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Journal of Technological Prototypes

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Presentation of Content

In the first article we present *Intelligent prototype for the collection of small urban solid waste*, by ROSADO-CASTELLANOS, Damián Uriel, PACHECO-FARFÁN, Ivette Stephany, FUENTES-CHAB, Iván Humberto and CHABLE-JIMENEZ, Eliezer, with adscription in the Instituto Tecnológico Superior de Escárcega, in the next article we present *Design and development of a prototype for the drying of coffee from the use of sieves in a controlled environment*, by HERNÁNDEZ-SANDOVAL, Dennis Roberto, SOLÍS-JIMÉNEZ, Miguel Ángel, DEL VALLE-JUAREZ, Bárbara and CALDERON-PALOMARES, Luis Antonio, with adscription in the Instituto Tecnológico Superior de Huatusco, in the next article we present *Design of a lettuce dryer machine for the company JASL TETLA*, by VIVALDO-VICUÑA, Araceli, CORTEZ-CALDERÓN, Luis and CÓRDOVA-PULIDO, Miguel Ángel, with adscription in the Tecnológico Nacional de México/ San Martín Texmelucan, in the next article we present *Design of pictorial diagrams for the development of self-taught teaching electronics kits at the Instituto Tecnológico Superior de la Región Sierra*, by UTRILLA-DIAZ, Maricela, HERNANDEZ-VELASCO, Jonás, REYES-HERNANDEZ, Adán and PEREZ-GÓMEZ, Gerardo Ernesto, with adscription in the Instituto Tecnológico de la Región Sierra.

Content

Article **Journal of Technological Prototypes**
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Intelligent prototype for the collection of small urban solid waste

Prototipo inteligente para la recolección de residuos sólidos urbanos de tamaño pequeño

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Abstract

Wasting disposal systems are a crucial sector in society, improper management of solid urban waste (SUW) can be harmful to health and the environment. In the state of Campeche, Mexico, an average of 3528.32 KG of waste is collected by every person, around 227 people are hired for this activity. This means that the generation of waste exceeds the collecting capacity in the state. This work presents an intelligent prototype for the collecting of small SUW. To achieve this task, we designed and created a model based on different electronic components (Raspberry, sensors, camera, etc.), as well as we created and implemented a SUW collection algorithm for its autonomy. The design of the prototype consists of two metal structures and the electronic components are integrated into the Raspberry. The creation and implementation of the algorithm work with artificial

Prototypes, Urban Solid Waste Management, Intelligent Systems, Artificial Vision

Resumen

Los sistemas de eliminación de desechos son un sector crucial en la sociedad, un manejo inadecuado de los residuos sólidos urbanos (RSU) puede ser perjudicial para la salud y el medio ambiente. En el estado de Campeche, México se estima una media 3528.32 KG de desechos recolectados por persona de un total de 227 personas contratadas para esta actividad. Esto indica que la generación de desechos sobrepasa la capacidad de recolección en el estado. En este trabajo se presenta un prototipo inteligente para la recolección de RSU de tamaño pequeño. Para lograr esta tarea diseñamos y creamos un modelo basado en diferentes componentes electrónicos (Raspberry, sensores, cámara, etc.), así como creamos e implementamos un algoritmo de recolección de RSU para su autonomía. Los resultados muestran el proceso de desarrollo del prototipo, así como el código generado en el lenguaje de programación Python.

Prototipos, Manejo de Residuos Sólidos Urbanos, Sistemas Inteligentes, Visión Artificial

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Introduction

Throughout history, human activity has always generated solid urban waste (MSW). MSW is a heterogeneous material with different production rates and composition depending on the place and the season (Qdais H. et Al, 1997). Waste disposal systems are a crucial sector in human civilization (Hossain S. et Al, 2019), which can be harmful to health and the environment without proper management. Only in Campeche, Mexico the generation of MSW amounts to 800,930 Kilograms per day of which there are 227 people for the collection at the state level according to the study of (Ministry of Urban Development and Environment, SF) giving an average 3528.32 Kilograms per person, which indicates an excessive workload making it difficult to cover MSW collection in the state.

Waste disposal systems require the implementation of MSW collection automation. In different works of the state of the art, different solutions are proposed based on the creation of remote-controlled and autonomous robots with artificial vision techniques. In (Mehta N. et Al, 2018) they propose a solution based on the collection of MSW with Arduino, GPS and different elements, whereby means of Google Earth coordinates it recognizes the areas to be cleaned. In (Samano Villegas R.E et Al, 2016) a remote-control prototype based on Arduino and other electrical components for the collection of objects is proposed. (Shamim Hasan A. et Al, 2017) proposes a solution of an object collector using video transmission and remote control based on smart mobile devices based on Arduino and the Android operating system. In (Gourav S. et Al, 2017) a MSW collector is proposed for domestic homes and work offices, its proposed methodology is based on an intelligent algorithm to collect without the need for human intervention. (Almosalami A. et Al, 2018) propose a system for collecting MSW on beaches through a network of interconnected and tele-operated robots in a virtual reality environment. In (Khandare S. et Al, 2018) he proposes a robot to clean the MSW around a trash can based on image processing and an ultrasonic sensor.

(Hossain S. et Al 2019) proposes an autonomous MSW collector using a deep learning algorithm on a Raspberry Pi and electronic devices. In (Othman H. et Al, 2020) they propose the common elements, methodology and classification of cleaning systems as a basis for new collectors.

This article proposes the design and implementation of a RSU collector prototype based on artificial vision techniques, *Raspberry Pi* and other electronic components. The main objective is that autonomously and without human intervention perform a 360-degree search in the environment to locate objects classified as MSW and carry out the collection.

Methodology

For the development of the RSU collector prototype, see figure 1, a digital sketch developed in the Free version of the SketchUp design and modeling software is considered as the basis, which consists of two levels, plus a protective casing. The first level is intended to store the battery, travel and harvest servo motors. The second level stores the Raspberry Pi, the breadboard, and the connections to different electronic components. Finally, the protective casing allows the collector prototype to be turned on / off, as well as to contain the video screen so that the user can view the images of the robot's camera and its operation.

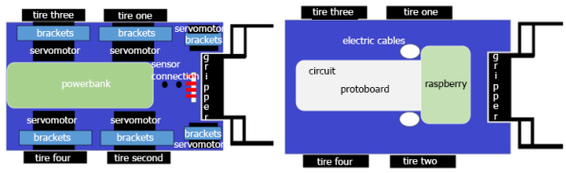

Figure 1 Digital sketch of the prototype. The Figure on the left is the first level of the prototype where battery and servo motors are integrated. The Figure on the right is the second level that contains the *Raspeberry Pi*, breadboard and connections
Source: (Own elaboration)

The integration of the electronic components considers different devices, see table 1, which allows the operation of the collection algorithm to search, locate and collect MSW.

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Component	Description
Breadboard	600 perforations with dimensions of 6.4 cm front by 8.6 cm high.
Set of cables	Dupont Type Cables. 40 plug-to-plug cables. 40 jacks to plug cables. 28AWG gauge. Length 15 cm.
Ultrasonic sensor	Tx and Rx sensor in one. Detection range 1.7 to 400 cm. 40kHz frequency. 15 degree opening angle and 5V power supply.
Servo motors	Servo motor with a 6.5 to 12 Kgf / cm stem with 360-degree rotation and 4.8-6V input with 100mA maximum. Weight of 55 grams with dimensions of 40 by 20 by 39 mm.
Raspberry Pi	Model 3B with 4GB of RAM.
Camera	Pi Cam version 2 with 8MP.
Drums	Brand Tedge Model CP 10000
Screen	Generic display with 3.5-inch HDMI input.

Table 1 Electronic components
Source: (Own source through data collection)

The proposed algorithm implements artificial vision techniques such as the detection of objects by segmentation of color spaces, (Gil, P. et Al, 2004), which allow the detection of the position of the object and its classification as an RSU object or not, as well as the functionality of the electronic components integrated in the collector prototype. The stages of the algorithm are made up of 4 general steps for collecting MSW:

Search for MSW: In this stage the detection of MSW is evaluated based on the sequence of images obtained from the camera. If the object is not detected, the collecting robot will rotate on its own axis, otherwise it stops the servomotors that allow the rotation.

Align Proximity Sensor with RSU: In this stage, an alignment adjustment is made between the location of the proximity sensor and the position of the RSU detected in the image. This ensures that the measured distance corresponds to the RSU and not to another object.

Approach RSU: In this stage the distance of the RSU is evaluated based on the current position of the robot. If the distance is less than a defined threshold, it stops the servomotors that allow the approach, otherwise it will continue advancing.

Collect RSU: In this stage the collection of the object begins through the servomotors implemented in the robot gripper.

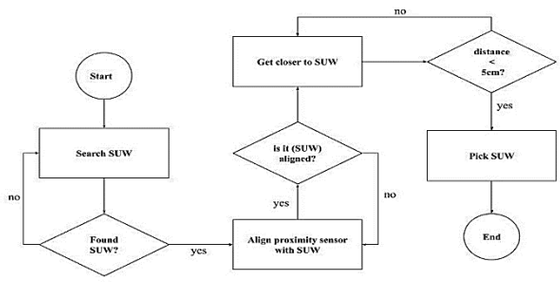

Figure 2 Object collection algorithm composed of 7 different stages for the collection of MSW
Source: (Own elaboration)

The workflow is carried out by using servo motors to move the robot on its same axis at a 360-degree angle. During the turn, the evaluation of a descriptor based on color spaces is made for the detection of MSW. The descriptor is generated from the conversion of the RGB color space obtained from the camera image to the HSV color space (Nallaperumal K. et Al, 2013), where the pixel values of the H channel are obtained, which represents the purity of the color of the MSW composition and from the definition of two thresholds it is determined whether the object of study is considered as MSW or not.

Once the RSU is found, the next step is to stop the servomotors so that the robot stops rotating on its own axis and makes a small turn in the opposite direction to align the proximity sensor with the detected RSU, this step is carried out due to a Image processing delay on the raspberry given the capabilities of the CPU.

As soon as the robot is aligned, the RSU object detection stops working to reduce the processing load and turn on the servomotors that allow movement based on the distance provided by the proximity sensor. If the distance is less than the threshold defined by 5 cm, the collector prototype will approach the object, otherwise it stops the measurement of the proximity sensor and the servomotors.

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When the distance is ideal for the robot's grippers, the next step is to turn on the servomotors that allow the object to be collected.

Results

MSW collector prototype

The construction of the prototype starts from the definition of the connection circuit of the electronic components, see Figure 3, where the Protoboard will be providing a 5V supply, as well as a ground bridge to the components, while the direct connection to the Raspeberry Pi allows communication for the execution of the components.

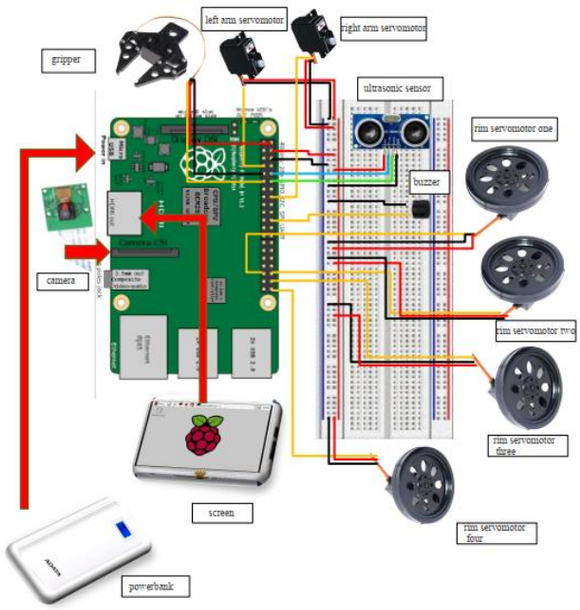

Figure 3 Connection diagram of electronic components connected to the *Raspberry Pi* and used in the creation of the RSU collector prototype
Source: (Own elaboration)

The connection diagram consists of a 10,000 mA battery which generates a 5V output to power the Raspberry Pi. An 8 MP camera is also integrated which is connected directly to the CAMERA port of the raspberry, in the same way a video screen is integrated into the HDMI port. The proximity sensor and the servomotors that allow movement are connected to the breadboard as a power supply in different rows, as well as the connection with the pins of the Raspberry.

The structure of the robot is based on the dimensions of the electrical components. Therefore, the first step was to measure and cut the base metal structure composed of two levels. The first level is made up of the displacement and harvesting servomotors, see Figure 4, where the assembly was carried out with 8cm support bars and 1-inch screws, as well as the wheels were integrated. For the harvesting servomotors, the clamp was integrated with metal extensions to allow a precision grip and a space was left for mounting the battery and connection cables.

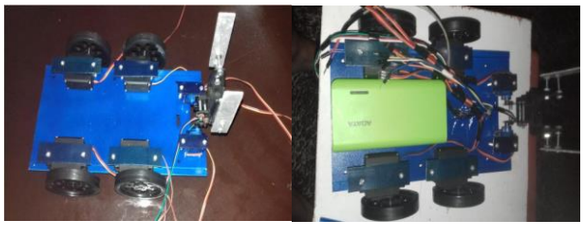

Figure 4 Assembly of servomotors on the first level. The Figure on the left shows the basic structure and the integration of the servomotors. The Figure on the right shows the integration of the battery and the connection cables for the *Raspebbery Pi*
Source: (Own elaboration)

The second level consists of the Raspeberry and other elements, see Figure 5, where the mounting was done with half-inch screws to the metal plate. Once assembled, the connection with the servomotors was made, as well as the integration of the proximity sensor in the lower front part and the camera in the upper front part without obstructing the collector clamp.

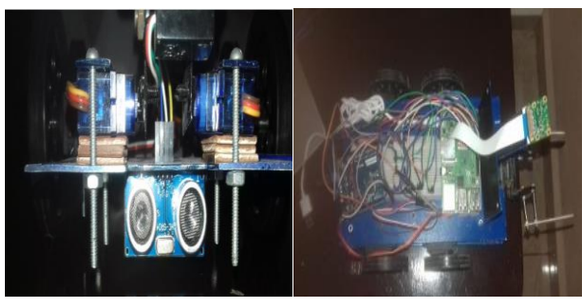

Figure 5 Assembly of Raspberry Pi and other electronic components on the second level. The Figure on the left shows the front view of the prototype integrated by the proximity sensor and servo motors for collecting objects. The Figure on the right shows the aerial view of the Raspberry mounting, camera and connections to the electronic components
Source: (Own elaboration)

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Finally, to protect the circuit, see Figure 6, a metal casing was made to protect it from the surrounding environment. At the top it integrates the video screen and an on / off button that allows you to start the Raspberry Pi. At the bottom there are a series of insulators to avoid direct contact of the circuit with metal in order to protect the electronic components and avoid any short.

Figure 6 Circuit protective shell. The left Figure shows the exterior of the protective case and its power button. The Figure to the right shows the inside of the protective case and the connections of the power button with the *Raspberry Pi*
Source: (Own elaboration)

The integration of all these elements results in the MSW collector prototype, see Figure 7, given its design and structure, it allows different movements such as moving forward, backward and turning on its own axis, this helps a suitable movement for the search and collection of MSW. . Likewise, due to the electrical components used, the robot supports a maximum weight of 20Kg with a maximum width of 7cm. The base structure is mostly made of metal, particularly aluminum, painted blue for easy viewing in the environment in which it is located.

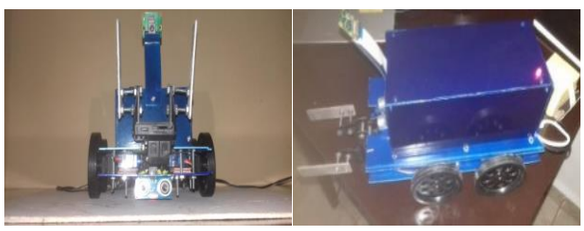

Figure 7 Object collector prototype. The Figure on the left is the final front view of the prototype integrated by camera, harvesting servomotors and proximity sensor. The Figure on the right is the lateral aerial view of the prototype showing the prototype's protective casing and scroll wheels
Source: (Own elaboration)

Once the prototype was completed, an algorithm created by the authors, see Figure 8, was implemented in the Python programming language and with the OpenCV computer vision library (Zelinsky, A., 2009) that provides the necessary autonomy to perform the task. collection without human intervention.

```
stop = False
alineado = False
medirDistancia = True
recogerObjeto = False
alineado2=False
while not stop:
    _, origen = cap.read()
    origen = cv2.resize(origen,size,interpolation=cv2.INTER_AREA)
    frame = cv2.medianBlur(origen,5)
    frame = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)
    h,s,v = cv2.split(frame)
    hs    = cv2.merge((h,s))
    mask  = cv2.inRange(hs,lower,upper)
    mask  = cv2.erode(mask,kernel,iterations=2)
    mask  = cv2.dilate(mask,kernel,iterations=5)
    _, contours, _ = cv2.findContours(mask, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
    if len(contours) == 0 or len(contours) > 1:
        servomotorBuscar();
    if len(contours) == 1 and not alineado:
        area = cv2.contourArea(contours[0])
        if area > areamin:
            (x,y,w,h) = cv2.boundingRect(contours[0])
            m0 = ( int(x+(w/2)) , int(y+(h/2)) )
            cv2.rectangle(origen,(x,y),(x+w,y+h),red,1,cv2.LINE_AA)
            cv2.rectangle(origen, (m0[0]-5, m0[1]-5),(m0[0]+5, m0[1]+5),white,1,cv2.LINE_AA)
            if(m0[0] > cenl[0] and m0[0] < cenr[0]):
                alineado = True
            else:
                servomotorBuscar();
        else:
            servomotorBuscar();
    if alineado and medirDistancia:
        distancia = sensorProximidad()
        if distancia > 11:
            if not alineado2:
                servomotorAlinear()
                alineado2=True
            servomotorAcercar()
        else:
            medirDistancia = False
            recogerObjeto = True
    if alineado and recogerObjeto:
        servomotorRecoger()
        stop = True
    cv2.rectangle(origen,cenl,cenr,green,1,cv2.LINE_AA)
    cv2.imshow("frame",origen)
    cv2.waitKey(1)
cap.release()
cv2.destroyAllWindows()
```

Figure 8 RSU collector algorithm code developed in the Python programming language and with the OpenCV machine vision tool
Source: (Own elaboration)

The algorithm allows the manipulation of all electronic components for their proper operation from the sequence of images obtained from the camera. Given the image, if the object is not detected, the prototype will keep rotating on its axis. If the RSU is detected the prototype will stop rotating and will make an alignment with the RSU and the proximity sensor. Once aligned, the robot will stop processing the images and will move towards the object as long as the distance is greater than 5 cm, otherwise the robot will stop and collect the object.

The MSW collector prototype allows the automation of solid waste collection processes in both public and private areas, being a useful tool for improving the service of waste disposal systems in the state of Campeche. This means that the workload of the cleaning staff can be considerably reduced by automating the collection process. This allows better management of MSW, which reduces the probability of damage to human health and the environment.

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This research project was carried out thanks to the support of the National Technological Campus Escárcega (Higher Technological Institute of Escárcega), which provided the necessary spaces for its development and execution.

Conclusions

The results obtained show that the proposed design with a simple and easy-to-navigate structure allows the integration and proper operation of the implemented algorithm and the electronic components connected to the Raspberry Pi, given that it has a limited amount of memory and processing.

The creation and implementation of the model from the metal structures and the integration of different electronic components such as Raspberry Pi, camera, proximity sensor, servo motors, among others used in the development methodology, allow the creation of a physical prototype for collecting MSW.

The algorithm proposed in the Python programming language and based on artificial vision techniques with the OpenCV tool, allows to give autonomy to the physical prototype, so that, for the operation of electronic devices, it does not require human intervention and can perform actions to starting from the conditions given in the environment.

The development of this prototype provides a tool to support the human being that allows reducing times and increasing the collection capacity of the waste systems of the state of Campeche, Mexico.

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Design and development of a prototype for the drying of coffee from the use of sieves in a controlled environment

Diseño y elaboracion de un prototipo para el secado de café a partir de la utilizacion de zarandas en ambiente controlado

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Abstract

Coffee production, being a high consumption product, one would think that each of the participants in the value chain would have high profits, but the economic income in the first stage (harvest) is low for the small producer. When coffee is sold at more advanced levels of the value chain, profits increase. Unfortunately, few coffee growers can access these levels due to the cost of the equipment. The project's goal is to develop a method that, based on the design of drying equipment, allows coffee growers to commercialize their coffee in parchment, obtaining higher profits. The methodology begins by identifying the right moment to carry out the harvest with the analysis of the Brix degrees of coffee in cherry, and subsequently, take it to the drying prototype where coffee with high scores in the cup of excellence can be obtained. The main goal is to give small producers a way to work their harvest through implementing a process that will provide them with a high-quality parchment coffee with which they will be able to enter a new sales market.

Brix degrees, Coffee drying, Cup quality

Resumen

El café, al ser un producto de alto consumo se pensaría que cada uno de los participantes en la cadena de valor tendrá elevadas ganancias, pero el ingreso económico en la primera etapa (cosecha), es baja para el pequeño productor. En la medida en que el producto se vende en niveles más avanzado de la cadena de valor, las ganancias aumentan, lamentablemente, son pocos los cafeticultores que pueden acceder a estos niveles por los costos de los equipos. El objetivo es desarrollar un método que, a partir del diseño de un equipo de secado, los cafeticultores, puedan comercializar su café en pergamino, obteniendo mayores ganancias. El método parte de identificar el momento justo para llevar a cabo la cosecha con el análisis de grados brix del café en cereza, y posteriormente, llevarlo al prototipo de secado donde se pueda obtener un café con altos puntajes en la taza de excelencia. La finalidad es dar a los pequeños productores una forma de trabajar su cosecha mediante la implementación de un proceso el cual les otorgara un café pergamino de alta calidad con lo que podrán introducirse en un nuevo mercado de venta.

Grados Brix, Secado de café, Calidad en taza

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Introduction

One of the main sources of income for families in the central zone of the state of Veracruz, particularly in the city of Huatusco, is the plantation and production of coffee. This zone is nationally recognized as one of the ideal places for coffee production because it is grown at an altitude of 1200 meters above sea level, which is an extremely important factor for obtaining a higher quality product.

For the small coffee plantation owners, this product generates little profit, due to the fact that it is mostly sold in cherry, being this point of the process in which the price of coffee has the lowest value. There is a saying among coffee growers that "the best price for coffee is when it is served in the cup". Unfortunately, small coffee growers do not seek to take their product to this point in the process or at some point closer to it, because they consider it expensive and do not have the equipment to be able to carry out the wet and dry processing in order to sell it as parchment coffee, where it already has a better price.

The coffee drying process is a very important phase in the coffee processing. This process allows the conservation of quality by reducing the moisture content of the bean (50-55%) to levels that allow the conservation of the bean (10-12%) and thus avoid its deterioration.

Based on this idea, an innovation will be made in the coffee drying process, through the combination of sieves and elements of temperature, humidity and PH control, hoping with this, a process that achieves greater efficiency in the drying of coffee and at the same time higher quality, so that there will be greater profits for small producers. This will be carried out in two prototypes with different technical characteristics, but with the same base of sieves placed in tandem.

Having said that, the work is distributed as follows: the first section presents the theoretical information on which the project is based for its development. This section presents the ideal moment for cultivation based on the measurement of Brix degrees, the equipment used for this purpose, and a procedure for sampling the degrees and determining when the harvest is at its point for cultivation.

Likewise, the process of coffee processing, the analysis of quality and its sensory analysis are presented.

The second part presents the methodology, starting by describing the farms where the study was carried out, then the results obtained in Brix degrees are presented applying the methodology described, a brief description is given of the construction of the prototypes for the drying of the coffee, and finally the methodology is presented that implies from the cutting to the drying to obtain quality coffee.

The third part shows the results of the project obtained from the cupping of the coffee as well as the prices that can be obtained in case the coffee is sold during this season.

Finally, the acknowledgements and conclusions reached during the development of the project are presented.

Background

Coffee harvesting

The harvesting of coffee fruits is usually done with the empirical criterion of the color of the cherry, which when ripe shows a mixture of green, yellow and red shades, depending on the variety, and as a result a harvested product is obtained that includes green, pinto, ripe, overripe and dry fruits. (Ramírez, 2016)

Figure 1 Classification of grains by color in their percentage of ripeness
Source Ramírez, 2016

ISSN 2444-4995

Each of these types of fruit has specific physical and chemical characteristics that determine the quantity and quality of the product obtained during the processes of processing, threshing, storage and preparation of the beverage.

When coffee cherries are harvested at an early stage of maturity (green and yellow shades), they may lack the appropriate conditions for consumption and, in addition, premature harvesting will imply losses in weight and yield, due to the fact that the fruits are smaller in size than the ripe ones.

On the other hand, fruits harvested late may be overripe or dry, and present an elastic behavior of the pulp that impairs the conditions for optimal processing, as well as diminish their organoleptic qualities, with a greater predisposition to ferment-type flavors, physiological alterations and attack by insects or pathogens.

In general, it has been demonstrated that the fruits that have a green coloration of the pulp degrade the quality of the coffee in all the post-harvest processes up to the beverage, producing low yields, rancid flavors and aromas and very bitter characteristics.

Likewise, the harvesting of dry fruits provides a hard beverage, due to the fact that they are senescent fruits with a high percentage of insect damage, while the fruits known as ripe are those that externally present a uniform reddish coloration and provide the best beverage quality.

Brix degrees

Brix degrees (symbol °Bx) measure the total ratio of sucrose dissolved in a liquid.

1 degree Brix (Bx) = 1 g sucrose / in 100 g solution.

The Brix scale is a refinement of the Balling scale tables, developed by the German chemist Karl Balling. It is used in the food sector, to measure the approximate amount of sugars in fruit juices, wine or soft drinks, and in the sugar industry. (Villeda, 2014).

The refractometer

It is an optical instrument that measures the sucrose concentration of a solution based on the refractive index produced by light in that solution.

Figure 2 Manual refractometer
Source: Vidal, 2014

Figure 2 shows the equipment, which has the appearance of a small telescope, with a window that must be lifted to place the sample (1 or 2 drops) and wait about 30 seconds to allow the sample to stabilize thermally and in turn to disperse uniformly. (COPERSA, 2008)

Sampling method for Brix determination

Vidal (2014), presents a sampling method, which allows determining the ideal range of soluble concentration (Brix) during the ripening period of coffee and its influence on the cup in two varieties (catuai and Catimor), this work is presented at three altitudinal levels (1000msnm, 1250msnm, 1500msnm). The method should be carried out with the following steps:

1. Determine the amount of plants necessary to conform the composite sample. It was taken into account that on average there are 3,500 plants per hectare and the sample is determined by the formula:

$$N = \frac{K^2 Npq}{e^2(N-1)+K^2 pq} \quad (1)$$

Where:

N: is the population size.

k: 95% confidence level.

e: Is the master error.

2. Sampling of coffee beans as soon as they present visual signs of maturation.

ISSN 2444-4995

3. Sampling 31 plants per 0.25 ha (2500 mts^2) and from each plant 10 grains were collected per bandola.

4. A bandola was taken from each cardinal point and grains were collected from the low, medium and high growth of the plant to obtain a sub-sample.

5. From the grains collected, placed in a container and mixed to homogenize all the sub samples and form a composite sample.

6. 0.5 kg of grains were taken at random and the honeys were manually extracted from them, collecting the juices in a container.

7. With a dropper a sample is obtained and placed in a digital refractometer to determine the concentration of sugars in Brix.

8. It is repeated three times to have certainty of the data. According to bibliographic antecedents (PROMECAFE, 2013). The range should be between 15 and 24° Brix.

9. The farm records were reviewed to determine how many days after flowering the 15° Brix were reached and thus determine how many days are counted to harvest and not affect the quality of the cup due to overripe coffee, a point which, according to the literature review, is above 24° Brix.

According to this study, the Brix degrees at different heights are the following:

Low stratum	Middle stratum	High stratum
1000 msnm	1250msnm	1500 msnm
18.5-20.5 Brix	17.5-20.5 Brix	16-19 Brix

Table 1 Average Brix limits at three different altitudes
Source Villeda 2014

Coffee processing

Coffee processing is an extremely important process in the coffee value chain. In this process dry parchment coffee is obtained from cherry coffee, in a mass ratio of approximately 1 to 5 (Montilla, 2006), in addition to obtaining by-products from this process, which are pulp and mucilage.

According to Oliveros (2007), the coffee preparation process includes a series of operations such as classification, washing, pulping, removal of mucilage and drying.

The most relevant stage for its contribution to the value of coffee is drying (Roa et al, 1999), since its purpose is to reduce the humidity content of coffee from 53% on a wet basis to a range between 10% and 12% humidity, suitable for commercialization.

As mentioned by Alvarado (2004), drying ensures a greater economic benefit to the producer because the dried product suffers little or no deterioration if it is well stored, it allows the conservation of the seed for long periods of time preserving its germination power and acquires a greater added value if it is packaged for the consumer.

At this point it is important to mention that coffee drying has traditionally been carried out using two methods: solar drying and mechanical drying, and there is a need to carry out research to make these processes (especially the mechanical one) more efficient and less contaminating from the moment the equipment is designed to the operation and maintenance of the same (Gutiérrez, 2008).

Coffee quality

Quality is determined by genetic aspects and influenced by many factors such as growing conditions, climate, soil, phytosanitary care and agronomic practices in general, as well as by the selective harvesting of a greater proportion of ripe fruits, the type and control during the processing, threshing, roasting and preparation of the beverage. (SCAA, 2013)

After finishing the drying process, parchment beans of homogeneous appearance are obtained with a fresh characteristic smell of coffee, light yellow color and a humidity between 10 and 12%. Good quality almond coffee has a bluish-green color with a homogeneous and healthy appearance; its size is heterogeneous according to the variety and is measured in meshes of 12/64 to 18/64 of an inch.

ISSN 2444-4995

The defects of the almond coffee bean according to (FEDERACAFE, 2013) established in two categories are the following:

Defects of the first group: full, partial or dry blacks, whole or partial vinegars, yellow or carmelite reposados and amber or butter.

Defects of the second group: Loose, cardenillo, discolored (veined and bleached), bitten or cut, bitten by insects, over-dried or burnt, split, malformed or deformed, immature, crushed, floating or balsudo and damaged or wrinkled.

Sensory analysis of specialty coffees

The purpose of the protocol is the perception and description of the quality, determined by the cupper; analyzing the specific attributes and then with the previous experience, the samples are qualified on a numerical scale, comparing the scores between samples. (Ruiz, 2009)

The specific attributes correspond to positive quality scores that reflect a judged rating of the taster with values ranging from 0 to 10. Defects are negative scores and denote unpleasant taste sensations; the quality scale by attribute is shown in the table below, where quarter point increments between numerical values from 6 to 9.75 are shown (SCAA, 2014).

Quality scale			
6.00 Good	7.00 Very good	8.00 Excellent	9.00 outstanding
6.25	7.25	8.25	9.25
6.50	7.50	8.50	9.50
6.75	7.75	8.75	9.75

Table 2 Positive attributes to quality reflected in score given by taster
Source: Puerta, SCAA 2014

Finally, the sum of the attributes and the subtraction of the negative values of the defects generate a score on a scale of 0 to 100 points; for the final results the quality of the coffee is classified as described in the following table:

Total Score	Category	Ranking
90-100	Outstanding	Special
85-89.99	Excellent	
80-84.99	Very Good	
<80	Below Special Quality	Not special

Table 3 Quality classification
Source: Puerta, SCAA 2014

Methodology

The main objective of this work is the development of a prototype to improve the coffee drying process which, as mentioned in the previous section, is an extremely important point since, if done correctly, it ensures conservation for long periods of time, in addition to achieving a higher quality coffee and therefore a better price and higher profits.
In addition to the prototype, we also seek to have an impact on quality by finding the ideal moment for harvesting, using the methodology described and adapted to the area of Huatusco for the determination of Brix degrees.

Study farms

The project is carried out in two farms with different characteristics, it should be noted that the idea is to test the drying prototypes in these farms with different characteristics: one with a higher degree of attention and technification and the other that represents the majority of small producers with the basic attention necessary for their crop. The idea is to observe if there is a considerable difference in the drying and quality of the coffee. The prototypes have different characteristics, so the objective is to analyze if there is a considerable impact on the technification of the drying model or if only with certain controls an improvement can be achieved that will result in greater benefits.

Doña Juana Farm

This is a farm dedicated to the cultivation, production and commercialization of coffee in several variants (cherry coffee, parchment coffee, seed coffee) created on the borders of the towns of Tlavictepan and Sochibebeca, by Mrs. Juana de Bernardi, currently managed by Mr. Anthony Bulbarella Cancela.

This farm has a total of 20 hectares, which are cataloged by varieties of low quality and quality. It also contains certified varieties such as: Geisha, Lapar 39, Costa Rica, Colombia among nine other varieties.

Annual controls are carried out for each variety, taking into account the surface area, sketch by variety, total number of plants, planting date, and the percentage of fertilizer to be applied to each plant.

ISSN 2444-4995

At the same time a record is made of the harvests per year from the beginning to the end of the harvest, where the number of cutters needed to carry out the cut, the type of coffee, the kilos produced by each variety, and the kilos weighed in the mill are recorded. These last two usually vary a little, since in the mill they are usually careful not to carry impurities (leaves, stones, or fruit). In addition, there is a record of the total care of the farm, such as pruning of the plants, harvesting of the farm, inputs or tools used, months worked and employees required.

Las Palmas Ranch

It is a small farm dedicated to coffee cultivation created seventy years ago by Mr. Félix Roberto Hernández González. Currently, it has 4 hectares with coffee plantations of the following varieties: Costa Rica, San Roman, Oro Azteca, Colombia. The farm is in charge of Mr. Rogerio Gelasio Hernández Sandoval.

It is a farm that currently works in a very traditional way according to the work techniques that are present in almost all the plots of a small producer, in which there is no control of the periods of application of fertilizers, since for a period of 15 years it was working as an organic specialty farm.

The farm is currently in a transition point of change of plantation, since the farm was already of an advanced age, so it has begun planting new plantations, in which the San Román and Oro Azteca varieties predominate.

The farm is located in Carrizal Capulapa, Huatusco, Veracruz, at an altitude of 900 to 1050 meters above sea level, with a temperature variation of 22 to 25 degrees Celsius.

Determination of the Brix degrees of the farms

Once the harvest time was reached, the Brix levels of both farms were determined. Table 4 shows the general characteristics of the farms, as well as the Brix levels considered optimal for the crop.

	Las Palmas Ranch	doña Juana Ranch
Optimum Brix	19-21	17-19
Variety	Colombia and San Roman	Geisha
Area	1250 square meters	5029 square meters
Plantation	400 plants	1137 plants
Type of seeding	Standard of 1.5 m between each plant and 2 m distance in each furrow.	At unevenness with a 2 mts groove between floors by 2.5 mts of street.
Sample size	16 plants	33 plants

Table 4 Farm characteristics
Source: own elaboration

Applying the Brix sampling methodology described above, and measuring them using the refractometer as shown in Figure 3, the results obtained on average are as follows:

Average Brix degrees	
Las palmas Ranch	Doña Juana Ranch
19.9625	16.8375

Table 5 Brix degrees
Source: own elaboration

Figure 3 Sample of the Brix measurement with the refractometer at Rancho Las Palmas and Rancho Doña Juana
Source: own elaboration

Development of the drying prototypes

There are two types of drying modules, a drying shed at Rancho Las Palmas and a temperature-controlled module at Rancho Doña Juana.

ISSN 2444-4995

Rancho Las Palmas Prototype

The drying shed used for coffee drying at Rancho Las Palmas, located in the town of Carrizal, Huatusco, has 8 sieves of 2.5 meters long by 0.80 meters wide, made of pine wood and metal mesh, which are arranged in tandem. The drying shed is lined with a white thermal nylon that covers the structure of oak wood and bamboo complemented by three iron arches to give it the shape of a dome, measuring 6 meters long by 3 meters wide and with a height of 3 meters taking into account the dome as shown in Figure 4.

The capacity of this vessel is approximately four quintals of parchment coffee, which is equivalent to one ton of cherry coffee. Figure 5 shows the thickness of the layer of coffee that each sieve should contain.

In the lower part of the walls of the building, an uncovered space is left so that air can circulate inside the building to prevent fungus from forming on the product (coffee) and solar energy is used as the main source of drying. It is important to mention that this prototype does not have a heat source at night, which makes the drying process inefficient.

Figure 4 Shows the structure of how the prototype was built at Rancho Las Palmas
Source: Own elaboration

Figure 5 Shows how parchment coffee was dried at Rancho las Palmas
Source: Own elaboration

Doña Juana Ranch Prototype

At the Doña Juana ranch, a controlled temperature chamber was built with an area of (6 meters long by 1.5 meters wide) with wood materials for the skeleton of the building and white plastic with a sliding door, which has a capacity to store 18 sieves in 3 columns of 6 and has a dimension of 1. 35 meters long by 0.75 meters wide, with a maximum height of 5 cm, which is made of pine wood and a 70% shade mesh and is reinforced with tanza wire, the assembly of the sieves is by 2 poles with heel and rope to hang the sieves with a height of 30 cm between each one.

The vessel has a ventilation method for the internal circulation of the air flow in the opposite direction to form a continuous flow. In order to control the temperature, a heater with high-performance infrared burners (99.5%) and high-performance catalytic panels is used. For steam adsorption, a dehumidifier covering an area of up to 25 square meters is used, with a filling sensor.

A 7.5 cm high by 5.3 cm long humidity clock with an LCD display showing the measurements obtained is used to monitor the humidity and internal temperature conditions.

Figure 6 Temperature controlled module "Rancho Doña Juana"
Source: Own Elaboration

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Cutting, Pulping and Drying

Once the optimum Brix degree data has been obtained and the prototypes have been built, the coffee is cut, where only the intense red and grape red beans should be harvested, leaving the beans that have a lower tonality or that are still brown or green, as well as those that are overripe such as the black and wrinkled ones. At the end of the harvest, the coffee is placed in a container with water to remove those beans that are hollow or have any anomaly caused by the coffee berry borer or other pests. It should be left to rest in water for at least 3 hours so that the beans are softened and suffer the least possible damage at the time of pulping. For the next step, which is to carry out the pulping process, the pulping machine to be used must be calibrated, whether it is a drum or a disc, as long as the process causes the least possible damage to the grain.

Once the pulping is finished and depending on the conditions of the work area, the seed should be left to rest either in a tank or in buckets without water for a minimum period of 24 hours, this is mainly so that the sweetness that the bean has in these instances is easy to remove, in addition to the fact that during this time is when the bean ferments allowing a greater concentration of the physical and sensory characteristics typical of coffee, once the fermentation time has elapsed the seed should be washed and later taken to dry in the module. The process consists of putting water in the buckets where the coffee ferments and moving the bean either with the hands or with the help of a stick repeatedly so that the bean releases all the sweetness.

It should be taken into account that the bean should be clean in its totality, that is why three or more repetitions should be made and in each one of them change the water used, this will also help to observe that the bean is already clean since the water will no longer change tonalities. Before introducing it into the sieves, as much water as possible should be removed to avoid damaging the sieves.

The seeds will be deposited on the sieves respecting a thickness no greater than 5 centimeters and taking care that this thickness is uniform throughout the area of the sieve.

Depending on the characteristics of the module, both in height and length, the number of sieves with which it will be possible to work will be determined. From here on the process will take depending on the weather conditions will reduce or increase the days of drying within an interval of 10 to 15 days for the grain to reach a decrease in its percentage of moisture leaving it in a range of 10 to 12 percent moisture, which given the documented information indicates that it is the optimal point for not losing any of the sensory characteristics and allowing empowerment and some other advantages.

During the course of the days of drying and establishing a periodic and constant work, at least two movements per day should be carried out to prevent the seed from starting to generate a pathogen that ends up affecting the quality, in addition to the fact that in this process one more will be added which will be to choose those grains that have some deformity, are broken, round, or that its yellow-white hue is changed by some other coloration.

After 10 days and if the necessary equipment is not available to calculate the percentage of humidity, the technique that consists of peeling the bean and biting it can be applied so that if when it is broken it is heard to thunder uniformly it will give an idea that the bean has an adequate percentage of humidity to be packed, although it is always better to make a measurement of the most adequate percentage to have no doubt that the coffee is in the best conditions.

As a summary of the above, the diagram in Figure 7 shows the above mentioned process.

ISSN 2444-4995

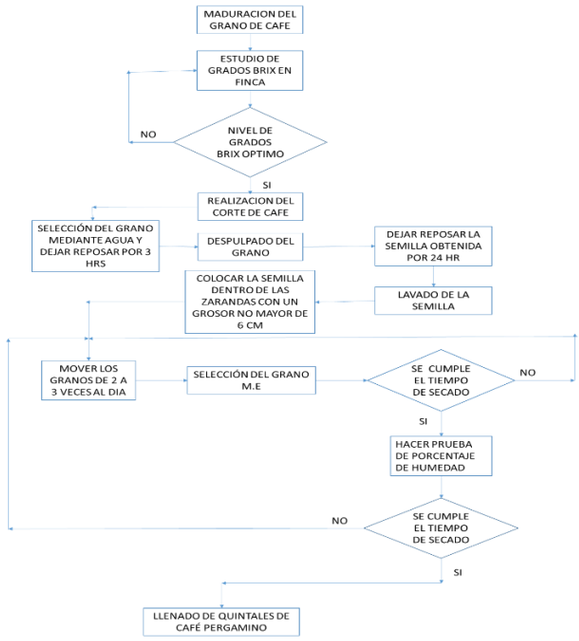

Figure 7 Methodology carried out to obtain quality coffee
Source: Own elaboration

Results

During the field work of measuring Brix degrees, it was obtained as a result that the percentage level of the bean is given by the advance of maturation and this is affected by the rain that occurs at the time of cutting; the bean had a significant decrease in this percentage. The analysis carried out indicates that the level of sweetness of the seed or bean is affected when it comes into contact with water, causing the percentage of sweetness to drop, affecting the properties of the coffee, which is why the Brix percentage level should be allowed to increase in order to give way to the beginning of the harvesting of the bean.

This could be observed in the sampling carried out at Rancho Doña Juana in which the average Brix degrees in study one is approximately 16% and in the average in study two it drops to 13%. It is worth mentioning that during the waiting time between analysis 1 and 2 there were rains, which affected the analysis considerably, so it was necessary to wait a little longer to carry out the cutting, which gave way to the following two measurements in which the percentage rose to almost 17%. Once this data was obtained, the cut was made because the grain was already at an advanced stage of maturation and waiting for the grain to increase the Brix percentage would not be convenient since the grain could fall or lose some of its properties.

The following images show the cupping results of the 2020-2021 harvests from the two ranches.

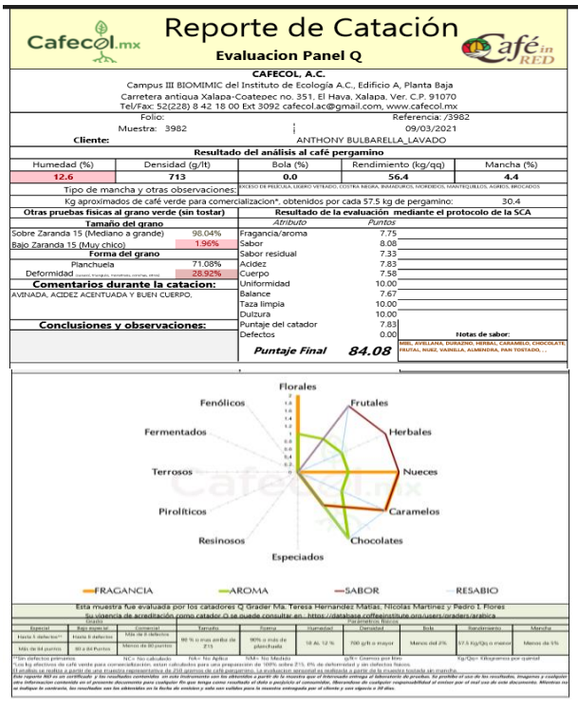
Reporte de Catación
Evaluacion Panel Q
CAFECOL, A.C.
Campus III BIOMIMIC del Instituto de Ecología A.C., Edificio A, Planta Baja
Carretera antigua Xalapa-Coatepec no. 351, El Haya, Xalapa, Ver. C.P. 91070
Tel/Fax: 52(228) 8 42 18 00 Ext 3092 cafecol.ac@gmail.com, www.cafecol.mx
Folio: Referencia: /3982
Muestra: 3982 09/03/2021
Cliente: ANTHONY BULBARELLA_LAVADO
Resultado del análisis al café pergamino
Humedad (%) 12.6 | Densidad (g/lt) 713 | Bola (%) 0.0 | Rendimiento (kg/qq) 56.4 | Mancha (%) 4.4
Tipo de mancha y otras observaciones:
Kg aproximados de café verde para comercialización*, obtenidos por cada 57.5 kg de pergamino: 30.4
Otras pruebas físicas al grano verde (sin tostar)
Tamaño del grano
Sobre Zaranda 15 (Mediano a grande) 98.04%
Bajo Zaranda 15 (Muy chico) 1.96%
Forma del grano
Planchuela 71.08%
Deformidad 28.92%
Comentarios durante la catacion:
AVINADA, ACIDEZ ACENTUADA Y BUEN CUERPO,
Conclusiones y observaciones:
Resultado de la evaluación mediante el protocolo de la SCA
Atributo / Puntos
Fragancia/aroma 7.75
Sabor 8.08
Sabor residual 7.33
Acidez 7.83
Cuerpo 7.58
Uniformidad 10.00
Balance 7.67
Taza limpia 10.00
Dulzura 10.00
Puntaje del catador 7.83
Defectos 0.00
Puntaje Final 84.08
Notas de sabor:
MIEL, AVELLANA, DURAZNO, HERBAL, CARAMELO, CHOCOLATE, FRUTAL, NUEZ, VAINILLA, ALMENDRA, PAN TOSTADO, ,.
Florales
Frutales
Herbales
Nueces
Caramelos
Chocolates
Especiados
Resinosos
Pirolíticos
Terrosos
Fermentados
Fenólicos
FRAGANCIA
AROMA
SABOR
RESABIO

Figure 8 Rancho Las Palmas cupping report
Source: Cafecol

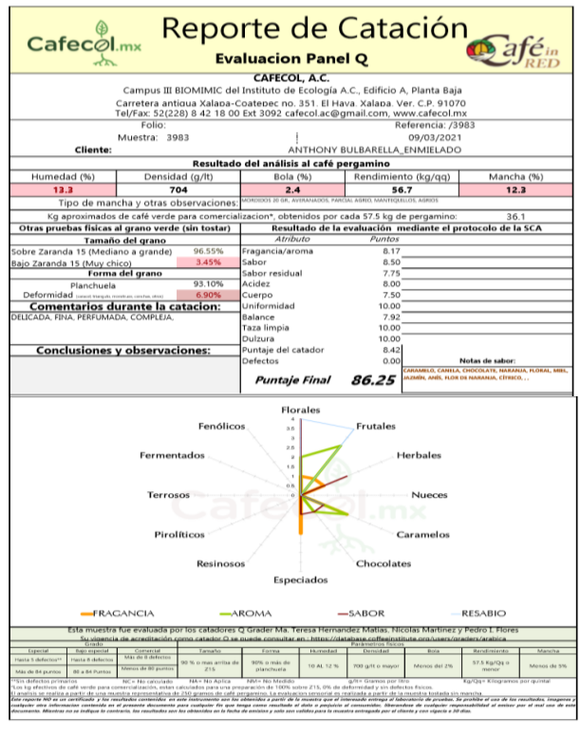
Reporte de Catación
Evaluacion Panel Q
CAFECOL, A.C.
Campus III BIOMIMIC del Instituto de Ecología A.C., Edificio A, Planta Baja
Carretera antigua Xalapa-Coatepec no. 351, El Haya, Xalapa, Ver. C.P. 91070
Tel/Fax: 52(228) 8 42 18 00 Ext 3092 cafecol.ac@gmail.com, www.cafecol.mx
Folio: Referencia: /3983
Muestra: 3983 09/03/2021
Cliente: ANTHONY BULBARELLA_ENMIELADO
Resultado del análisis al café pergamino
Humedad (%) 13.3 | Densidad (g/lt) 704 | Bola (%) 2.4 | Rendimiento (kg/qq) 56.7 | Mancha (%) 12.3
Tipo de mancha y otras observaciones:
Kg aproximados de café verde para comercialización*, obtenidos por cada 57.5 kg de pergamino: 36.1
Otras pruebas físicas al grano verde (sin tostar)
Tamaño del grano
Sobre Zaranda 15 (Mediano a grande) 96.55%
Bajo Zaranda 15 (Muy chico) 3.45%
Forma del grano
Planchuela 93.10%
Deformidad 6.90%
Comentarios durante la catacion:
DELICADA, FINA, PERFUMADA, COMPLEJA,
Conclusiones y observaciones:
Resultado de la evaluación mediante el protocolo de la SCA
Atributo / Puntos
Fragancia/aroma 8.17
Sabor 8.50
Sabor residual 7.75
Acidez 8.00
Cuerpo 7.50
Uniformidad 10.00
Balance 7.92
Taza limpia 10.00
Dulzura 10.00
Puntaje del catador 8.42
Defectos 0.00
Puntaje Final 86.25
Notas de sabor:
CARAMELO, CANELA, CHOCOLATE, NARANJA, FLORAL, MIEL, ALMEN, ANÍS, FLOR DE NARANJA, CÍTRICO, ,.
Florales
Frutales
Herbales
Nueces
Caramelos
Chocolates
Especiados
Resinosos
Pirolíticos
Terrosos
Fermentados
Fenólicos
FRAGANCIA
AROMA
SABOR
RESABIO

Figure 9 Tasting report of Rancho Doña Juana
Source Cafecol

The results show that both harvests can be considered specialty coffee due to the score of 84.08 points for Rancho Las Palmas and 86.25 for Rancho Doña Juana.

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It should be noted that these values allow achieving much higher sales prices since the quintal of specialty parchment coffee can be marketed at up to $4,000.00 MN, and the price of specialty parchment coffee, such as that of Rancho Doña Juana, can achieve prices of up to $12,920.00 MN per quintal.

Acknowledgement

We would like to thank Mr. Anthony Bulbarella Cancela, owner of Rancho Doña Juana, as well as Mr. Félix Roberto Hernández González, owner of Rancho Las Palmas, who kindly allowed us to sample the cuts, as well as their trust and economic support for the construction of the drying modules where we were able to verify the improvements in the processes.

We would also like to thank the National Technological Institute of Mexico who, through the 2021 Call for Technological Development and Innovation Projects, provided funding for the development of the project.

Conclusions

The main conclusion obtained from this work is that when comparing the quality tasting results of the two ranches, it can be observed that the scores of both confirm the effectiveness of the implemented methodology. In addition, it shows that the process can be used for any type of farm, whether conventional or specialty, given that the difference between one result and the other is only 2 points, which gives the small producer a greater marketing opportunity.

It should be mentioned that this is achieved thanks to the methodology and way of working in the selection and drying of the coffee, since these are the essential points that must be worked on so that a small producer can compete in the market with the large companies that exist today.

A very important fact that was obtained in the work is that the maturation of the coffee bean when measured with the Brix degree scale allows determining the ideal moment for cutting, but that this is easily varied when it comes into contact with water, which makes it uncertain to a certain extent to obtain the ideal percentage of Brix degrees for a better quality as presented in some other investigations that have been carried out on the same subject.

This is due to the fact that when the grain presents an increase in water, the sucrose tends to decrease and if so, it delays the sweetness fermentation process, thus allowing more time before cutting, waiting for the sucrose level to increase again.

The level of maturation of the grain should not be overlooked, since it follows its natural course and if several days go by waiting for the Brix percentage to rise before cutting, the grain would be affected because it tends to suffer physical damage due to its high level of maturation, which results in a raisin-shaped grain and in other cases it tends to break or open.

This gives way to a hypothesis in which it can be said that depending on the zone, altitude, climate and variety, an optimum Brix percentage level could be standardized. And with this obtain a better qualification of quality in the cup of excellence which would help the final result (parchment coffee) to be marketed in a better way so that this would be profitable in the earnings of a small producer.

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Article **Journal of Technological Prototypes**
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Design of a lettuce dryer machine for the company JASL TETLA

Diseño de una máquina secadora de lechugas para la empresa JASL TETLA

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Abstract

The development of agricultural production of horticultural services is growing in the company JASL TETLA, which is dedicated to the sowing, harvesting, washing, drying, packaging and delivery of vegetables. This company require the use of machinery to increase work productivity, which makes the acquisition of specialized equipment necessary. The purpose of the present work is to develop the design of a lettuce centrifuge machine that reduces the drying time, which is currently 30 minutes for approximately 20 kg of lettuce, the centrifugal system is the most suitable for the drying process but it was considered a variant on the traditional circular design. The analysis was carried out to determine the appropriate type of the machine's transmission system, determining the number of transmissions bands to be used and the power of the motor, due to the characteristics of the process and the environment where the material used in the machine will be worked is steel stainless AISI 304.

Centrifuge machine, Design, Transmission system

Resumen

El desarrollo de la producción agrícola de servicios hortícolas está creciendo en la empresa JASL TETLA, que se dedica a la siembra, cosecha, lavado, secado, envasado y entrega de verduras. Esta empresa requiere el uso de maquinaria para aumentar la productividad del trabajo, lo que hace necesaria la adquisición de equipos especializados. El propósito del presente trabajo es desarrollar el diseño de una máquina centrífuga para lechuga que reduzca el tiempo de secado, que actualmente es de 30 minutos para aproximadamente 20 kg de lechuga, el sistema centrífugo es el más adecuado para el proceso de secado pero se consideró una variante del diseño circular tradicional. El análisis se realizó para determinar el tipo adecuado del sistema de transmisión de la máquina, determinando el número de bandas de transmisión a utilizar y la potencia del motor, debido a las características del proceso y al ambiente donde se trabajará el material utilizado en la máquina es acero inoxidable AISI 304.

Máquina centrífuga, Diseño, Sistema de transmisión

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Introduction

The agricultural company JASL TETLA, located in the community of San Juan Tetla, in the Municipality of San Lorenzo Chiautzingo, in the State of Puebla, is dedicated to the planting of different types of lettuces, as well as their distribution, being a company, which is in expansion and in one of the different stages of its process require a machine that allows the lettuce to dry before being packed, the lettuce is sold washed and disinfected, ready to eat.

Of the different types of vegetables consumed in Mexico and in the world, lettuce is the one that has registered the best acceptance in consumption according to the data of the Agri food and Fisheries Information Service (SIAP) (Rios, 2012), they regulate bodily functions, are a source of nutritional subsistence, produce energy, which is why which are of vital importance for man (Alcazar O, 2010)

In Mexico, the concern for compliance with standards defined by good agricultural and manufacturing practices have been established not based on the health of domestic consumers, but on market demand (Vera, 2016). The JASL TETLA company is concerned with delivering very good quality products and guarantees the safety of its products.

In Mexico, the production of vegetables has evolved due to the characteristics of the activity and the weather conditions that largely determine the annual production volumes. Trends in consumer habits and product prices are also determining factors in farmers' decisions about which crops to sow or plant. (Rodriguez, 2013)

With the antecedents of the importance of the consumption of vegetables in the daily diet, the company seeks to facilitate the use and consumption of the products by delivering them ready to eat, avoiding time invested in cleaning and disinfection, as well as the expense of cleaning supplies. This fact generates the need to speed up the times mainly of the drying process.

Considerations for the design process

In order to carry out the design of the vegetable centrifuge machine, we start from the existing problem in the company JASL TETLA, which consists of reducing the drying time of the lettuces, currently the time is 5 boxes of the product in 30 minutes.

Type of lettuce	Weight per cycle
Romaine lettuce	20 to 25 kg for 30 minutes
Lollo rosso lettuce	15 kg for 30 minutes

Table 1

To deposit the already leafless lettuces, the company uses mesh containers made of polyethylene material that facilitate air flow and drainage as shown in figure 1, they are resistant to shocks, cracks and chipping with molded handles on 4 sides to easily lift, the measurements are: 0.60 m long by 0.40 m wide by 0.28 m high with eyelet (handle) of 0.11 m by 0.035 m.

Figure 1 Container with leafless lettuce
Source: Own elaboration

These containers are very important, because the washing and disinfection tanks are built with measurements according to the size of the boxes and are 0.66 m wide by 2.70 m long, the washing process is by submersion and is a previous process to spin.

Design

Mechanical design requires many skills (Shingley, 2012) and it is necessary to subdivide large relationships into a series of simple tasks, it is considered that in order to design the first thing to do is create a plan and if that plan allows the creation of a centrifuge machine, then the product must be functional, safe, reliable, competitive and marketable.

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The lettuce centrifuge machine is based on generating a centrifugal force, which has a circular motion and keeps the element in the circular path, but points in an opposite orientation.

Methodology to be developed

First, an investigation was carried out on the characteristics of lettuces where it was necessary to know the weight, height and volume that a lettuce can occupy. It was determined that the most convenient thing is to avoid rough contact and not manipulate the product so much.

The revolutions of the structure were set at 1200 rpm and the rest of the elements were determined for the correct operation of the centrifuge. For the design of the machine, it was considered to use the containers inside the structure to avoid handling or mistreating the lettuces, so a rectangular and not circular design was chosen.

Results

The following are the necessary calculations that are required for the transmission system.

Belt calculation

The service factor k, selected is 1, which is recommended for working a shift, according to the request of the company.

For the calculation of the gear ratio R

$$R = \frac{N}{n} = \frac{1800rpm}{1200rpm} = 1.5 \quad (1)$$

N revolutions of the driver motor

n revolutions of the driven machine

Diameter of the largest pulley

$$D = dR = 4.72\ in = 120mm \quad (2)$$

4.75 is selected because it is a commercial value

Pulley center distance

$$E > \left(\frac{(R+1)d}{2}\right) + d \quad (3)$$

To calculate the length of the strap

$$Lp = 2E + \frac{\pi}{2}(D+d) + \frac{(D-d)^2}{4E} \quad (4)$$

$$Lp = 1116.38mm$$

Calculation of contact angle A

$$A = 180 - 57\frac{(D-d)}{E} = 174.3° \quad (5)$$

Belt speed

$$V_t = \frac{\pi dN}{60(100)} = \frac{7.54\text{m}}{\text{s}} \quad (6)$$

Effective belt power

$$Pe = Pb * Fcl * FcA = 1.39\ Hp \quad (7)$$

Calculation of the number of belts

$$Nbelts = \frac{Pc}{Pe} = 2.1 = 2\ belts \quad (8)$$

V-belts are used that do not require lubrication or maintenance, they also solve slippage and alignment problems, they are capable of covering a load range from less than 1 HP to 500 horsepower. They basically serve to reduce the input speed and increase the torque values

Centrifuge machine design

The design of the base that will support the structure and the weight of the lettuces was made, for the construction the structural tubular stainless-steel profile was used, which is recommended for structures, as well as cuts of 8 x 8 stainless steel plates of ¼" thick and with wall bearings that function to support an axis of rotation and have high load capacities as shown in figure 2, the base has dimensions of 0.25 m high by 0.80 m wide.

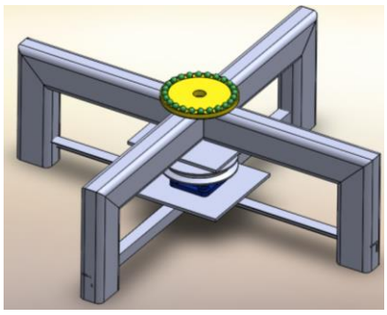

Figure 2 Machine base
Source: Own elaboration

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In the figure 3 shows the yellow structure that was built with two plates, one fixed at the base below and the other part is movable in the upper structure and must rest on the bearings of diameter of 3/8", which will be lubricated with grease registered as category H1 with suffix VP311 and NBR rubbing seal, on both sides.

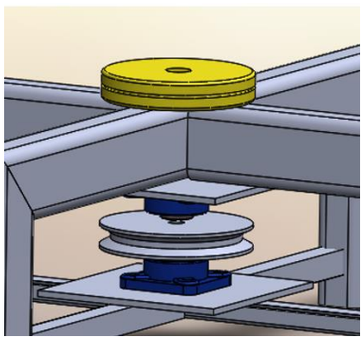

Figure 3 Bearing plate
Source: Own elaboration

Figure 4 shows the spaces available (3 compartments) to place the containers with the lettuce, the materials are angles of stainless steel AISI 304, screeds of the same material.

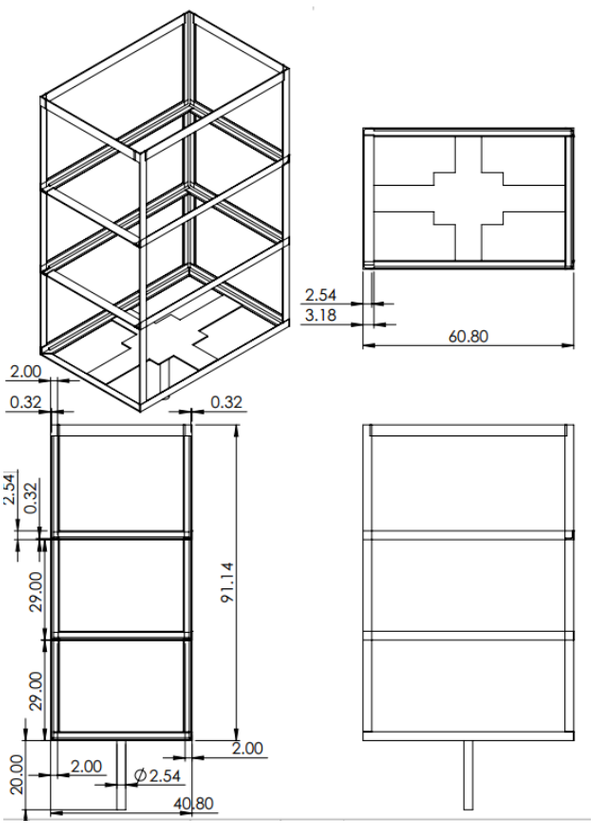

Figure 4 Design of the mobile structure of the machine
Source: Own elaboration

In the figure 5 shows the assembly of the base and the mobile structure coupled with the design of the bearing plate, the gray structure is a door to give access to place the boxes and at the same time prevents movement between them and prevents them from leaving.

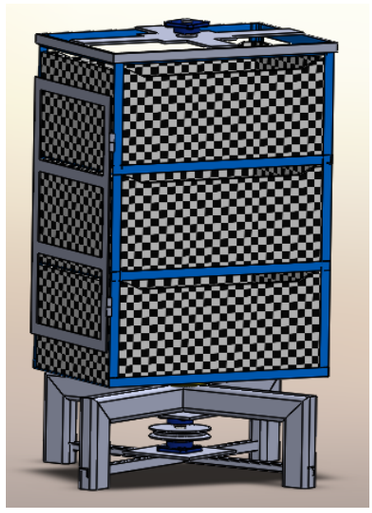

Figure 5 Machine Assembly
Source: Own elaboration

Annexed A

TABLA DE CARACTERÍSTICAS TÉCNICAS DEL ACERO INOXIDABLE			SERIE 300	
			Acero al Cromo - Níquel	Acero al Cromo – Níquel - Molibdeno
DESIGNACIÓN	TIPO AISI		**304**	**316**
	COMPOSICIÓN QUÍMICA		**C ≤ 0.08%* Si ≤ 1.00% Mn ≤ 2.00% Cr 18% - 20%* Ni 8% – 10,5%***	**C ≤ 0.08%* Si ≤ 1.00% Mn ≤ 2.00% Cr 16% - 18%* Ni 10% – 14%* Mo 2% – 2.5%***
PROPIEDADES FÍSICAS	PESO ESPECÍFICO A 20C (DENSIDAD)	(g/cm³)	7.9	7.95 – 7.98
	MÓDULO DE ELASTICIDAD	(N/mm²)	193,000	193,000
	ESTRUCTURA		AUSTENÍTICO	AUSTENÍTICO
	CALOR ESPECÍFICO A 20C	(J/Kg K)	500	500
	CONDUCTIVIDAD TÉRMICA A 20C/100C	(W/m K)	15 / 16	15 / 16
	COEFICIENTE DE DILATACIÓN A 100C	(x 10^6 C^{-1})	16.0 – 17.30	16.02 – 16.5
	INTERVALO DE FUSIÓN	(C)	13981454	13711398
PROPIEDADES ELÉCTRICAS	PERMEABILIDAD ELÉCTRICA EN ESTADO SOLUBLE RECOCIDO		AMAGNÉTICO 1.008	AMAGNÉTICO 1.008
	CAPACIDAD DE RESISTENCIA ELÉCTRICA A 20C	(μΩm)	0.72 – 0.73	0.73 – 0.74
PROPIEDADES MECÁNICAS A 20C	DUREZA BRINELL RECOCIDO HRB/CON DEFORMACIÓN EN FRÍO		130150 / 180330	130185 / -
	DUREZA ROCKWELL RECOCIDO HRB/CON DEFORMACIÓN EN FRÍO		7088 / 1035	7085 / -
	RESISTENCIA A LA TRACCIÓN RECOCIDO / DEFORMACIÓN EN FRÍO	Rm (N/mm²)	520 - 720 / 540 - 750	540690 / -
	ELASTICIDAD RECOCIDO / CON DEFORMACIÓN EN FRÍO	Rp (N/mm²)	210 / 230	205410 / -
	ELONGACIÓN (A_5) MIN	(%)	≥ 45	
	RESILIENCIA KCUL / KVL	(J/cm²)	160 / 180	160 / 180
PROPIEDADES MECÁNICAS EN CALIENTE	ELASTICIDAD RP(0.2) A 300C/400C/500C	(N/mm²)	125 / 97 / 93	140 / 125 / 105
	ELASTICIDAD RP(1) A 300C/400C/500C	(N/mm²)	147 / 127 / 107	166 / 147 / 127
	LÍMITE DE FLUENCIA A 500C/600C/700C/800C	σ1/10ʸ/t (N/mm²)	68 / 42 / 14.5 / 4.9	82 / 62 / 20 / 6.5
TRATAMIENT. TÉRMICOS	RECOCIDO COMPLETO RECOCIDO INDUSTRIAL	(OC)	ENFR. RÁPIDO 10081120	ENFR. RÁPIDO 10081120
	TEMPLADO		NO ES POSIBLE	NO ES POSIBLE
	INTERVALO DE FORJA INCIAL / FINAL	(C)	1200 / 925	1200 / 925
	FORMACIÓN DE CASCARILLA, SERVICIO CONTINUO / SERVICIO INTERMITENTE		925 / 840	925 / 840
OTRAS PROPIEDADES	SOLDABILIDAD		MUY BUENA	MUY BUENA
	MAQUINABILIDAD COMPARADO CON UN ACERO BESSEMER PARA a. B1112		45%	45%
	EMBUTICIÓN		MUY BUENA	BUENA
* Son aceptables tolerancias de un 1%				

Stainless steel data sheet
Source: Carbone Stainless Steel

Conclusions

For the design of the lettuce centrifuge machine, special characteristics of size, shape and position were chosen.

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Considering that lettuces are leafless and placed in a mesh container for transport and washing, the machine was designed to maintain that principle.

The design of the machine is to place inside 3 of the boxes full of lettuce that can be easily placed within the spaces of the structure, generating triple the product in the same time of 30 minutes, providing economic benefits for the company because it increases the production of the packaged product and can meet the delivery of more product.

Different calculations were made to determine a good transmission system that can favorite correct drying in the shortest possible time of 5 minutes per cycle.

The materials for the construction of the lettuce centrifuge are AISI 304 steel (see annex A) which have excellent corrosion resistance, ductility and shock resistance and are easily found on the market, allowing viability and is approved for the food industry.

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Article **Journal of Technological Prototypes**
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Design of pictorial diagrams for the development of self-taught teaching electronics kits at the Instituto Tecnológico Superior de la Región Sierra

Diseño de diagramas pictóricos para la elaboración de kits de electrónica de enseñanza autodidacta en el Instituto Tecnológico Superior de la Región Sierra

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Abstract

The year 2020 was seen with a high rate of affectation in all economic and educational sectors, generating a high academic lag, in which the SEP began to generate strategies such as distance education, thereby complying with the provisions of the new Normality ensuring that the National Education System will not be paralyzed by the SARS-COV-2-(COVID19) pandemic, and what was done, will serve for the future of education in Mexico. This modality of the educational system is perhaps ahead of its time, in terms of years, because the response of teachers and students to this new distance experience has been satisfactory for both teachers and students. But the reality and the geographical context of the students is not favorable for the development of the expected competencies in each of the educational plans, to be specific in the area of electronics, the practices in the laboratories were annulled to 100% and taking into account the above, teachers of the Industrial Engineering area in collaboration with the Electromechanical Engineering Career belonging to the Tecnológico Nacional de México, Campus of the Sierra Region, seek to develop a research project that integrates a Basic Electronics Kit to allow students to be self-taught and develop specific skills in the area of electronics, thus avoiding educational backwardness at the higher level.

Electronics, Distance education, Competitiveness

Resumen

El año 2020 se vio con un alto índice de afectación en todos los sectores económicos y lo educativo, generando un alto rezago académico, en el cual la SEP empezó a generar estrategias como la educación a distancia, cumpliendo con ello las disposiciones de la nueva Normalidad asegurando que el Sistema Educativo Nacional no se paralizará ante la pandemia del SARS-COV-2-(COVID19), y lo que se hizo, servirán para el futuro de la educación en México. Esta modalidad del sistema educativo es quizá adelantado a su tiempo, en términos de años, porque la respuesta de docentes y alumnos a esta nueva experiencia a distancia ha sido satisfactoria tanto de docentes y alumnos. Pero la realidad y el contexto geográfico de los alumnos no es favorable para el desarrollo de las competencia esperadas en cada uno de los planes educativos, para ser específicos en el área de electrónica se anularon al 100 % las prácticas en los laboratorios y tomando en cuenta lo anterior, docentes del área de Ingeniería Industrial en colaboración con la Carrera de Ingeniería Electromecánica pertenecientes al Tecnológico Nacional de México, Campus de la Región Sierra, buscan desarrollar un proyecto de investigación que integra un Kit de electrónica Básica para permitir que los alumnos sean autodidactas y puedan desarrollar las competencias específicas en el área de electrónica evitando así el rezago educativo en el nivel superior.

Electrónica, Educación a distancia, Competitividad

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Introduction

With the arrival of the COVID-19 pandemic, the educational process was interrupted without prior notice and millions of students went to confinement and the educational authorities, trying to counteract this impact, launched an educational plan called "distance education" in order to protect health, safety and, if possible, avoid learning loss in students, seeking to avoid high-level dropouts using new techniques to promote rapid recovery from learning.

Mexico, through the Ministry of Public Education (SEP), decided to suspend face-to-face classes. It is an extraordinary situation that shows us different realities related to inequality and poses great challenges, but it also offers us opportunities to act jointly and in a participatory manner. Thus, we see teachers accompanying and supporting students in the face of difficulties, professionals who continue to educate, and also mothers and fathers who put their shoulders to collaborate with this effort. With the above we can point out that as the school system stabilizes and students return to classrooms again, they will need more appropriate systems that allow them to acquire knowledge and skills exponentially. And this is where this project aims to do that; that is, providing the student with a kit that includes materials, a guide and tutorial videos so that he can carry out his electronics practices without the need to be at school and in a laboratory will allow him to avoid the loss of skills in his academic productivity.

Due to the contingency and the geographic location of many students who are pursuing their higher education in electromechanical careers at the Higher Technological Institute of Macuspana and industrial engineering from the Technological Institute of the Sierra Region, they do not have easy access points to technology such as the internet, including a telephone signal and due to the foregoing, this proposal is aimed at all students who take electronics subjects, since when designing the pictorial diagrams it will be facilitated the realization of a basic electronics kit that will include components for the realization of their practices and at the same time correcting part of the problem, as this crisis will have serious consequences for both governments and families, and will hit both the demand and supply sectors of education

Method description

For the development of the study, an experimental and deductive study was chosen, due to the nature of the research.
This research was proposed to:

- The experimental study and understanding of the knowledge acquired in the course of the subject of electricity and electronics.

- The generation of material that facilitates the understanding of matter electricity and electronics.

The established procedure is described below with a series of steps to follow in order to fulfill the project objective.

1.- Interviews The application of interviews to students to reaffirm the lack of knowledge and laboratory practices, due to the isolation caused by the pandemic, with this it was possible to corroborate the lack of a more flexible learning method.

2.- Design of practices. With which, by way of experimentation, it is confirmed that the designed model will serve and will be easy for students to understand when interpreting it, this accompanied by the knowledge they acquire during the semester.

3.- Experimentation and development of practices. Through the running of the practices in a software its functionality is determined, and they are carried out physically for their verification and approval.

4.- Design of pictorial diagrams. The design of the pictorial diagrams in the Fritzing software that will serve as a means for drawing up the plans of the elements that are required.

Analysis from the method

The proposed methodology allows a functionality analysis to be carried out since it is reduced to the study and evaluation of the operation of the electronics kit, so it is necessary to find out its components first of all and the reason for each of these, from another perspective it is also necessary view the same object in use.

All this in order to diagnose the use for which it is intended, which will be to comply with the practical skills of the electronics field; being equally essential that the scope of it can be evidenced.

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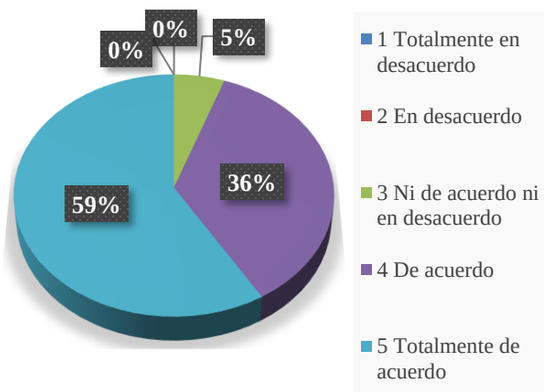
At the beginning, the problem was raised focused on the null use of laboratories in the pandemic, which leads to not reaching the practical competencies of the study plan. This being an important factor at the time of graduation of ITSS students.

For this, some solutions were sought, of which it was decided to develop a practical electronics kit at home. An investigation of the basic elements for the understanding of this technology was carried out, always looking for the iteration with the subjects assigned in the syllabus of the subject in question.

Once the topics of interest were selected, the opinion of the students was sought through a survey. From which the following graph was obtained



Graphic 1

59% of the students (54 students) fully agree to work on a basic electronics kit from home and that it would be an excellent way to carry out laboratory practices, 36% (33 students) agree with this statement , 5% (5 students) neither agree nor disagree, while no student disagrees and totally disagree.

At the end of the survey, it was decided to make the diagrams that include the components selected in the research. They were carried out in a software called Proteus8.0 and were simulated right there for analysis.

Pictorial diagrams were also made in Fritzing for better understanding of the students and at the end the physical practices were carried out to verify that the diagrams and simulations worked correctly

Results

The following results of the pictorial diagram design are presented through the study:

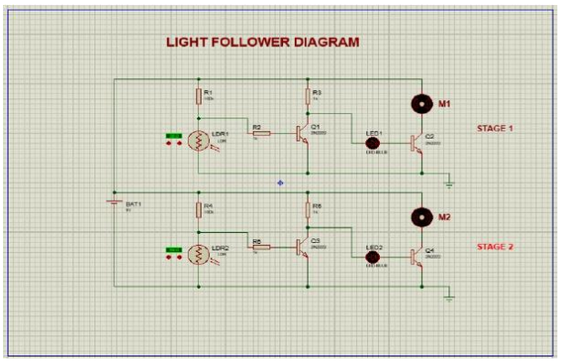


Figure 1 Light follower

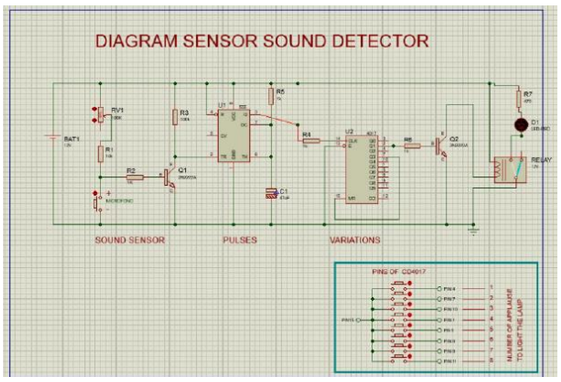


Figure 2 Sound detector sensor

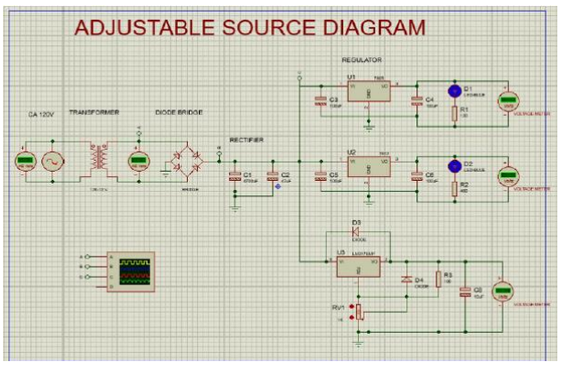


Figure 3 Adjustable source

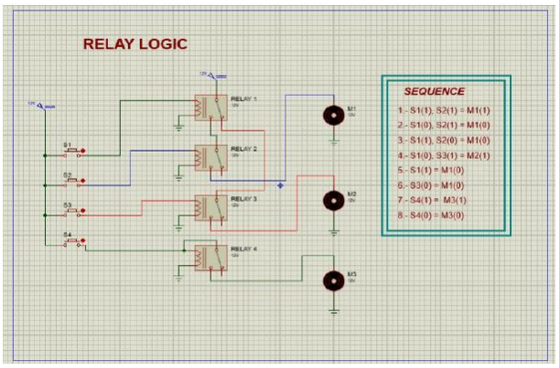


Figure 4 Relay logic

In the end, the veracity of the circuits that will be part of the basic electronics kit to carry out practices at home was verified through the schematic, pictorial and physical diagrams on the breadboard.

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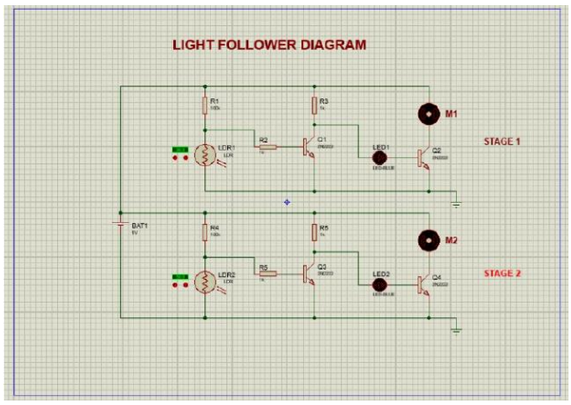

Figure 5 Schematic diagram

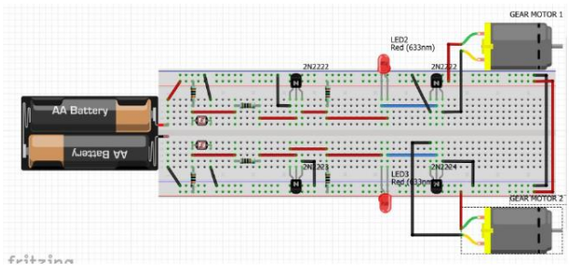

Figure 6 Pictorial Diagram

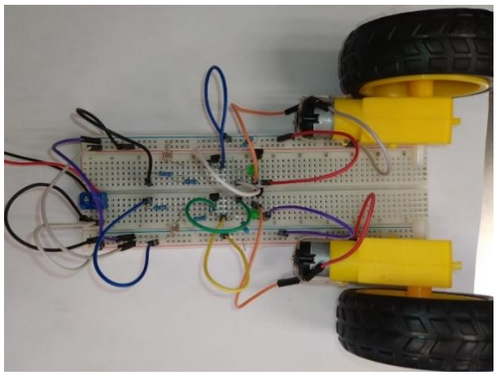

Figure 7 Diagram on real breadboard

Conclusions

The constant search for information helps us and provides better tools for understanding and analyzing the data obtained, which is why the design of pictorial diagrams provides us with a better understanding of electrical circuits for the time of interpretation and experimentation. component physics in practice.

By obtaining the expected results, its functionality in the teaching method is confirmed, which allows students in a dynamic and didactic way to carry out practices supported by teachers, and the means provided to them.

It should be noted that the present study is part of an investigation, in which it is intended to design self-taught teaching kits, therefore it represents a representative advance and confirms that the knowledge of the experts will be distributed in the best way.

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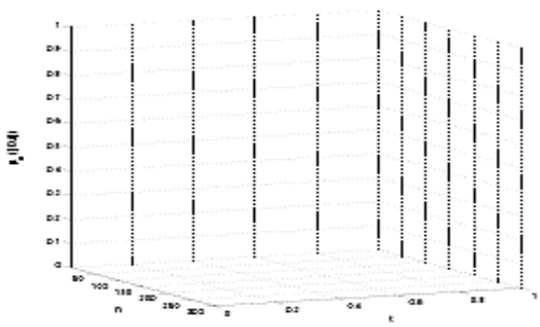

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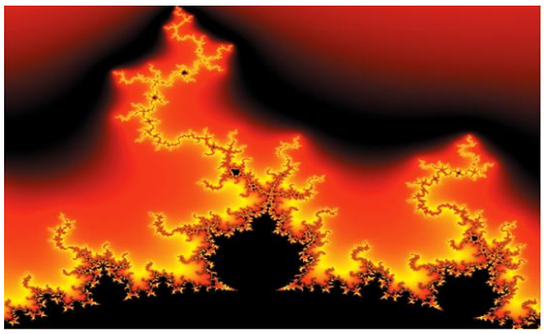

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