ-VÁZQUEZ, J. Merced, ZUÑIGA-CERROBLANCO, José Luis and RODRIGUEZ-ORTIZ, Gabriel
Universidad Politécnica de Juventino Rosas

2 5 3 1 2 1 8 9
ISSN 2531-2189

www.ecorfan.org