ISSN 2523-6792

Volume 7, Issue 19 – January – June - 2023

Journal of Technical Invention

ECORFAN®

Journal of Technical Invention, Volume 7, Issue 19, January - June 2023, is a journal edited six monthly by ECORFAN-Taiwan. Taiwan, Taipei. YongHe district, ZhongXin, Street 69. Postcode: 23445. WEB: www.ecorfan.org/taiwan, revista@ecorfan.org. Chief Editor: GUZMÁN - HURTADO, Juan Luis. PhD. ISSN-On line: 2523-6792. Responsible for the latest update of this number ECORFAN Computer Unit. ESCAMILLA-BOUCHÁN, Imelda, PhD, LUNA-SOTO, Vladimir. PhD. Taiwan, Taipei. YongHe district, ZhongXin, Street 69, last updated June 30, 2023.

Journal of Technical Invention

Definition of Research Journal

Scientific Objectives

Support the international scientific community in its written production Science, Technology and Innovation in the Field of Engineering and Technology, in Subdisciplines Computers, Communications, Control, Design and systems, Electronic devices, Semiconductor devices, Computer electronics, Industrial electronics, Electronics and telecommunications, Electrochemistry, Optical fibers, Electrical and electronic industry, Computing, Control engineering, Materials engineering, Instrumentation, Inter frequencies, Microelectronics, Microwaves, Data processing, Digital networks, Robotics, Digital systems, Electronic systems.

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 CONAHCYT-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 - CONAHCYT Research Centers.

Scope, Coverage and Audience

Journal of Technical Invention is a Research Journal edited by ECORFAN-Mexico S.C in its Holding with repository in Taiwan, is a scientific publication arbitrated and indexed with semester periods. It supports a wide range of contents that are evaluated by academic peers by the Double-Blind method, around subjects related to the theory and practice of Computers, Communications, Control, Design and systems, Electronic devices, Semiconductor devices, Computer electronics, Industrial electronics, Electronics and telecommunications, Electrochemistry, Optical fibers, Electrical and electronic industry, Computing, Control engineering, Materials engineering, Instrumentation, Inter frequencies, Microelectronics, Microwaves, Data processing, Digital networks, Robotics, Digital systems, Electronic systems with diverse approaches and perspectives, That contribute to the diffusion of the development of Science Technology and Innovation that allow the arguments related to the decision making and influence in the formulation of international policies in the Field of Engineering and Technology. The editorial horizon of ECORFAN-Mexico® extends beyond the academy and integrates other segments of research and analysis outside the scope, as long as they meet the requirements of rigorous argumentative and scientific, as well as addressing issues of general and current interest of the International Scientific Society.

Arbitration Committee

Assignment of Rights

The sending of an Article to Journal of Technical Invention 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 Taiwan 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-CONAHCYT- 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 CONAHCYT 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 Research 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

The works must be unpublished and refer to topics of Computers, Communications, Control, Design and systems, Electronic devices, Semiconductor devices, Computer electronics, Industrial electronics, Electronics and telecommunications, Electrochemistry, Optical fibers, Electrical and electronic industry, Computing, Control engineering, Materials engineering, Instrumentation, Inter frequencies, Microelectronics, Microwaves, Data processing, Digital networks, Robotics, Digital systems, Electronic systems and other topics related to Engineering and Technology.

Presentation of the content

In Issue 19 as the first article we present, *Implementation of a BSN for the detection of activities during the coffee harvest* by MAGÍN-MURILLO, Dagoberto, SÁNCHEZ-MEDEL, Luis Humberto, SOLÍS-JIMÉNEZ, Miguel Ángel, MELCHOR-HERNÁNDEZ, César Leonardo and TEJEDA-GARCÍA, Rafael with adscription in the Instituto Tecnológico Superior de Huatusco and Instituto Tecnológico de Orizaba, in the next article we present, *Development, design, and implementation of a Solar Cooling System* by ESPARZA-DELGADO, María del Carmen, PEREZ-ORTEGA, Eva Claudia, CHAVIRA-ALVAREZ, Alberto and MOLINA-DE LA ROSA, Laura, with adscription in the Universidad Tecnológica de Chihuahua, in the next article we present, *Web system for vehicle management in a University Center* by ZAMORA-RAMOS, Víctor Manuel, JIMÉNEZ-RODRÍGUEZ, Mario, PULIDO-GONZÁLEZ, Hector and MACÍAS-BRAMBILA, Hassem Rubén, with adscription in the Universidad de Guadalajara and Universidad Tecnológica de Jalisco, in the last article we present, *Decision support system for environmental monitoring systems using data logs* by CABALLERO-LÓPEZ, Emma Isabel, VÁZQUEZ-ROSAS, Sergio, HERNÁNDEZ-SÁNCHEZ, Uriel Alejandro and MALAGÓN GONZÁLEZ, Gonzalo, with adscription in the Universidad Tecnológica del Centro de Veracruz.

Content

Article **Journal of Technical Invention**
June 2023 Vol.7 No.19 1-8

Implementation of a BSN for the detection of activities during the coffee harvest

Implementación de una BSN para la detección de actividades durante la recolección de café

MAGÍN-MURILLO, Dagoberto[1]†*, SÁNCHEZ-MEDEL, Luis Humberto[2], SOLÍS-JIMÉNEZ, Miguel Ángel[1], MELCHOR-HERNÁNDEZ, César Leonardo[1] and TEJEDA-GARCÍA, Rafael[1]

[1]*Instituto Tecnológico Superior de Huatusco*
[2]*Instituto Tecnológico de Orizaba*

ID 1st Author: *Dagoberto, Magín-Murillo* / **ORC ID**: 0000-0001-7138-9074, **CVU CONAHCYT I**D: 1194039

ID 1st Co-author: *Luis Humberto, Sánchez-Medel* / **ORC ID**: 0000-0002-6783-585X, **CVU CONAHCYT ID**: 655387

ID 2nd Co-author: *Miguel Ángel, Solís-Jiménez* / **ORC ID**: 0000-0002-8125-0989

ID 3rd Co-author: *César Leonardo, Melchor-Hernández* / **ORC ID**: 0000-0003-2154-6654

ID 4th Co-author: *Rafael, Tejeda-García* / **ORC ID**: 0009-0003-7994-8055

DOI: 10.35429/JOTI.2023.19.7.1.8 Received January 12, 2023; Accepted June 24, 2023

Abstract

Currently, Body Sensor Network (BSN) body sensor networks are generating great interest due to applications in different scientific and industrial environments, they form a technology that allows data acquisition for research and process control. That is why the design of an architecture is proposed, based on networks of body sensors for real-time analysis during the coffee harvesting process because the workers are subject to repetitive physical movements and thus generate a knowledge base and a machine learning model to present the mathematical models with the intention of justifying the decisions made from the coffee harvesting activity. The suit consists of two modules placed on the arms of the people and another on the thorax, which are the reference points for taking the data, thus making use of today's wearable devices.

Acquisition, Movements, Models

Resumen

En la actualidad las redes de sensores corporales Body Sensor Network (BSN) están generando gran interés debido a las aplicaciones en diferentes ámbitos tanto científicos como industriales, forman una tecnología que permite la adquisición de datos para la realización de investigaciones y control de procesos. Es por ello que se plantea el diseño de una arquitectura, basada en redes de sensores corporales para el análisis en tiempo real durante el proceso de recolección de café debido a que los trabajadores están sujetos a movimientos físicos repetitivos y así generar una base de conocimientos y un modelo de Machine Learning para presentar los modelos matemáticos con la intención de justificar las decisiones tomadas de la actividad de recolección de café. El traje consiste en dos módulos colocados en los brazos de las personas y otro sobre el tórax, los cuales son los puntos de referencia para tomar los datos, por lo que se logra hacer uso de los dispositivos vestibles de la actualidad.

Adquisición, Movimientos, Modelos

Citation: MAGÍN-MURILLO, Dagoberto, SÁNCHEZ-MEDEL, Luis Humberto, SOLÍS-JIMÉNEZ, Miguel Ángel, MELCHOR-HERNÁNDEZ, César Leonardo and TEJEDA-GARCÍA, Rafael. Implementation of a BSN for the detection of activities during the coffee harvest. Journal of Technical Invention. 2023. 7-19: 1-8

*Correspondence to Author (e-mail: magindago@gmail.com)
† Researcher contributing as first author.

June 2023 Vol.7 No.19 1-8

Introduction

Growing coffee is a job that involves a lot of physical activity and forced postures, which increases the risk of muscle injuries. It is important to improve the coffee harvest conditions to make it more comfortable and ergonomic, as well as reduce the weight load and work time. These improvements are necessary to prevent musculoskeletal disorders and improve the health of agricultural workers, considering the economic importance of coffee cultivation. One solution is to use a network of body sensors to record and analyze the movements and signals of the human body, allowing a better understanding of ergonomic risks and the identification of more effective solutions. The demand for these devices continues to grow, which has led to improvements in their quality of service and reliability by applying them in different examples: weather forecasting, identifying medical disorders, predicting customer purchasing preferences, detecting and classifying signals, controlling robots in manufacturing and vehicles, and support of bionic implants (Golden, 2020).

A BSN is an independent system used to monitor a person's activities of daily living, (Sangwan & Bhattacharya, 2015), The functionalities and ease of use of these systems have also received an important boost thanks to the diffusion of portable devices such as wearable devices that represent the complement for portable nodes, becoming an increasingly important part of technology and their use is going from be simple accessories to more specialized and practical applications(Lai *et al*., 2013).

The article is organized in different sections. The first section focuses on the state of the art, reviewing what has already been investigated in relation to the use of inertial body sensors. In the methodology section, it is described how the research was carried out, what techniques and tools were used to obtain the results. The functional tests section focuses on showing the results obtained by implementing the proposed techniques with decision tree algorithms that have the advantage of being easily expressed as rules. (Dreiseitl & Ohno-Machado, 2002).

In the future proposal section, possible improvements or future applications of the research are proposed. Finally, in the conclusions section, the most important findings are presented and the results obtained are summarized.

1. State of the art

As mentioned, smart wearable devices have allowed the development of wearable technology at an accelerated rate adapted for various applications during the last years (John Dian et al., 2020). Wearable devices have become an easy tool for the recognition of human activities and it is common to find devices with temperature sensors, gyroscope, accelerometer, among others, the main added value is used to capture body movement data, can provide various monitoring and scanning functions, including feedback or other sensory physiological functions (Lee & Lee, 2020).

Advances in the development of machine learning algorithms have allowed these advances and generated, of course, a very broad domain (Shalev-Shwartz & Ben-David, 2013). The wearable devices that we know and use today have gained popularity thanks to the market introduction and marketing of these products as shown in Figure 1.

Figure 1 Wearable Device

1.1 Accelerometers

Accelerometers are sensors found in wearable devices because their sensing capabilities range from different types of linear and gravitational accelerations. The measurement capabilities allow the data that has been obtained to be programmed for different uses, for example, when a user runs, it can generate the maximum speed and acceleration (Aroganam *et al*., 2019).

ISSN 2523-6792

1.2 Gyroscopes

Gyroscopes are another common type of sensor found in wearable devices. The main difference with the accelerometer is that it exclusively measures angular accelerations, the advantage of combining both is to filter errors and increase the precision of the monitored data. *(Aroganam et al.*, 2019).

In areas such as health, the use of BSNs can be implemented, then the design of a wireless network of body sensors for the integrated acquisition of signals that is made up of wireless modules for the acquisition of biosignals is described, the objective of the work was design and develop a wireless Body Sensor Network system that allows the synchronous acquisition of cortical and muscular activity for the evaluation of sensory responses, due to the architecture of the system and the good quality of the results obtained, the proposed device represents an advance in state-of-the-art technology in terms of the simultaneous acquisition of electroencephalography (EEG) signals and high-density surface EMG (HD-sEMG).

This is how (McClure *et al*., 2020) shows an investigation where a breathing analysis system was developed using data from the accelerometer and gyroscope implemented in wearable devices placed on the chest and abdomen to detect different breathing patterns to solve in emergency medical situations.

To do this, various respiratory events were simulated and synthetic data sets were constructed by injecting annotated examples of the various patterns into segments of normal respiration. In order to obtain the results, the convolutional neural network artificial intelligence model was used to detect the location of each event and classify it into one of the previous types of events.

A mean score of 92% was achieved for normal breathing, 87% for central sleep apnea, 72% for cough, 51% for obstructive sleep apnea, 57% for sighing, and 63% for yawning.

The results of this study demonstrate that the use of wearable devices to analyze movement data from the thorax and abdomen combined with artificial intelligence models provides an unobtrusive means of monitoring breathing pattern and could have applications in medical situations.

Critical as the detection of sleep apnea at home and the control of respiratory events in patients with mechanical ventilation in the intensive care unit. In (Sattar *et al*., 2019) it is described how BSN systems that use inertial sensors are replacing video-based systems to monitor performance in athletes, and this considerably reduces the work involved in installing the video camera, as well as the calibration procedure.

The important feature of the BSN system is the integrated way of creating a small portable device with computational power to process the data using various analysis techniques to monitor and improve performance in sports. The work carried out by (Chen, 2021) also considers the use of wearable devices to evaluate the performance of athletes during sports activities. The process involves recording movement variables at a high enough sampling rate throughout a series of tests to monitor training load, capture, and interpret data.

To carry out the analysis, he proposes the use of the Support Vector Machine (SVM) supervised learning algorithm to guide training and monitor athlete muscle measurement to result in improvements in measures related to poor physical health effects.

2. Methodology to develop

To develop the artificial intelligence model, the following steps described in Figure 2 should be considered.

ISSN 2523-6792

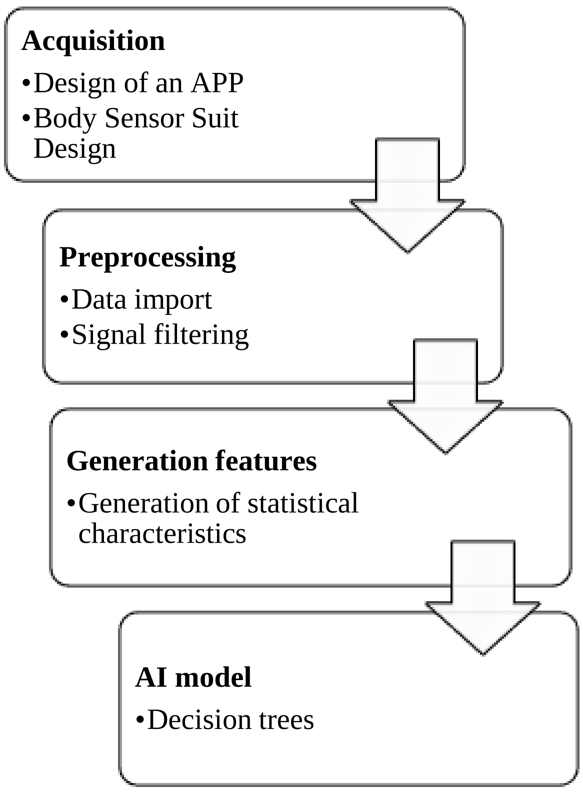


Figure 2 Methodology to develop

2.1 Data acquisition

In the acquisition stage, the objective is to obtain the input data to be able to train the intelligence model and thus be able to classify the activities shown in Figure 3. Because the activities are labeled, supervised learning is applied.

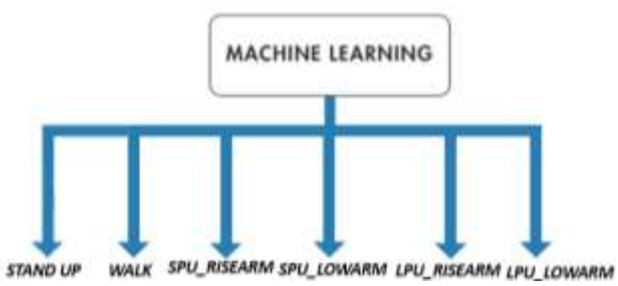


Figure 3 Activities to classify

To carry out the acquisition it is necessary to have the wearable device, which users must carry to carry out the activities throughout the day, for this reason the 3 modules shown in Figure 4 were modeled in 3D to later print the parts and start with data acquisition tests.

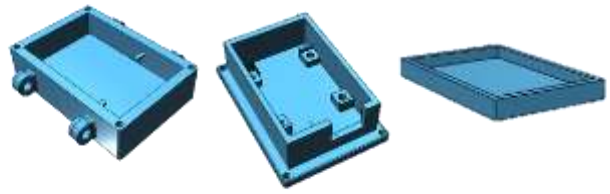


Figure 4 Wearable Device 3D Model

Inside the wearable device, the electronic components are assembled to acquire the data, which consists of a 3.7-volt LiPo battery as seen in Figure 5, due to its rechargeable characteristics, as well as the OpenLog Artemis, shown in Figure 6, sensor that includes an IMU for integrated recording of accelerometer data and triple axis gyroscope.

Figure 5 3.7V Lipo Battery

Figura 6 OpenLog Artemis

For the acquisition of data, the BSN is used on the reference points of the users, which are the right arms, left arms and on the thorax, as shown in Figure 7.

Figure 7 User-implemented modules

During the tests, the activities are labeled with the help of an application developed in Android to classify each action carried out by the user as shown in Figure 8. The activities are repeated until the data for each activity to be classified is available. The obtained data is stored in a text file as it is easy to work with a flat file format, such as text or CSV, and it makes it easy to import data for processing.

Figure 8 Data acquisition

2. Preprocessing

Machine learning algorithms are not smart enough to differentiate between noise and valuable information, that is why before using the data for training, Figure 9 shows the signals obtained directly from the sensors, it is for Therefore, we must ensure that they are clean and complete, for this the preprocessing must be carried out.

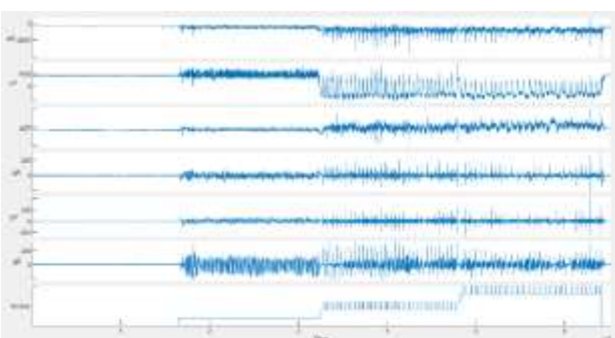


Figure 9 Signals without preprocessing

To carry out the preprocessing, it is carried out using the temporary window method where only small parts of the signal are analyzed through a temporary window where the width is defined depending on the frequency with which the data was obtained and thus it slides along. of the whole signal.

Figure 10 shows the processed signal eliminating outliers.

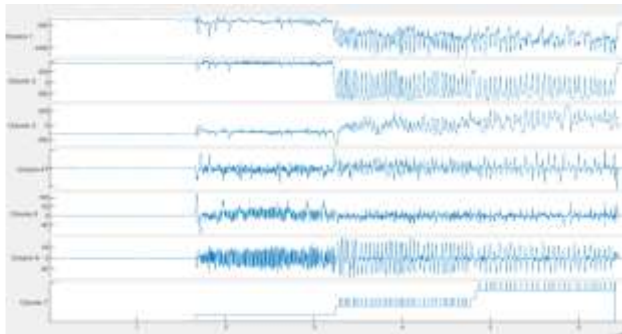


Figure 10 Preprocessed signal

3. Generation of features

For the phase of extraction of characteristics from the knowledge base, it consists of making use of these characteristics as input data for a classifier that allows to improve the results obtained in the classification, in comparison if these are used directly from the data obtained by the device. wearable. The characteristics obtained are representative according to the temporal and frequency domain that is taken into account and allow the creation of different groups to verify which of them achieves a better result when classified. The most commonly used features are shown in Table 1

Selected features	
Mean	Returns the mean of the elements of the first dimension of array.
Harmmean	Calculates the harmonic mean of a sample.
Kurtosis	Returns the kurtosis sample.
Median	Returns the mean value.
Mode	Returns the value that appears most frequently.
Min	Returns the least elements of an array.
Max	Returns the maximum elements of an array
Peak2peak	Returns the difference between the maximum and minimum values.
Rms	Returns the root mean square (RMS) value of the input data.
Skewness	Returns the skewness of the sample.
Std	Returns the standard deviation of the elements.
Sum	Returns the sum of the elements in the first dimension of the array.
Trimmean	Returns the mean of the values.
Var	Returns the variance of the elements.

Table 1 Statistical characteristics

ISSN 2523-6792

To carry out the generation of statistical characteristics, the code was made using the MATLAB® programming language.

4. Artificial Intelligence model

To carry out the machine Learner model, it is done with the Classification Learner application of the MATLAB® software, Figure 11, which is in charge of training models to classify data. With this application, you can explore supervised machine learning using various classifiers, explore the data, select its features, specify validation schemes, train models, and evaluate the results. To carry out the automated training, it is carried out with the decision tree classification model of Figure 12, due to the fact that automatic learning is supervised and that it provides a set of labeled data.

Figure 11 Classification Learner

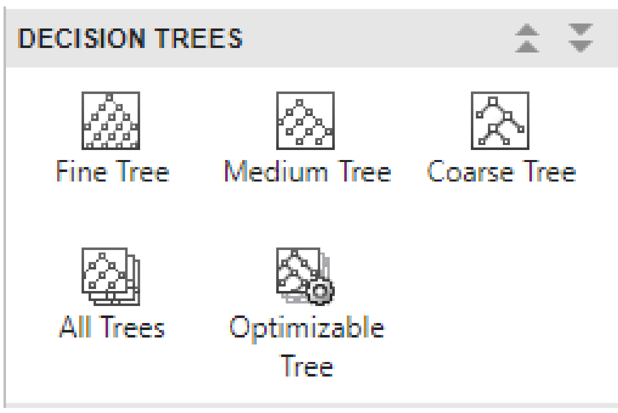


Figure 12 Decision Trees

When building your model, you should start with something simple; since it will be faster to execute and easier to interpret, so the coarse Tree is generated, which shows a prediction of 80% of the classification of activities, as shown in Figure 13. To see how it works, generate the confusion matrix of Figure 14, to compare the classifications made by the model with the actual class labels.

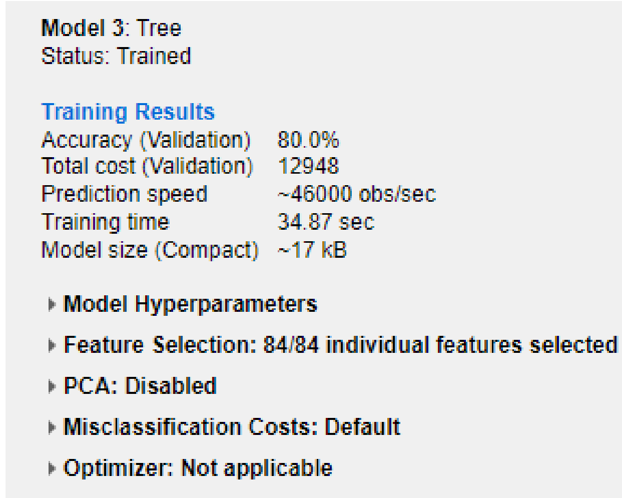


Figure 13 Summary

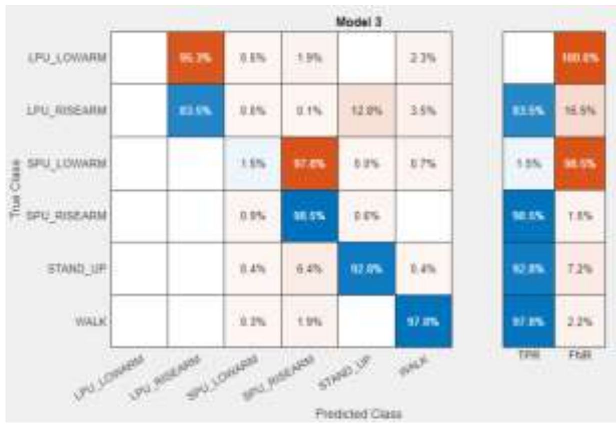


Figure 14 Confusion matrix

One or more classifiers can be automatically trained to compare the validation results and choose which is the best model that works for the classification of activities. For the Coarse Tree of Figure 15, it shows that our model has problems distinguishing all the activities, so the model must be trained again with a medium level, to improve the prediction or train the Fine Tree.

Figure 15 Coarse Tree

ISSN 2523-6792

Article **Journal of Technical Invention**
June 2023 Vol.7 No.19 1-8

Results

To obtain a better precision of the model obtained, the Fine Tree algorithm is trained, which returns an accuracy of 97.1% Figure 16, compared to 80.1% for the coarse tree. The confusion matrix of Figure 17 also shows an improvement in the results, it shows a diagonal with cells in blue, which indicates the true values, and the results obtained in the TPR column.

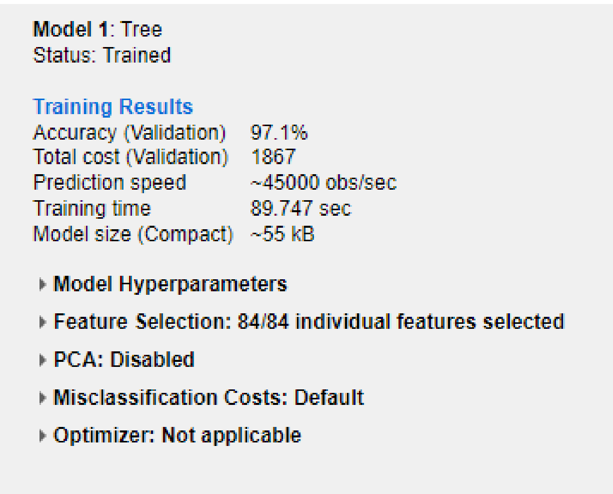


Figure 16 Summary Fine Tree

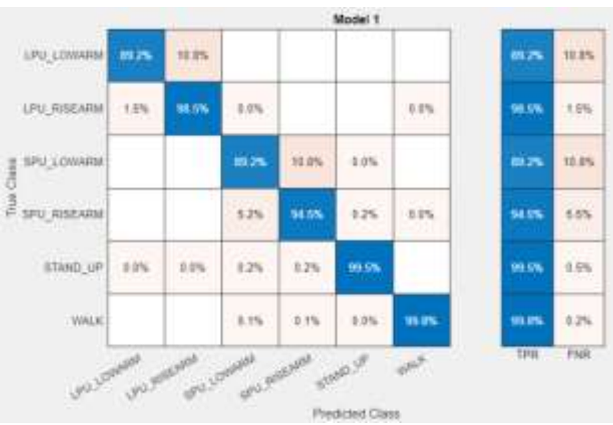


Figure 17 Confusion matrix Fine Tree

Figure 18 shows through the ROC Curve the different comparisons that the algorithm makes to carry out the classification of the activities carried out during the coffee harvesting process, so it can be said that the predictions generated are reliable.

The ROC curve shows the true positive rate (TPR) versus the false positive rate (FPR) calculated by the Fine Tree. The true positive rate that are in the range of 0 to 1, and the AUC values being the largest correspond to the percentage correctly performed of the positive class observations, therefore, they indicate a better performance of the trained model in recognizing the activities. made during the coffee harvesting process.

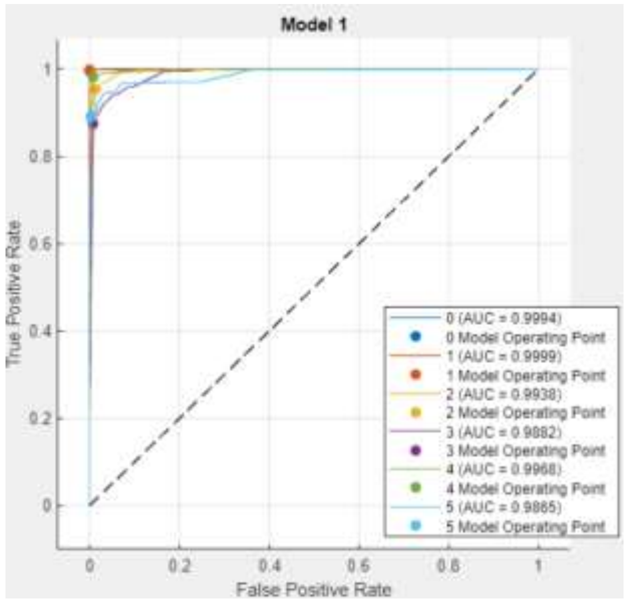


Figure 18 ROC Curve

Financing

Financing: This work has been funded by CONAHCYT [scholarship number: 830166,2022]

Conclusions

The artificial intelligence model gives an accuracy of 97.1%, so the model has characteristics of greater predictive power to classify activities reliably, so it can be said that Artificial Intelligence models make automatic learning possible by carrying out carry out efficient computational processes for the recognition of human activities in different areas of interest.

These capabilities provide new opportunities to improve the efficiency and accuracy of signal processing, which can have a significant impact in various areas and industries that require advanced signal processing and analysis.

References

Golden, R. M. (2020). Formal Machine Learning Algorithms. In Statistical Machine Learning. https://doi.org/10.1201/9781351051507-3

Sangwan, A., & Bhattacharya, P. P. (2015). Wireless Body Sensor Networks: A Review. International Journal of Hybrid Information Technology, 8(9), 105–120. https://doi.org/10.14257/ijhit.2015.8.9.12

Lai, X., Liu, Q., Wei, X., Wang, W., Zhou, G., & Han, G. (2013). A survey of body sensor networks. In Sensors (Switzerland) (Vol. 13, Issue 5). https://doi.org/10.3390/s130505406

Dreiseitl, S., & Ohno-Machado, L. (2002). Logistic regression and artificial neural network classification models: A methodology review. Journal of Biomedical Informatics, 35(5–6), 352–359. https://doi.org/10.1016/S1532-0464(03)00034-0

F. John Dian, R. Vahidnia and A. Rahmati, "Wearables and the Internet of Things (IoT), Applications, Opportunities, and Challenges: A Survey," in IEEE Access, vol. 8, pp. 69200-69211, 2020, https://doi.org/10.1109/ACCESS.2020.2986329

Lee, S. M., & Lee, D. H. (2020). Healthcare wearable devices: an analysis of key factors for continuous use intention. Service Business, 14(4), 503–531. https://doi.org/10.1007/s11628-020-00428-3

Shalev-Shwartz, S., & Ben-David, S. (2013). Understanding machine learning: From theory to algorithms. In Understanding Machine Learning: From Theory to Algorithms (Vol. 9781107057). https://doi.org/10.1017/CBO9781107298019

Aroganam G, Manivannan N, Harrison D. Review on Wearable Technology Sensors Used in Consumer Sport Applications. Sensors (Basel). 2019 Apr 28;19(9):1983.https://doi.org/10.3390/s19091983

McClure, K., Erdreich, B., Bates, J. H. T., McGinnis, R. S., Masquelin, A., & Wshah, S. (2020). Classification and detection of breathing patterns with wearable sensors and deep learning. Sensors (Switzerland), 20(22), 1–13. https://doi.org/10.3390/s20226481

Sattar, F., Azad, A. A. M., Sikder, M. S., & Arefin, M. S. (2019). Body sensor networks for monitoring performances in sports: A brief overview and some new thoughts. Artificial Intelligence Research, 8(1), 25. https://doi.org/10.5430/air.v8n1p25

Chen, F. (2021). Athlete muscle measurement and exercise data monitoring based on embedded system and wearable devices. Microprocessors and Microsystems, 82(December 2020), 103901.https://doi.org/10.1016/j.micpro.2021.103901

Development, design, and implementation of a Solar Cooling System

Desarrollo, diseño e implementación de Sistema de Refrigeración Solar

ESPARZA-DELGADO, María del Carmen†*, PEREZ-ORTEGA, Eva Claudia, CHAVIRA-ALVAREZ, Alberto and MOLINA-DE LA ROSA, Laura

Universidad Tecnológica de Chihuahua, Mecatrónica y Energías Renovables.

ID 1st Author: *María Del Carmen, Esparza-Delgado* / **ORC ID**: 0000 0001 8276 6031, **Research ID Thomson**: S-7823-2018, **CVU CONAHCYT ID**: 520791

ID 1st Co-author: *Eva Claudia, Perez-Ortega* / **ORC ID**: 0000-0002-4739-9237, **Research ID Thomson**: S-6728-2018, **CVU CONAHCYT ID**: 388994

ID 2nd Co-author: *Alberto, Chavira-Alvarez /* **ORC ID**: 0000-0002-2705-6851, **Research ID Thomson**: S-7881-2018, **CVU CONAHCYT ID**: 250601

ID 3rd Co-author: *Laura, Molina-De La Rosa*

DOI: 10.35429/JOTI.2023.19.7.9.14 Received January 12, 2023; Accepted June 24, 2023

Abstract

Variations in extreme temperatures seriously affect crops, making it necessary to maintain a stable temperature inside the greenhouses between 17°C and 24°C. The conventional air conditioning systems used by the producers are electricity and gas, both highly polluting and expensive. Considering the benefits of alternative energies, this project is developed, which consists of the design, development, and start-up of an experimental research prototype that works with solar energy. The objective is to create a refrigeration system using a parabolic channel with a solar tracker, complemented with an absorption machine that allows maintaining the temperature of a greenhouse at 24°C, an interface in specialized software, and data collection with compact RIO. It is concluded that the prototype performs the heat transfer in such a way that it generates cold with the heat accumulated by the parabolic trough. Operational limits of the parabolic trough, the absorption machine, and the system's feasibility to scale to one- hectare greenhouse was established. It is recommended to continue investigating and implementing strategies that use alternative energies that contribute to reducing polluting emissions into the environment.

Parabolic trough collector, Cooling system, Alternative energies

Resumen

Las variaciones de temperaturas extremas afectan gravemente los cultivos, siendo necesario mantener una temperatura estable en el interior de los invernaderos de 17°C a 24°C. Los sistemas de climatización convencionales utilizados por los productores son, electricidad y gas, ambos altamente contaminantes y costosos. Considerando los beneficios de las energías alternativas se desarrolla el presente proyecto que consiste en el diseño, desarrollo y puesta en marcha de un prototipo de investigación experimental que trabaja con energía solar. El objetivo es crear un sistema de refrigeración utilizando un canal parabólico con seguidor solar, complementado con una máquina de absorción que permita mantener la temperatura de un invernadero a 24°C, se integra al diseño una interfaz en software especializado y la recolección de datos con CompactRIO. Se concluye que el prototipo realiza la transferencia de calor de manera que genera frio con el calor acumulado por el canal parabólico. Se establecieron límites de operatividad del canal parabólico, de la máquina de absorción y la viabilidad del sistema para escalar a un invernadero de una hectárea. Se recomienda continuar con la investigación e implementación de sistemas que utilicen energías alternativas que contribuyan a la disminución de emisiones contaminantes al medio ambiente.

Canal parabólico, Refrigeración, Energías alternativas

Citation: ESPARZA-DELGADO, María del Carmen, PEREZ-ORTEGA, Eva Claudia, CHAVIRA-ALVAREZ, Alberto and MOLINA-DE LA ROSA, Laura. Development, design, and implementation of a Solar Cooling System. Journal of Technical Invention. 2023. 7-16: 9-14

*Correspondence to Author (e-mail: cesparza@utch.edu.mx)
†Researcher contributing as first author.

Introduction

In regions such as the northern states of Mexico with extreme climates where temperatures vary over the course of the year from -10°C to 50°C (INEGI, 2023), farmers see their harvests continually affected, necessitating the creation of artificial climates. A common practice used by some farmers is the creation of greenhouses where temperature and humidity are controlled. The climate control systems conventionally used to maintain a stable temperature inside a greenhouse, which fluctuates between 21°C and 24° (Franco, Valera, & Peña, 2014), work with electrical energy and gas, unfortunately they are expensive and highly polluting systems.

Considering the benefits of alternative energies, this project consists of the design, development and implementation of an experimental research prototype that works with solar energy, which is environmentally friendly.

The objective is to create a cooling system using a parabolic trough with a solar tracker, complemented by an absorption machine that allows a greenhouse temperature of 24°C to be maintained. Considering that the optimum temperature inside a greenhouse depends on the geographical location, climate and type of crop, the prototype is designed to sustain the maximum recommended temperature (24°C), in support of the conventional cooling system.

The system is mainly composed of a parabolic trough with a mirrored surface that concentrates the sun's rays and directs them onto a copper tube that runs along the length of the trough (Cano M, 2002). To follow the movement of the sun's rays, a solar tracker is integrated, which is a device designed to orient the parabolic trough according to the position of the sun, with the characteristic that, when it gets dark, it returns to the starting point. Another indispensable element is the heat transfer unit consisting of an absorption machine that produces cold from the heat generated by the parabolic trough (Duffie & Beckman, 2005).

The receiver tube, which runs through the entire parabolic trough, circulates the fluid that receives the sun's rays and raises its temperature.

Another important element is the expansion valve that regulates the injection of the liquid refrigerant through compression or expansion according to the pressure required by the cooling system.

The overall performance of the system depends to a large extent on the materials, dimensions and speed of the circulating fluid. For the monitoring phase an interface is used in LabVIEW (Laboratory Virtual Instrument Engineering Workbench), a graphical programming language for the design of data acquisition, instrumentation and control systems, allows the design of user interfaces through an interactive console, it has its main application in measurement systems, such as process monitoring and control applications with real-time processing (NI, 2023).

Data logging is performed by a CompatRIO, this system has high-performance processing capability, sensor-specific conditioned I/O and a tightly integrated software toolset that makes it ideal for Industrial Internet of Things (IIoT), monitoring and control applications. The real-time processor offers reliable and predictable behaviour, ideal for long-term data acquisition (NI, 2023). Other modules used for monitoring and control operation were the NI9219, to measure thermocouple signals, the NI 9263 which is an analogue output module, for data acquisition the wireless sensor network Gatewey was used. (NI, 2014).

For monitoring temperatures in the parabolic trough, Pt100 sensors were used, for readings from the absorption machine thermocouples were used, to monitor humidity a HX93AV series transmitter was used and to monitor wind speed the FMA900A series sensor was used.(Serna, 2010).

Materials and Methods

1. Determination of variables to be considered

It is determined that the variables to be measured are temperature, humidity, wind speed.

Greenhouse temperature

– The required internal temperature for the greenhouse is 20-24ºC, maximum 35ºC and minimum 8ºC, plants such as sweet pepper and aubergine, outside these ranges there is an effect on the product.

– Positioning of the sensors, they were placed at a height of 1.20m considering that the height of the product is a maximum of 1.50m and this is the region of interest to be sensed.

– The greenhouse must maintain a comfortable temperature between 20 to 24°C, so it is sensed every 15 minutes.

– The system operates under an On-Off control.

– Once the temperature oscillates between 27°C and 30°C the system is activated until it reaches 23°C for deactivation.

Greenhouse humidity

The relative humidity of the air in the greenhouse depends on the type of plants to be housed. 40-60% is recommended.

Greenhouse ventilation

Greenhouse ventilation varies depending on the seasons. In winter, it is recommended to ventilate for 1 hour at midday to renew the oxygen. In summer, the function of ventilation is to help expel hot air (Franco, Valera, & Peña, 2014).

The ventilation is placed in low and high positions to establish an adequate air flow.

2. Development of the automated system in LabVIEW

Linking LabVIEW with CompactRIO

The specialised software was installed, activating the LabVIEW FPGA modules, the LabVIEW Real-Time Module and the NI-RIO controller on the PC (NI, 2023). The modules were connected, the system was wired, and the modules were configured.

Programming in LabVIEW:

The programming with which the variables such as humidity, wind and the different temperatures of the environment, parabolic trough, cooler and absorption machine will be controlled was carried out using the different modules of the CompactRIO.

Figures 1 and 2 show the block diagram of the connections for sensing each of the variables to be considered for monitoring and control.

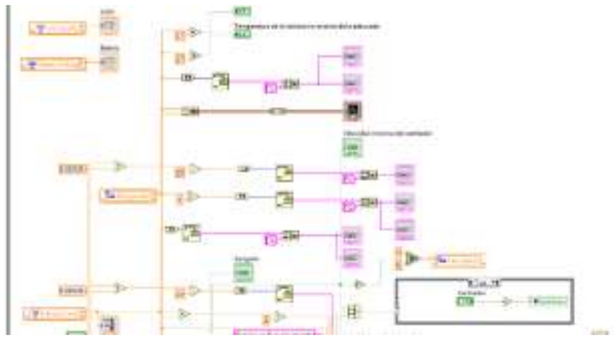


Figure 1 Programming block diagram

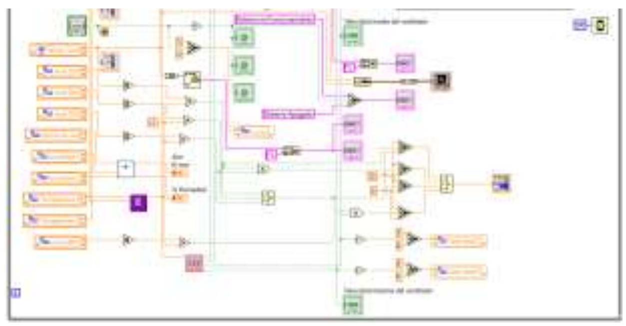


Figure 2 Programming block diagram 2

Programming in LabVIEW (interface)

Figure 3 shows the elements of the system where the controls and indicators that record the measurements of the sensors are observed, as well as the graphical representation of the system, the piping system, the parabolic trough, the pump, the accumulator, the fan and the location of the different types of sensors.

Figure 3 Graphical interface of the system 1

The following image shows the monitoring interface (Figure 4) where the indicators of the variables used are observed, as well as the graphs where the temperatures are compared, such as room-refrigerator and parabolic channel-environment**.**

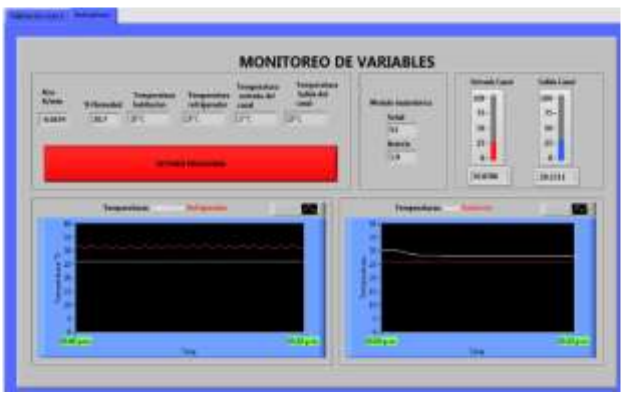


Figure 4 System graphical interface 2

3. Equipment design

Parabolic channel

The function of the parabolic trough is to concentrate solar energy into a small area, increasing the energy intensity (Duffie & Beckman, 2005). The base structure for the solar collector is designed to support the weight of the collector, movement, wind, snow and rain loads, ensuring anchorage and attachment to the support base.

As it is a prototype, the system is designed to cover an area of 140 m3, the resulting dimensions of the collector are 3m long and 80cm wide, the dimensions of the collector support are 3.35 m long, 1.01 m wide and 78cm high, the dimensions of the aluminium sheet are 3m. long by 1.2m wide.

The absorber used is a copper tube 2 inches in diameter by 3.5m long, with bell type reductions, from 2 to 1 inch and from 1 to ¾ inch to be able to couple the system with the plus pipe lines used.

Figure 5 Parabolic trough

Absorption machine

An absorption machine was used which, by means of the hot coolant produced by the parabolic channel circulating through it, generates the evaporation and condensation of the coolant located inside the machine.

4.- Connection of sensors and CompactRIO.

For the acquisition of data from the temperature, humidity and wind sensors, the connections were made to the National Instruments modules used, as shown in Figure 6.

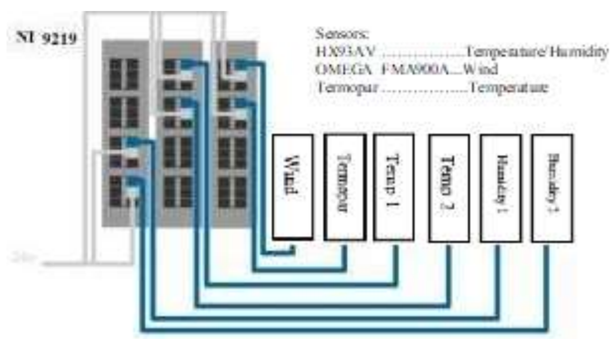


Figure 6 Universal Module Connections

As can be seen in the image, in the universal module 1 (NI-9219) the humidity sensor 1 was connected in channel 2, while in the same module, but in channel 3, the humidity sensor 2 was connected, both are connected in pins 4 and 5 of their respective channels, while pin 4 is where the signal is connected, pin 5 is where the neutral is connected.

It can also be observed that in the universal module 2 (NI-9219) the temperature sensor 1 was connected in channel 0 while in the same module, but in channel 1, the temperature sensor 2 was connected, in the same way that the humidity sensors are only connected in pins 4 and 5 of their respective channels. In the universal module 3 (NI-9219), the wind sensor was connected to pins 4 and 5 of channel 0, while in the same module, but in pins 4 and 5 of channel 1, a thermocouple sensor was connected to monitor the temperature in the absorption machine.

The sensors are connected to the different modules, which can be directly manipulated as double signals by means of the LabVIEW software, so that they can be monitored and, with the help of the different programming structures, assigned an important action for the correct operation of the solar cooling system. The following figure shows the connection of outputs which activate the relay boards to which they are connected (fan speed, pump start and ON/OFF lights). This helped to be able to handle high voltages not supported by the CompactRIO modules such as 127V AC.

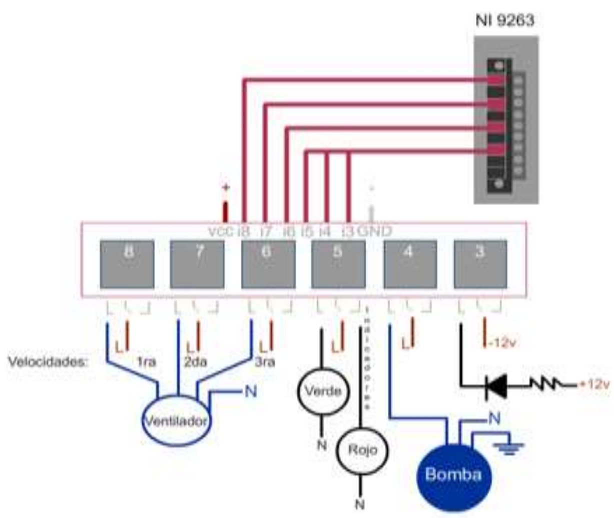


Figure 7 NI-9263 Module Connections

4. Tests

The system is tested under different circumstances to see what temperatures were reached in the parabolic trough, cooler and room, all these readings are automatically recorded in an Excel sheet through LabVIEW, the scenarios are with auxiliary boiler located in the accumulator, with auxiliary boiler located in absorption machine, without auxiliary boiler, with sun, cloudy, etc.

01/05/2019							Room		Machine Input	Meteorological		
	Colector Input		Colector Output		Absorption machine							
Time	rogra m	yrome ter	rogra m	yrome ter	rogra m	yrome ter	rogra m	yrome ter	yrome ter	Wind	Tempe rature	Status
13:30												
13:45		33		32.8		30.4		30.5	33	0	29	Cloudy
14:00		32.4		32.8		29.6		29.8	33.1	8	30	Cloudy
14:15	35	31.9	35	32.4	32	29.9	30	30.1	31.9	13	30	Cloudy
14:30		32.5		35.3		31		31.3	32.9	13	30	Cloudy

Table 1 Temperature recordings in the parabolic trough, chiller and room with auxiliary boiler located in the storage tank

05/04/2019												
	Colector Input		Colector Output		Absorption machine		Room		Entrada máquina	Meteorological		
Time	Program	Pyrometer	Program	Pyrometer	Program	Pyrometer	Pyrometer	Program	Pyrometer	Wind	Temp	Status
13:15		28		30.3		29.4		29.1	49.4	8	28	Cloudy
13:30	32.8	30.7	31	30.2	28.5	29	27.6	28.5	95.5	8	28	Cloudy
13:45	33.4	30.7	31.1	30.1	28.1	28.2	27.6	27.8	95.1	8	28	Cloudy
14:00	33.8	31	31.2	30.4	28.8	27.4	29	27.5	88.3	10	28	Cloudy
14:15	34.4	30	31.5	29.3	28.7	27.5	27.9	27.2	90.5	10	25	Cloudy
14:30	34.4	29	30.7	28	28.5	27.5	27.4	27.4	55	15	25	Cloudy
14:45	33.5	28.5	30	28	28	27	27.8	26.6	56.4	10	25	Cloudy

Table 2 Temperature recordings in the parabolic trough, chiller and room with auxiliary boiler located in the absorption machine

Results

A cooling system was designed using a parabolic trough with a solar tracker, complemented with an absorption machine to maintain the temperature of a greenhouse at 24°C, a specialised software interface and data collection with CompactRIO is integrated into the design.

The system allows the monitoring and control of temperature, humidity and ventilation of a room with a volume of $140m^3$.

The behaviour of the system shows favourable results in the control of the established variables of interest, which are humidity, ventilation and temperature, which was the main objective at the beginning.

Given the characteristics, the size of the prototype and the volume to be covered, the feasibility and viability of using the system on a larger scale to cover larger volumes is determined.

Conclusions

It is concluded that the prototype performs the heat transfer in such a way that the absorption machine generates the required cooling with the heat accumulated by the parabolic trough. Operational limits of the parabolic trough, the absorption machine and the feasibility of the system to scale up to a one hectare greenhouse were established.

Recommendations

It is recommended to continue with the research and implementation of systems that use alternative energies that contribute to the reduction of polluting emissions to the environment.

Acknowledgements

The Authors would like to thank the Technological University of Chihuahua for their collaboration and interest in this research project.

Referencias

Cano M, J. M. (2002). Refrigeración por absorción. Interés energético e impacto ambiental. *Comité Científico ATECYR.* Obtenido de http://www.cientificosaficionados.com/energia%20solar/aire%20acondicionado.pdf.

Duffie, J. A., & Beckman, W. A. (2005). *Solar Engineering of thermal processes* (3era edición ed.). Wiley.

Franco, A., Valera, D., & Peña, A. (2014). *Energy Efficiency in Greenhouse Evaporative Cooling Techniques: Cooling Boxes versus Cellulose Pads*. (A. S. Develop, Editor, & MDPI) Recuperado el 1 de 08 de 2023, de https://www.mdpi.com/1996-1073/7/3/1427.

INEGI. (23 de mayo de 2023). Obtenido de Instituto Nacional de Estadística y Geografía: https://inegi.org.mx/contenidos/app/areasgeograficas/resumen/resumen_08.pdf.

NI. (2014). Insdustrial Comunications for EtherCAT Installation Guide. (N. Instruments, Ed.) Obtenido de https://www.ni.com/pdf/manuals/374786a.html.
NI. (3 de 01 de 2018). *www.ni.com*. (N. I. Corp., Productor) Recuperado el 2023, de Sistemas CompactRIO: https://www.ni.com/es-mx/shop/compactrio.html.

NI. (15 de febrero de 2023). *www.ni.com*. (N. I. Corp., Productor) Obtenido de Cree interfases de usuario para pruebas: https://www.ni.com/es-mx/shop/labview/monitor-interact-test.html.
Serna, A. (2010). *Guia practica de sensores.* Copyright SL.

Article

Journal of Technical Invention

June 2023 Vol.7 No.19 15-23

Web system for vehicle management in a University Center

Sistema web para la gestión vehícular en un Centro Universitario

ZAMORA-RAMOS, Víctor Manuel[1]†*, JIMÉNEZ-RODRÍGUEZ, Mario[1], PULIDO-GONZÁLEZ, Hector[1] and MACÍAS-BRAMBILA, Hassem Rubén[2]

[1]*Universidad de Guadalajara – Centro Universitario de Ciencias Exactas e Ingenierías, Blvd. Marcelino García Barragán No. 1421, Col. Olímpica, CP 44430*
[2]*Universidad Tecnológica de Jalisco – Av. Luis J. Jiménez No. 577, Col. Primero de Mayo, CP. 44970, Guadalajara, Jalisco. México*

ID 1st Author: *Victor Manuel, Zamora-Ramos* / **ORC ID**: 0000-0001-9537-6630, **CVU CONAHCYT ID**: 903643

ID 1st Co-author: *Mario, Jiménez-Rodríguez* / **ORC ID**: 0000-0001-5073-473X, **CVU CONAHCYT ID**: 1044155

ID 2nd Co-author: *Héctor, Pulido-González* / **ORC ID**: 0000-0002-8619-3012, **CVU CONAHCYT ID**: 313575

ID 3rd Co-author: *Hassem Rubén, Macías-Brambila* / **ORC ID**: 0000-0002-6540-7464, **CVU CONAHCYT ID**: 902812

DOI: 10.35429/JOTI.2023.17.9.15.23 Received January 12, 2023; Accepted June 24, 2023

Abstract

This article presents the development process of a web application designed to manage the entrances and exits of institutional vehicles at the University Center for Exact Sciences and Engineering of the University of Guadalajara, under the supervision of the Coordination of General Services. A detailed description of the analysis, design and development of the project is provided. The web application was developed in the Mobile Programming and Innovation Laboratory, with the purpose of digitizing and automating the vehicle registration and control process, replacing the manual filling of sheets or folios with an efficient web system. The main objective of the project was to improve the efficiency and precision in the registration of departures and returns of vehicles, through the capture, storage and consultation of various data related to drivers, vehicles, itineraries, fuel, tools and equipment, mileage, among others. Relevant aspects for vehicle control. The development of the project was carried out applying the agile SCRUM methodology, which is characterized by its focus on adaptability, iterative delivery, effective collaboration, value generation and efficient risk management. SCRUM allowed greater flexibility in development, ensuring customer satisfaction and alignment with their needs and expectations.

Scrum, Software, Web System

Resumen

El presente artículo presenta el proceso de desarrollo de una aplicación web diseñada para gestionar las entradas y salidas de vehículos institucionales en el Centro Universitario de Ciencias Exactas e Ingenierías de la Universidad de Guadalajara, bajo la supervisión de la Coordinación de Servicios Generales. Se brinda una descripción detallada del análisis, diseño y desarrollo del proyecto. La aplicación web se desarrolló en el Laboratorio de Programación e Innovación Móvil, con el propósito de digitalizar y automatizar el proceso de registro y control vehicular, sustituyendo el llenado manual de hojas o folios por un sistema web eficiente. El objetivo principal del proyecto consistió en mejorar la eficiencia y precisión en el registro de salidas y retornos de vehículos, mediante la captura, almacenamiento y consulta de diversos datos relacionados con conductores, vehículos, itinerarios, combustible, herramientas y equipo, kilometraje, entre otros aspectos relevantes para el control vehicular. El desarrollo del proyecto se llevó a cabo aplicando la metodología ágil SCRUM, que se caracteriza por su enfoque en la adaptabilidad, entrega iterativa, colaboración efectiva, generación de valor y gestión eficiente del riesgo. SCRUM permitió una mayor flexibilidad en el desarrollo, asegurando la satisfacción del cliente y la alineación con sus necesidades y expectativas.

Scrum, Software, Sistema Web

Citation: ZAMORA-RAMOS, Víctor Manuel, JIMÉNEZ-RODRÍGUEZ, Mario, PULIDO-GONZÁLEZ, Hector and MACÍAS-BRAMBILA, Hassem Rubén. Web system for vehicle management in a University Center. Journal of Technical Invention. 2023. 7-19: 15-23

*Correspondence to Author (e-mail: victor.zamora@academicos.udg.mx)
† Researcher contributing as first author.

Introduction

The efficient management of general services plays a fundamental role in the optimal functioning of any educational institution or academic center. In this sense, the Centro Universitario de Ciencias Exactas e Ingenierías (CUCEI) has faced challenges in the Coordination of General Services (CSG), specifically in the control and registration of entry and exit of official vehicles. Currently, a paper-based registration system is used, in which drivers must manually complete information on related administrative tasks, such as the acquisition of supplies or the distribution of personnel. However, this approach presents several limitations and challenges that affect the efficiency and accuracy of vehicle control management. Some of the problems identified include:

– Inefficient operations: The manual process of filling out the log sheets takes considerable time, which negatively affects the efficiency of vehicle control management. The personnel in charge must spend a significant amount of time manually capturing data, which slows down operations and limits responsiveness.

– Risk of transcription errors: When completing log sheets manually, there is an increased risk of transcription errors. These errors can affect the accuracy and reliability of the recorded data, which could have adverse consequences on decision making and planning of vehicle services.

– Difficulty in accessing and consulting information: With the paper-based system, accessing and consulting the necessary information becomes a tedious process and limited in terms of availability. Authorized personnel must search and review the physical sheets, which hinders agile decision making and efficient planning of vehicle services.

Faced with this problem, the CSG has sought a solution through collaboration with the Mobile Programming and Innovation Laboratory (CuceiMobile), which is part of the CUCEI and aims to develop software solutions on various platforms for the benefit of the university community.

Methodology

The development of the project took place in 2021 and the SCRUM methodology was adopted. This methodology, defined by Schwaber and Sutherland (2020) as a "framework within which people can address complex and adaptive problems while delivering products productively and creatively," is characterized by its adaptability, focus on iterative delivery, effective collaboration and communication, generation of business value, and efficient risk management. These attributes resulted in successful project execution, enabling greater efficiency, accuracy and customer satisfaction. The roles played in the project were as follows:

– Scrum Master: This figure assumes responsibility for ensuring the correct implementation of the Scrum process and removing obstacles that may arise during development. In the case of this project, the role of Scrum Master was played by the Director of CUCEI Mobile.

– Product Owner: The Product Owner represents the interests of the customer and is responsible for defining and prioritizing product requirements. In the context of the project, the CSG assumed the role of Product Owner, ensuring the objectives and needs of the institution.

– Development Team: This team, composed of 3 members, was responsible for carrying out the tasks necessary to deliver the product increments. Their work involved the implementation of the proposed software solutions, as well as the resolution of technical challenges and the optimization of the final result.

The combination of these roles, properly coordinated and closely collaborating, allowed the smooth progress of the project, the adaptation to changes and the achievement of the established objectives. The application of the SCRUM methodology in the development of the vehicle control management project at CUCEI has proven to be an effective approach to achieve a successful and satisfactory execution of the project.

Analysis

The first component developed was the Product Backlog, which integrates the information provided by the client and relevant to the project. In this phase, the functions to be implemented, the specific requirements to be met and their priority are described. Requirements determination, as defined by Sommerville (2016), is the process of discovering, analyzing, documenting and verifying the services, constraints and system needs to be met by a software product. This process is fundamental in software development, as it lays the foundation for system design, implementation and testing.

It is essential to understand and clearly define the system requirements to ensure that the software meets customer expectations and needs for requirements gathering, we used interviews with drivers, the vehicle fleet manager, and the general services coordinator were used to gather requirements. In addition, a documentary analysis of the printed forms used for vehicle registration and the electronic documents generated was carried out.

Once the interviews and the printed and electronic formats were obtained, the findings were classified and categorized, which resulted in the integration of the Software Requirements Specification (ERS) document using the IEEE Std 830-1998 template of the Institute of Electrical and Electronics Engineers (IEEE, 1998). This document specifies the different types of users, their characteristics, the scope of the system and both functional and non-functional requirements. Tables 1 and 2 show an extract of specific requirements.

Number	R.F.1
Name	Create user
Type	[X] Requisite [X] Restriction
Source	Interview 13/01/20 Record 10
Priority	[X] High [ ] Medium [ ] Low

Table 1 Functional Requirement 1

Number	R.F.2
Name	Register Output
Type	[X] Requisite [ ] Restriction
Source	Interview 13/01/20 Record 14
Priority	High [X] Medium [ ] Low [ ]

Table 2 Functional Requirement 2

Subsequently, the Sprint Backlog was defined, which is a document containing the list of tasks to be performed assigned to the team members in charge of developing them. The completion times for each task were specified and a Gantt chart was created for better organization. Within the Scrum methodology, a Sprint is a period of time, usually short, in which the development team works on a set of activities related to the system being designed. The duration of Sprints can be four weeks or even shorter, depending on the complexity of the project. Sprints determine the deliverables and allow module testing to be carried out.

In each Sprint, a Sprint Planning meeting is held, in which the team and the Product Owner participate to define the objectives, select the user stories and backlog items to be included in the Sprint. Team members met daily in the Daily Scrum (daily meeting) to share progress, plan tasks for the next meeting and discuss any impediments that have arisen in the execution of the plan. These meetings should last no longer than 15 minutes. For work management, the Kanban methodology, defined by Taiichi (1988), was used, which helps the development teams to visualize, limit and optimize work by creating notes with the tasks on a board composed of sections such as "to do", "in progress", "tested" and "finished".

Design

In this phase of the project, the architectural design of the application is carried out, focusing both on its general structure and on the organization of the data in the Database.. The process begins with the development of a block diagram that provides an overview of the modules or fragments of functionality and/or models of the application. This diagram is useful for determining the data flow, process inputs and outputs. Figure 1 shows the blocks of the developed system.

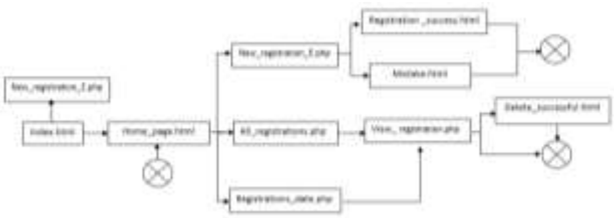


Figure 1 Block Diagram

Subsequently, a class diagram is elaborated to provide a more specific level of detail. According to Rumbaugh *et al*. (2007), this diagram is composed of the classes that make up the system, including their attributes, methods and relevant relationships. This approach allows the precise identification of the classes necessary for the system to function, as well as the auxiliary fragments that may be required.

The architectural design focuses on establishing a solid and coherent structure for the application, defining the interactions between the different components and ensuring that data is stored and accessed efficiently in the database. This design provides a clear view of the organization and functionality of the system as a whole. To provide greater detail, Class-Responsibility-Collaboration Cards (CRC) were used. These cards are used to describe the nature of each class and the relationships to be maintained in the system. Table 3 corresponds to the CRC card of the user class.

Clase:	**Usuario**
Responsabilidad	**Colaboración**
-Registrar Vehículo -Registrar Salida -Registrar Entrada -Registrar Falla	-Vehículos -Mantenimientos -Movimiento

Table 3 User Class CRC Card

For the modeling of the scenarios in which users interact with the system, a use case diagram was used. This type of diagram allows to graphically visualize the interactions between the actors and the system, which provides a clear view of the responsibilities of each user. The use case diagram models the behavior that the system will have, see Figure 2.

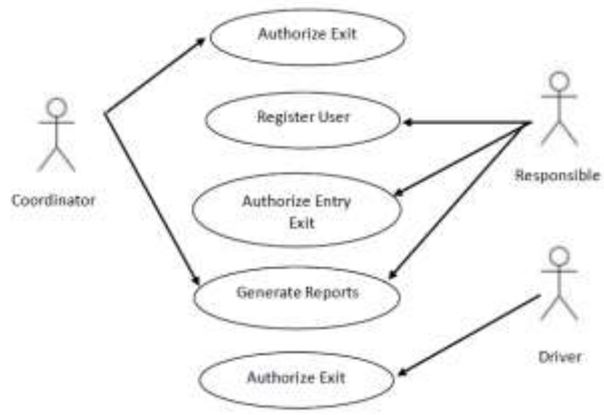


Figure 2 Use Case Diagram

As a complement to the use case diagrams, a detailed definition of each one of them was made. In this documentation, the activities of the actor and the activities of the system, as well as the alternative

The actor's activities and the system's activities were specified, as well as the alternative conditions that may arise. The project documentation was elaborated based on the diagrams that integrate the Unified Modeling Language (UML).

In addition, several activities were carried out in this design to ensure its correct implementation. These activities included the identification of actors, entities and object communication, as well as the use of the UML development standard to represent the use cases. In the area of semantic data design, an entity-relationship diagram was developed to define the logical structure of the data, as well as a relational model and the definition of the data for the database. data for the database.

ISSN 2523-6792

June 2023 Vol.7 No.19 15-23

Development

The application development phase was carried out in collaboration with students participating in the social service at CuceiMobile. During this stage, the Visual C++ programming language was used for the coding of the site, while the database manager used was MariaDB.

In order to achieve an efficient user interface design, we implemented the pattern Model-View-Controller (MVC) pattern was implemented. This design This design pattern is widely recognized in software engineering and is used to manage user interactions, present data in an appropriate manner and ensure proper communication with the domain layer. The MVC pattern divides the application into three main components: the model, which represents the data and business logic; the view, responsible for presenting information to the user; and the controller, which acts as an intermediary between the model and the view, managing interactions and updates.

The choice of Visual C++ as the programming language and MariaDB as the database manager was based on its wide adoption in the field of application development environment and its ability to provide a robust and efficient environment. In addition, the implementation of the MVC pattern in the user interface design ensured an organized and modular structure, facilitating the maintenance and scalability of the system.

The collaboration with the student social service providers in CuceiMobile not only provided a learning opportunity and hands-on experience for the participants, but also allowed the development of the application in a collaborative manner, fostering the exchange of knowledge and skills. This collaboration reflects the importance of the active participation of the academic community in software development projects, promoting the integral formation of students and strengthening the ties between academia and industry.

Access to the web portal is with the link: http://148.202.152.33/ControlVehicular/Index.html, the user to enter must log in, as shown in Figure 3.

Figure 3 Portal access view

The application interface plays a key role in the registration and tracking of vehicles, providing various functionalities to optimize the management of vehicle services at CUCEI. Among the main features are:

– Creation of vehicle output records: The person responsible for the general services area has the ability to generate output records for official vehicles. These records contain relevant information, such as the reason for the departure, the destination and the estimated duration of the trip. This data is essential to keep accurate control of vehicle travel and effectively plan resources.

– Authorization of records: Departure logs generated by the area manager must be authorized by the CSG holder before vehicles can depart. The purpose of this authorization is to ensure that departures are carried out in accordance with established policies and regulations, thus guaranteeing the proper use of vehicles and the optimization of institutional resources.

ISSN 2523-6792

– Consultation of generated records: The main interface allows access to all vehicle departure records in the system. This function facilitates the review and tracking of the departures made, providing an overview of vehicle movements in the school. In addition, additional details can be obtained for each record, such as the assigned driver, mileage and associated comments.

– Date-specific search: To speed up information retrieval, the main interface also offers the possibility to perform date-specific searches. This functionality allows filtering of vehicle output records according to a specific date range, which is useful for analyzing travel history over a given period or for specific reporting.

The implementation of these functionalities in the main interface, as shown in Figure 4 of the application, contributes significantly to improve the efficiency and accuracy in the management of vehicle services. and accuracy in the management of CUCEI's vehicular services. In addition, the use of a digital system for vehicle registration and tracking offers obvious advantages compared to traditional paper-based methods, such as reduced transcription errors and increased availability and accessibility of recorded information. This aligns with current developments in the field of general service management and the adoption of technological solutions that improve operational efficiency and promote data-driven decision making.

Figure 4 Main interface

The creation of records in the application is carried out using the following excerpt from the user interface shown in Figure 5.

Figure 5 Record Creation

The creation of logs is a fundamental step in the process of managing vehicle services, as it allows for the accurate documentation and recording of information related to vehicle departures. This information is not only necessary to keep proper control of trips, but also provides valuable data for analysis and decision making in fleet management.

The user interface designed for log creation has an intuitive the user interface designed for the creation of records presents an intuitive and user-friendly structure, facilitating the capture of relevant data. Specific fields and options have been implemented to allow the necessary information to be entered efficiently. In addition, usability and user-centered design principles have been applied to ensure a smooth and satisfactory experience during the registration process.

The design of effective and efficient user interfaces is a widely studied topic in the field of Human-Computer Interaction (HCI). Various theories and methodologies supported by scientific research, including Norman (2013), Shneiderman and Plaisant (2009) have demonstrated the importance of a user-centered design that is tailored to the needs, abilities and expectations of users. The use of intuitive and well-designed interfaces not only improves efficiency and accuracy in data capture, but also contributes to user satisfaction and error reduction.

In short, the creation of records in the application is done through a carefully designed and user-friendly user interface user interface. The record view provides a detailed and visual description of this interface, giving users a practical guide to use it correctly and effectively. The focus on user-centered design and the application of usability and intuitive design principles ensure an optimal experience during the registration process, thus improving the quality of the data collected and facilitating the management of vehicle services.

The web application allows users to access the registration information generated through data query. The ability to query the records generated in the web system is of vital importance for the management and monitoring of the activities related to vehicle services. Through this functionality, users can quickly access the necessary information and perform data-driven analysis for informed decision making. This interface features graphical elements and filtering options that facilitate efficient search and retrieval of information. Intuitive and user-friendly controls, such as search fields, filters by relevant criteria and sorting options, have been implemented to allow smooth navigation and exploration of records.

In addition to general record queries, the system also offers the ability to perform date-specific queries. The ability to query by date is very useful in the management of in the management of vehicle services, as it allows users to obtain specific records within a given time range. This facilitates the identification of patterns, the generation of reports and the evaluation of performance over specific periods.

Testing

For Pressman (2014) software testing is a systematic evaluation process to determine the quality of a software system or component. This process involves the execution of a program or system with the intention of discovering errors, evaluating its behavior against established requirements, and ensuring that it meets its intended objectives. Thus, the web system was subjected to rigorous testing at various stages of the development process, from requirements verification to final acceptance testing. These tests played a key role in identifying and correcting errors and problems before the final implementation of the system.

In the initial stage, verification testing was performed to ensure that the system met the requirements set forth in the Software Requirements Specification (SRS) document. These tests focused on validating the main functions, such as user creation and vehicle registration, verifying that they were carried out accurately and without errors. Non-functional requirements, such as security and usability, were also evaluated to ensure compliance and adequate performance. Subsequently, integration tests were carried out in order to evaluate the interaction between the different components of the system. During this phase, it was verified that the communication between the modules and the database worked correctly, ensuring that the data were stored and retrieved properly. In addition, tests were performed to detect any conflicts or incompatibilities between the system elements, in order to ensure that they were properly integrated and worked together.

Once the integration tests were completed, we proceeded to perform system tests, the objective of which was to evaluate the overall functioning of the system.

The objective of these tests was to evaluate the overall performance of the system. During this phase, real use situations were simulated to evaluate the performance, scalability and stability of the system. The system was tested to ensure that it could efficiently handle a high volume of vehicle check-ins and check-outs, and that it responded quickly and appropriately to user requests.

Finally, acceptance tests were carried out, in which the CSG actively participated. These tests were conducted to ensure that the system met the organization's specific expectations and needs. The presence and functionality of all required features was verified, as well as the ease of use and intuitiveness of the system for end users. CSG's comments and suggestions were considered and the necessary corrections were made before the final implementation of the system.

In summary, software testing played a critical role in the process of developing the web system for the CSG. These tests ensured the quality and efficiency of the system by identifying and correcting errors at different stages of development.

They also ensured compliance with the established requirements and usability of the system for CSG users. Through the application of exhaustive tests, a reliable and functional system that meets the organization's needs was obtained.

Results

The use of the Scrum methodology in the development of the vehicle control application provided positive results in terms of adaptability, iterative value delivery, effective collaboration, value generation and efficient risk management. These results contributed to the success of the project by ensuring customer satisfaction, early delivery of valuable functionality, and adaptation to the changing needs of vehicular control.

The use of the IEEE Std 830-1998 template in the development allowed for complete and accurate documentation of the system requirements. As well as the interviews allowed for effective communication between the development team and the between the development team and the customer to understand the needs and expectations of the end users.

For the selection of the development environment used for the construction of the web system, as well as the database the selection of the development environment used for the construction of the web system, as well as the database manager had no restrictions, however, we opted for the use of free access technologies, since it facilitates the adaptation as it does not represent costs for the acquisition of licenses.

The use of the controller view model allowed the delimitation of responsibilities, code reuse, ease of testing, flexibility, scalability, and collaboration among project members. All this contributed to make the development more structured, modular, maintainable; which facilitated the delivery of a higher quality software product, facilitating future modifications and improvements in the system.

To ensure access, efficient management, consistency, quality, integration, security, and data access control, it was determined that data storage would be centralized, providing a solid basis for analysis and informed decision making.

By having all data in one place, it is easier to perform queries, generate reports and obtain a holistic view of the information, which can help in identifying patterns, trends and opportunities for improvement.

The designed interfaces offer efficient search and retrieval functionalities, allowing users to access and analyze the information in the records in an intuitive way. The inclusion of visual annexes in the article supports readers' understanding and strengthens the validity of the research presented.

The use of exhasaustive software testing in the development of the web system enabled early detection of bugs, improved software quality, reduced risks, saved time and costs, increased client confidence, and facilitated system maintainability. This contributed to more efficient, reliable and successful software development.

Conclusions

The implementation of the web system for the General Services Coordination at the University Center of Exact Sciences and Engineering has proven to be a highly effective and successful solution to optimize the management of official vehicle departures.

In terms of the results obtained, there has been a clear improvement in the efficiency of operations related to vehicle control. The automation of the vehicle check-in and check-out process has significantly reduced the time required to carry out these activities. This has allowed a more agile management of resources and a faster response to the demands of the educational center.

In addition, a considerable increase in data accuracy has been observed. The elimination of the manual process of recording on paper sheets has reduced the likelihood of transcription errors. As a result, the information recorded in the system is more reliable and accurate, which has improved decision making based on up-to-date and accurate data. Another important benefit of the system is the ease of access and consultation of the information. Thanks to the web-based system, authorized users can access vehicle records quickly and easily, eliminating the need to search and review physical sheets.

This has saved time and improved the ability to search and retrieve relevant information, which is essential for efficient and effective management.

In conclusion, the implementation of the web-based system at CSG has proven to be a highly beneficial solution to optimize the management of official vehicle departures. The agile methodology used, the results obtained in terms of efficiency and data accuracy, as well as the ease of access and consultation of the information, support the effectiveness and positive impact of this system at the University Center for Exact Sciences and Engineering.

References

Date, C.J. (2001). *Introducción a los sistemas de bases de datos*. Pearson Education.

Fowler, Martin & Kendall Scott. (1999). *UML gota a gota*. Addison Wesley.

IEEE. (1998). IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications. Recuperado el 20 de mayo de 2017, de C - IEEE Computer Society Sitio web: https://standards.ieee.org/findstds/standard/830-1998.html.

Larman, Craig (2003). *UML y Patrones. Una introducción al análisis y diseño orientado a objetos y al proceso unificado*. Prentice Hall. Macías, H., Zamora, V., Becerra, V., Osorio, S. (2019). Aplicación web para la gestión de planes e informes de trabajo académico de profesores para Instituciones de Educación Superior. Revista de Tecnología y Educación, 3(7), 18-25. https://doi.org/ 10.35429/JTAE.2019.7.3.18.25. Norman, D. A. (2013). The design of everyday things. MIT Press.

Pressman, R. S. (2014). *Ingeniería del Software: Un Enfoque Práctico*. McGraw-Hill Interamericana de España. Rumbaugh J., Jacobson I., & Booch G. (2007). *El lenguaje unificado de modelado, manual de referencia*. (2a ed.). PEARSON, Addison Wesley.

Schwaber, K., & Sutherland, J. (2020). *The Scrum Guide: The Definitive Guide to Scrum: The Rules of the Game*. Scrum.org.

Shneiderman, B., & Plaisant, C. (2009). *Designing the user interface*. (5a ed.). Addison Wesley Longman Sommerville, I. (2016). *Software Engineering*. (10a ed.). Pearson.

Taiichi, O. (1988). *Kanban: A System for Just-in-Time Delivery*. Productivity Press. The Scrum Guide. (2020). Recuperado de https://www.scrumguides.org/scrum-guide.html Tuya, Javier; Ramos Roman, I. & Dolado Cosín, J. (2007). Técnicas cuantitativas para la gestión en la ingeniería de software. Netbiblio. Páginas 49-53.

ISSN 2523-6792

Article

Journal of Technical Invention
June 2023 Vol.7 No.19 24-29

Decision support system for environmental monitoring systems using data logs

Sistema de apoyo para la toma de decisiones en sistemas de monitoreo ambiental utilizando Data Log

CABALLERO-LÓPEZ, Emma Isabel†*, VÁZQUEZ-ROSAS, Sergio, HERNÁNDEZ-SÁNCHEZ, Uriel Alejandro and MALAGÓN GONZÁLEZ, Gonzalo

Universidad Tecnológica del Centro de Veracruz, Ingeniería en Mantenimiento Industrial, Av. Universidad 350, Cuitláhuac, C.P. 94910, Veracruz, México

ID 1st Author: *Emma Isabel, Caballero-López* / **ORC ID**: 0000-0002-6486-9368, **Researcher ID Thomson**: ABH-3859-2020, **CVU CONAHCYT ID**: 660625

ID 1st Co-author: *Sergio, Vázquez-Rosas* / **ORC ID**: 0000-0002-3259-382X, **Researcher ID Thomson**: P-8011-2018, **CVU CONAHCYT ID**: 857794

ID 2nd C-oauthor: *Uriel Alejandro, Hernandez-Sánchez* / **ORC ID**: 0000-0003-1488-3601, **Researcher ID Thomson**: Q-2907-2018, **CVU CONAHCYT ID**: 482289

ID 3rd Co-author: *Gonzalo, Malagón-González*

DOI: 10.35429/JOTI.2023.19.7.24.29

Received January 12, 2023; Accepted June 24, 2023

Abstract

This article describes the proposal of a support system for decision-making in agricultural automation using Data log, which is mainly focused on rice cultivation. This project has an Excel program (programming in Macros) configured to save temperature and humidity data in real time, as well as the date and time the data are recorded, in the same way they are presented graphically to facilitate the visualization of its advance or backward movement, it has functions that will allow to restart the data already saved (table and graph), this will help reduce times when eliminating data by data, in the same way it can be reusable as many times as necessary ; all of the above in order to provide a good production to farmers, reducing losses that are had with this grass, and avoiding unnecessary payment of catastrophic insurance.

Data log, Environmental monitoring, PLC, agricultural, crop, macros, reduce, automation

Resumen

En el presente trabajo se describe un sistema de apoyo para la toma de decisiones efectiva en el monitoreo ambiental utilizando Data log, enfocándose principalmente en el cultivo de arroz. El proyecto cuenta con un programa en Excel (programación en Macros) listo para guardar datos de temperatura y humedad en tiempo real, registrando la fecha y hora en que son guardados. Los datos se presentan de manera gráfica para facilitar la visualización de su avance o retroceso, cuenta con funciones que van a permitir reiniciar los datos ya guardados (tabla y gráfica), lo que ayudará a disminuir tiempos a la hora de eliminar dato por dato, para que de igual forma pueda ser reutilizable las veces que sean necesarias, con la finalidad de brindar una buena producción a los agricultores, disminuyendo pérdidas notorias que se tienen con esta gramínea, y evitando un pago innecesario de seguro catastrófico.

Data Log, Monitoreo ambiental, PLC, agrícola, cultivo, macros, reducir, automatización

Citation: CABALLERO-LÓPEZ, Emma Isabel, VÁZQUEZ-ROSAS, Sergio, HERNÁNDEZ-SÁNCHEZ, Uriel Alejandro and MALAGÓN GONZÁLEZ, Gonzalo. Decision support system for environmental monitoring systems using data logs. Journal of Technical Invention. 2023. 7-19: 24-29

† Researcher contributing as first author.

Introduction

In the processing industry, important decisions are made that lead to satisfactory financial remuneration, yet the agricultural industry has been underestimated, even though it is just as important as any other, because it provides the food basket that every human being needs to feed themselves, as well as generating income and jobs (Envira IOT, 2020).

The magazine Envira describes that one of the lines of development that is arousing most interest is precision agriculture, within the progressive digitalisation of the countryside. This can be defined as "an integrated agricultural information and production system that can collect precise data on each individual plot of land and thus personalise the cultivation of each site independently".

The newspaper "El dinero" mentions that rice production relies on technology to be competitive. The author of the newspaper mentions that the use of technology is taking over land preparation work (Severino Jairon 2013). The increase in labour costs has forced the search for more viable alternatives, as the planting, cultivation and harvesting of rice is one of the agricultural sectors with the highest technological absorption.

Over the years, the priority has been to reduce costs and maximise production in order to obtain better profits. Consequently, this has led to unemployment in the countryside, as it is a fairly high expense that, although it is a disadvantage for day labourers, for producers, the addition of technology to crops is a good alternative.

The article Technology for agriculture talks about Agriculture 4.0 as a result of the evolution of cyber-agriculture in which Big Data analysis, mobile communication and cloud services are introduced, thus seeking to merge the needs of the farmer with the most sophisticated advances in technology (HSBC Business Banking, 2019), in order to take advantage of the potential of the information that the field yields and change the way food systems are produced.

The aforementioned article reflects a strengthened relationship between the countryside and technology, which is why it is supported by bank financing, which seeks to help reduce losses in agriculture, as well as provide increased production for farmers.

Betzari Peláez mentions the impact of technology applied to agriculture, which, thanks to the arrival of technology and its positive use, has brought many favourable changes to agriculture (Peláez C. Betzari, 2017), for example: drones, telematic irrigation systems, seeders and tractors with GPS, etc. This has provided greater security by increasing farmers' production, and not only that, it has also improved the efficiency of business profitability.

With the above, we have another point in favour that corroborates once again that technology is extremely important in everyday life, especially in agriculture, because thanks to the good management of this tool, production, quality and profitability of the field can be improved.

In 2018, Seminis mentions the need for innovations to feed the world (Seminis, 2018), and that the agricultural industry increasingly presents new challenges as the population grows, so producers require all possible help in the innovations that technology can provide.

Methodology.

Figure 1 shows the methodology used in the development of this project, One of the most important activities in this project is the collection of data, because in order to start with the execution of the project it is of vital importance to know the temperature, humidity, type of soil, and everything necessary so that the project can be executed correctly and provide a good production (harvest); another important aspect is to register all the aforementioned data so that they can be executed correctly and the purpose is 100% satisfactory. Finally, there are the tests, which are essential to confirm that the project is working correctly, precisely at that moment is where it will be verified if something has failed (if so, the whole procedure must be reviewed again, to discover what was wrong), the tests must be carried out again and once it is ready, it can be executed.

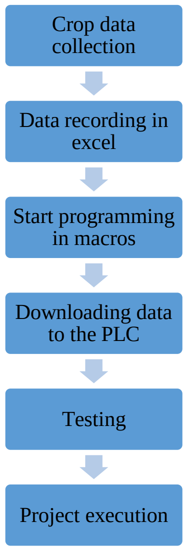


Figure 1 Project methodology
Source: Self Made

Development

After carrying out the research corresponding to the selected crop (necessary temperatures, humidity, type of soil, area in which the project will be implemented), the requested project begins, so a new spreadsheet must be opened to create the interface of user where the data registration will be carried out. The spreadsheet is one of the most used platforms for recording, storing and processing data, so using it for this purpose will facilitate the use of the information.

Spreadsheet settings

Headers were chosen, through the advice of an agricultural association, the table was stipulated with the following cells; Registration number, temperature, humidity, time and date. (Figure 2) The data will be recorded at the bottom of the headings, taking into account that, if the titles are very long, the cells must be reduced as desired and corresponding to each selected letter. This first table will be the one that connects the user and the process controlled by the PLC. While the second table will be responsible for showing the accumulation of data and the creation of the graph.

Data log			
Register number	CO_2	Temperature	Time and date
Register number	% Temperature	% Humidity	Time and date

Figure 2 Interactive and accumulation table creation
Source: Own Elaboration

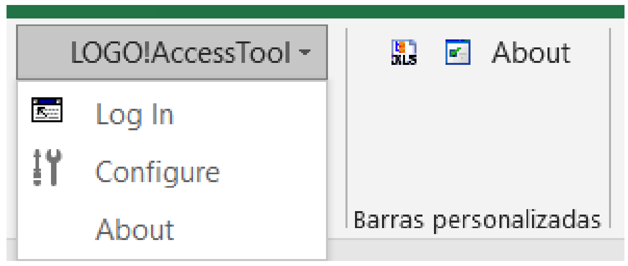


Figure 3 Coupling tool
Source: Own Elaboration

To establish communication between the spreadsheet platform and the local memory of the PLC, it is important to add an add-on to the system called "AccessTool" (Figure 3). This add-on will allow the use of reserved words (Table 1) as a formula for the transmission of data in text format.

Identifier	Reserved word
Digital Input	=LOGOVAR(“I1“)
Analogue Input	=LOGOVAR(“AI1“)
Digital Output	=LOGOVAR(“Q1“)
Analogue Output	=LOGOVAR(“VW1“)

Table 1 AccessTool reserved words
Source: Own Elaboration

You continue programming the date, for this you must select the cell in question, click on the tab that says "Formulas", select the option "Date and time", a window opens where at the end it says "Insert function", a new window opens and you must select the function "Now" (same function that contains a description "Returns the current date and time with date and time format") so the automatic time function will be programmed every time a data is added to the table.

Macro Configuration

For this section it is necessary to record macros, go to the "view" tab to select the macros option or use the command (Alt + F8), a window opens with three options (view macros, record macros, use relative references), select the option "record macros"; immediately a window opens, in which the name of the macro will be personalised, select "save in this book", a brief description can be added if desired.

ISSN 2523-6792

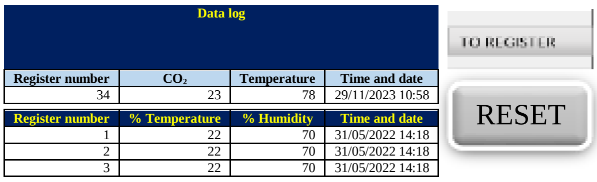


Figure 4 Insertion of functional buttons
Source: Own Elaboration

To add the function of the recorded macro to one of the buttons (Figure 4), you must position above the button that needs to perform the recorded function, to open the options window (cut, copy, modify text, modify points, hyperlink, assign macro, among others), right there, you must search and select the option "add macro", Afterwards, a dialogue box opens in which you must search for the name of the macro recording you made, select it, click on accept and you can start testing, recording data in the interactive table, and thus be sure that it is working correctly.

To insert now the "Reset" button, the same procedure is used, but with a different functionality; to delete the data in each cell of the accumulation table. To carry out the relevant tests and modifications that indicate whether the programme is working properly, the source code must be opened in Macros (Figure 5).

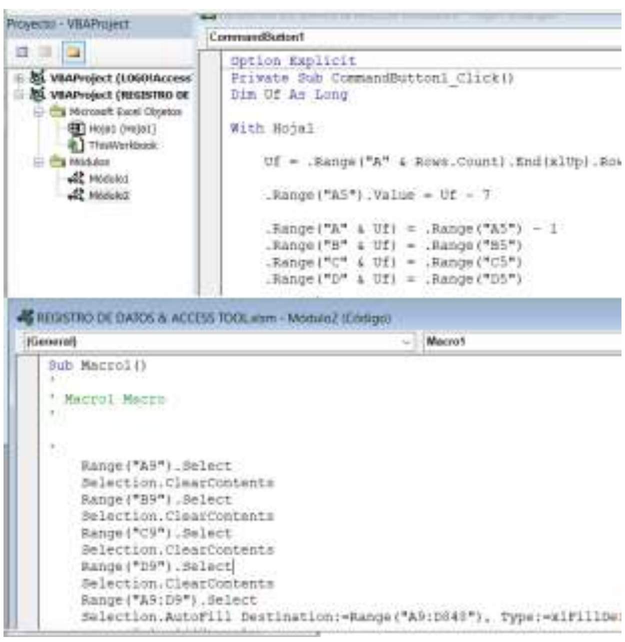


Figure 5 Code per functional module in Macros
Source: Own Elaboration

Graph Configuration

In order for the data that has been saved in the table to be reflected in a graph, you must select the information of the table that you want to graph, the option "Graphs" will appear, immediately the window changes and you must click on "insert", select "add graph", this will open a new window where you can choose the desired graph (column, line, circular, scatter, etc.), after this select the desired style of the graph (Figure 6). If the data provided in the chart automatically are not correct, they can be edited, this is by going to the chart, to customise and at the bottom will appear another one containing the options (delete, reset, change chart type, save as template, select data and plot line format) you must choose the "select data" option, then the legend entries (series) will appear, which you can delete or add more series to appear in column "Y" and column "X" in the chart.

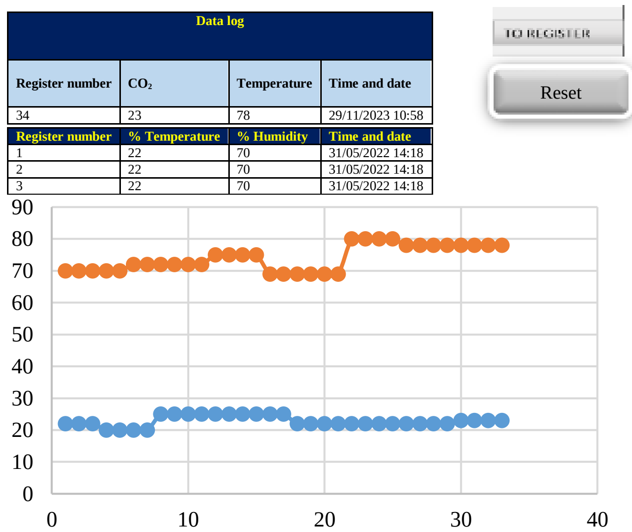


Figure 6 Scatter Graph
Source: Own Elaboration

PLC control programming

After having successfully completed the procedure in the spreadsheet, we will proceed to perform the relevant tests to support the decision to have successfully completed the required, for this as mentioned above, the data will be saved in the table and graph automatically, likewise will be removed from both the table and the graph by pressing the "Reset" button, will be tested, recording the data and observing that these have no problem when saved and deleted to continue recording data in this way. The aim of this is to reduce the time required to delete the saved data cell by cell, and if everything works favourably, the "support system" will have been successfully completed.

The control of the variables must be very simple, so that the user does not have any complications when making decisions. Therefore, an On-Off control using analogue threshold value switches and block logic was chosen, in addition to which a direct user interface was designed, using the features of the PLC. The control is designed exclusively for rice cultivation, and is also easily configurable for other types of products.

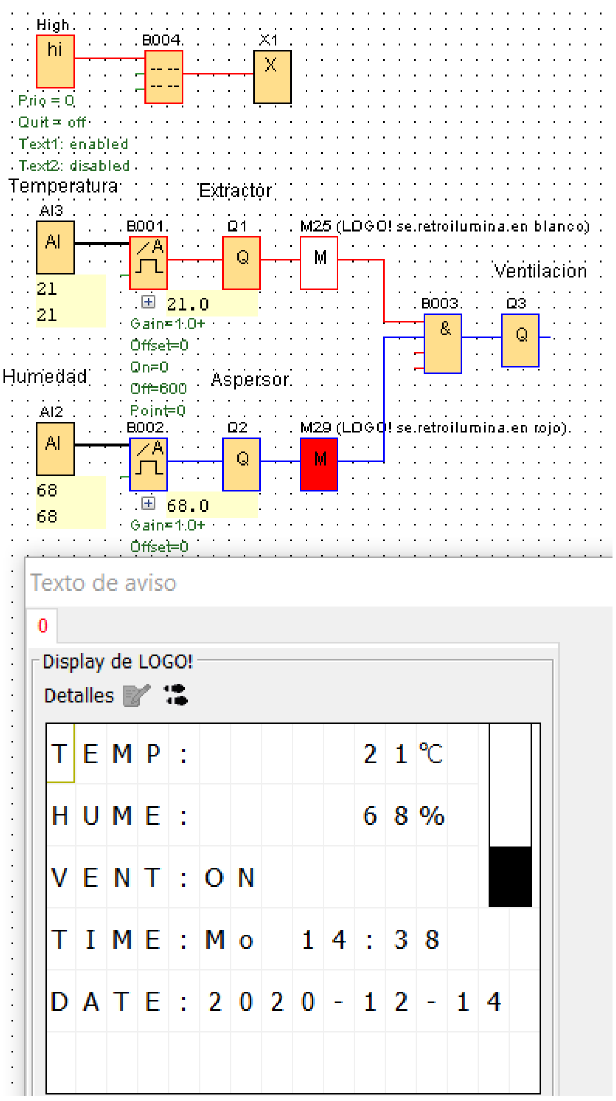


Figure 7 PLC programming
Source: Own Elaboration

Results

The system was elaborated with the purpose of registering agronomy variables, as well as to diminish losses that considerably affect the sowed product, it is an extremely important factor for the decision making since it favours the interpretation of the information, by means of a simple and friendly interface for the interested parties.

The aforementioned system implements an agricultural control system, making the most of one of the most evolved tools nowadays, such as programmable logic controllers (PLC) and spreadsheets, by manipulating and excluding factors that eradicate production, using them in a positive way to provide greater production, better quality and reduce wastage.

Conclusions

Veracruz is in the second place of rice production at national level, so it is mainly cultivated in the southern area, such as the Papaloapan basin, where there are numerous groups of farmers dedicated to produce it, in this study it was established that the most suitable type of sowing is: "Milagro filipino" and "Sica-4". Although analysing the quality and its improved variety, it is more common to use the former.

Temperature, solar radiation and wind have an influence on rice yield as they affect plant growth and physiological processes. This system indicated that the months of June and August are the most suitable for cultivating this grass, when there is more rainfall, as they require low temperatures and moist soil when sowing.

Other negative factors detected are pests, which reproduce and cause damage to the crop, causing irreversible problems in production due to the necessary temperatures required for sowing, and finally, diseases caused by fungi which attack various organs of the plant such as leaves, stem internodes, stalks and grains. These factors will be taken care of at a later stage thanks to the scalability of the system.

References

C., B. P. (8 de Diciembre de 2017). *SofOS*. Obtenido de Impacto de la tecnología aplicada en la agricultura: http://www.sofoscorp.com/impacto-tecnologia-aplicada-agricultura/

HSBC México, S. (18 de Junio de 2019). *HSBC Empresas*. Obtenido de Tecnología para la agricultura: https://www.empresas.hsbc.com.mx/es-mx/mx/article/tecnologia-para-la-agricultura

ISSN 2523-6792

IOT, E. (2 de Julio de 2020). *Actualidad*. Obtenido de Innovaciones y avances tecnológicos en la agricultura: https://enviraiot.es/innovaciones-en-la-agricultura-avances-tecnologicos/

Seminis, B. C. (13 de Julio de 2018). *Seminis*. Obtenido de Tecnología Agrícola: Innovaciones Para Alimentar Al Mundo: https://www.seminis.mx/tecnologia-agricola-innovaciones-para-alimentar-al-mundo/

Severino, J. (20 de Noviembre de 2013). *El Dinero*. Obtenido de La producción de arroz se auxilia de la tecnología para ser: https://www.eldinero.com.do/2488/la-produccion-de-arroz-se-auxilia-de-la-tecnologia-para-ser-competitiva/

Zhang, L. D. (2018). Internet of Things Applications for Agriculture. *Internet Of Things A To Z*, https://doi.org/10.1002/9781119456735.ch18.

[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-CONAHCYT) (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 Technical Invention. 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

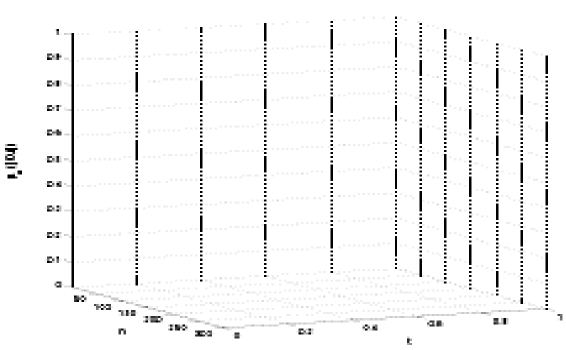
[Title No.12 in Times New Roman, single spaced and bold]

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.

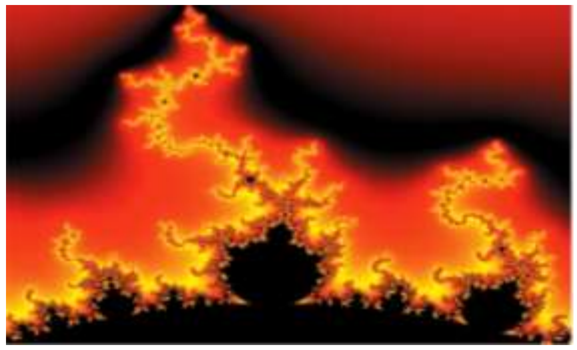


Figure 1 Title and *Source (in italics)*

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

Thanks

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

ISSN 2523-6792

Conclusions

Explain clearly the results and possibilities of improvement.

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

- Authentic Signature in Color of the Conflict of Interest Format of Author and Co-authors.

Reservation to Editorial Policy

Journal of Technical Invention reserves the right to make editorial changes required to adapt the Articles to the Editorial Policy of the Research Journal. Once the Article is accepted in its final version, the Research 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 Research 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 Technical Invention 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 Taiwan 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 Taiwan for its Journal of Technical Invention, 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

RESEARCH GATE (Germany)
GOOGLE SCHOLAR (Citation indices-Google)
MENDELEY (Bibliographic References Manager)
REDIB (Ibero-American Network of Innovation and Scientific Knowledge- CSIC)
HISPANA (Information and Bibliographic Orientation-Spain)

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

69 Street. YongHe district, ZhongXin. Taipei-Taiwan. 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,20-281 HB9-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

69 Street. YongHe district, ZhongXin. Taipei-Taiwan.

Journal of Technical Invention

ISSN 2523-6792