SOLAR DRONE FOR AERIAL FUMIGATION

[1,]JONNY C REYES,[2,] CRUZ NORBERTO G[3,]YAEL CARMONA C,[4,]LUIS G AGUILAR, [5,] PEDRO ALFARO G

Technological University of Tlaxcala, El Carmen Xalpatlahuaya, Huamantla, Tlaxcala, Mexico

ABSTRACT: In this project, we will implement a device that can perform tasks without human supervision. Solar energy is one of the most appropriate among the different renewable energy options available. The drone is a device whose power source has been a rechargeable battery, this causes a short operating time since the battery needs to be constantly recharged. The battery is responsible for the power supply of its components, this being one of the most limiting aspects of its operation. Poor battery performance is a problem we have to consider. Therefore, the main objective of this project is to give the drone the capacity to recharge using solar energy, this will help us to reduce costs considerably, as well as to take advantage of renewable and clean energy. This project has been developed through different phases that have allowed to facilitate the fulfillment of the proposed objectives, these stages start with the selection of the device where the fumigation system is implemented, proceed to the complete design of the device using specialized software for this task, then we work on the autonomy of the vehicle developing, the systems of identification of the application point, positioning and control of the device.

KEYWORDS: Fumigation, solar energy, design, performance.

I. INTRODUCTION

The use of photovoltaic energy (energy generated by light radiation) is considered one of the promising forms of renewable energy. To achieve this electrical energy solar panels are manufactured from different types of materials such as (Silicon, Gallium Arsenide) and that are aimed at generating a great power output of electrical energy and conversion efficiency. [1] The design and construction of solar energy use systems has allowed to reduce the environmental impact produced by conventional energies, improving the autonomy of devices that have it, which is a field of research and innovation in mechanical engineering and related careers. Given that the Sun is a renewable source of energy and its utility increases every day due to technological advances, it was decided to have this type of energy to improve the autonomy of a fumigated drone, Implementing a solar energy system that is made up of selected solar panels, which connect directly to the 2000 volt, 7.4 mAh battery that the drone has, serving as a support to increase battery life, and obtaining an extra duration of 1 minute and 40 seconds, to improve the performance of work in agriculture. For the selection of solar panels suitable for the project, the data on efficiency calculated by experimental tests are taken into account. On the other hand, it was verified by observation that the solar panels located above the drone do not generate instability during the flight. Field tests were then carried out to be able to quantitatively compare the efficiency of using a solar energy system with respect to a systemwhich is supplied with electrical energy. With the realization of this project it was possible to demonstrate the autonomy and efficiency of a fumigator drone, with solar panels as support for the electric battery of the drone.

II. MATERIALS AND METHODS

Materials and methods: Design and construction of a solar drone fumigator of vegetables

Mechanical Design

Propellers: Considering the helix definition, the device uses 11x4.7 propellers because of its efficient performance against the torque, this propeller is of an average size, the larger the helix, the longer the system takes to respond and the current consumption is greater. this would cause a decrease in the flight time of the equipment; if the helix is a small size, it will not generate enough thrust for the proposed application. Figure 11 shows a set of propellers of the sizeselected for the project.

Figure 1 Propellers

Dosing system: For the dosing system, 3 components are integrated for its correct performance, these are connected by hoses and plastic pipe.

Container tank: The material for making the drone tanks is stainless steel due to their corrosion resistance properties.
 The reference for coal steel with anti-corrosive primary, resistant to medium grades of acid is: 316, 304, 347, 309, 310, 302. The figure shows a tentative aluminum base tank for use in the project.

Figure 2 Container tank

At the time of choosing the tank for the project is the need to use breakwater baffle, since when the device is moving the liquid is swinging from one side to the other generating large stability disturbances, the solution divides the tank into two smaller ones because the disturbances of these are very small and it is not necessary to add breakwater systems in the tanks.

Sprinkler nozzle : The nozzle to be used will be fan type, orange as shown in figure 14, as it allows the lowest liquid output per minute (0.1 GPM) and will have an angle of 110° so that when spraying it covers more area.

Figure 3 Fan nozzle

Controller : To control the system, an Arduino Mega 2560, which has dimensions of 11x1.5x5.5 cm, is shown in the figure shown above. Additionally, for each motor a speed controller is required, the Soaring-60A controller was selected which has a weight of 60g and has dimensions of 70x31x14mm.

Figure 4 Controller

Engines : Brushless motors have been selected, as they have multiple advantages over DC brushless motors; The reference to use will be Leopard LC3542-5T which have a thrust of 2000g, a weight of 135g, its dimensions are 2.8 cm in diameter, 66.5mmde long, the axis is 6mm in diameter. The selected engine is shown in the figure below.

Figure 5 engines

Analysis of the electrical arrangement with the panels : In order to choose the suitable electronic arrangement to design a drone fumigator with solar panels to improve the autonomy of a drone, the arrangement that can be in parallel or combined was tested, and having a multimeter was measured how much voltage and current generates the electronic arrangement to be analyzed; this shows the arrangement that exceeds the voltage of the drone battery which is approximately 7.4 v, and which generates as much current as possible, as the more it produces,charging is more efficient and faster. Below are the solar panels, where the multimeter is measured. The arrangement was to locate the 6 solar panels as follows in a 2-2-2 arrangement in parallel.

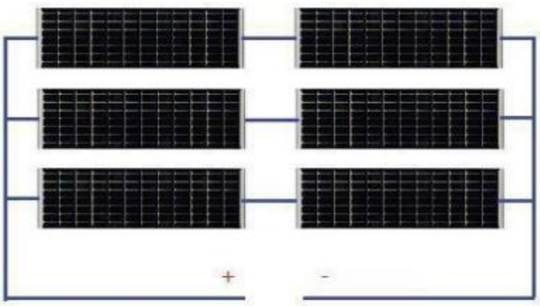

Figure 6 Connecting Electrical Array

Arduino : It is a development system which consists of a free hardware and a development environment; according to the board model the system uses different Atmel AVR microcontrollers and allows in-circuit programming. This facilitates the development of projects due to the decrease in wiring time and microcontroller characteristics, among these are for example PWM outputs, digital, analogue inputs, UART communication modules and I2C. Then,Figure 7 shows an Arduino Mega 2560 R3. [3]

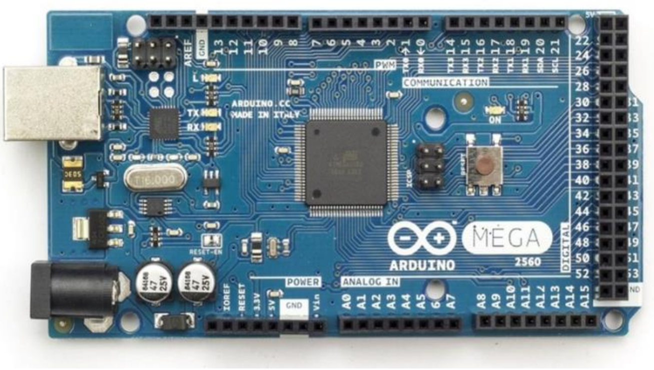

Figure 7 Arduino

Calculation of a new coordinate from an initial point, the distance to the starting point, and an angle:

To find a new coordinate, the following equations are used, which deliver a latitude and a longitude at a distance and direction from the starting point. [4]

$$\varphi 2 = \operatorname{asin}\left(\sin(\varphi 1) * \cos\left(\frac{D}{R}\right) + \cos(\varphi 1) * \sin\left(\frac{D}{R}\right) * \cos(\Theta)\right)$$ [11] Ecuación 5.

$$\lambda 2 = \lambda 1 + \operatorname{atan}\left(\frac{\sin(\Theta) * \sin\left(\frac{D}{R}\right) * \cos(\varphi 1)}{\cos\left(\frac{D}{R}\right) - \sin(\varphi 1) * \sin(\varphi 2)}\right)$$ [11] Ecuación 6

Where:
: Angle between points
: Initial Latitude
: New Latitude
: Initial Longitude
: New Longitude
D: Distance at which the new coordinate is to be found
R=6371 km: Geodesic radius of the earth

III. RESULTS AND CONCLUSIONS

Base : The need to create a base for mounting the components of the drone arises, for this purpose an aluminum plate is designed so that the most components can be placed on it, optimizing the spacing and removing parts of the plate that only generate weight; for example, on two sides, you add curves that are useless and produce weight. The designed base has dimensions of 20x20x2mmand a weight of 182.etug See figure below.

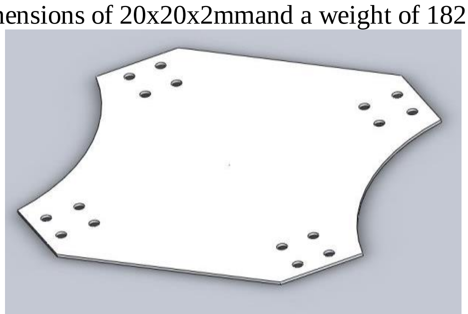

Figure 8 Drone Base

Bars : With the base, 8 aluminum bars are designed with the necessary perforations to join them with the base, the motor supports and the lining of the propellers, each bar has dimensions of Φ 12.7 mm x 240mm in length and a weight of 42,822 g. See figure below.

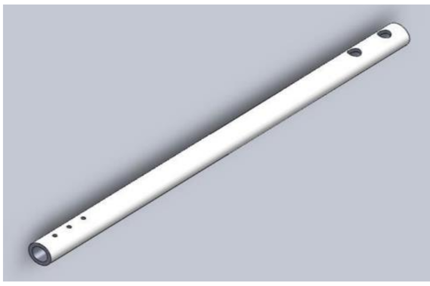

Figure 9 Drone Bars

Engine base : The bases of each motor are elements that normally come as part of a motor kit, each base change according to the dimensions of each motor. The designed base has dimensions of 32x32x2mm and a weight of 0.7g See figure below.

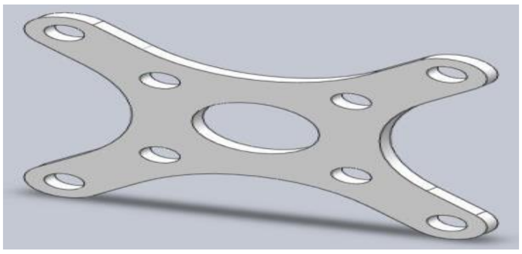

Figure 10 Drone Engine Base

Engines : The brushless motors were downloaded from the Grab CAD page, so that they are as close as possible to those used to the project. See figure below.

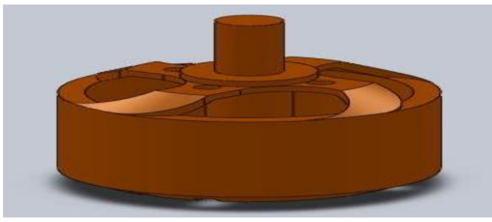

Figure 11 Drone engine

Propellers : The propellers for the drone engines were designed taking into account the specific dimensions of this component (12x5.7 inches). See figure below.

Figure 12 Drone Propeller

Propellers guard : The propeller coatings are designed in PET plastic to protect the propellers in the event of a collision with the floor or any element while the device is in flight and can also be attached to the drone bars. Its dimensions are Φ270mm and 40mm in width, it has a weight of 147.net See figure below.

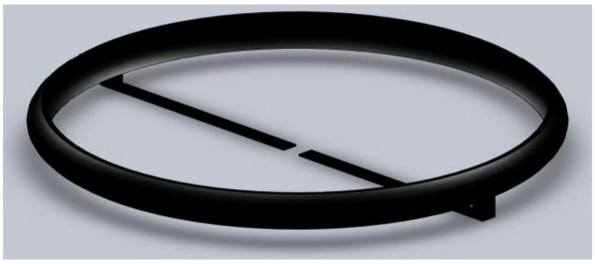

Figure 13 Drone Propeller Protector

Protective dome : The purpose of the dome is to protect all electronic components and is designed in this way to have the best possible aerodynamic characteristics; this dome is held directly to the initial base by a clamp or ratchet and is made from polyethylene terephthalate (PET); It has dimensions of Φ147mm x 73.5 in height, it has a weight of 224. Seefigure below.

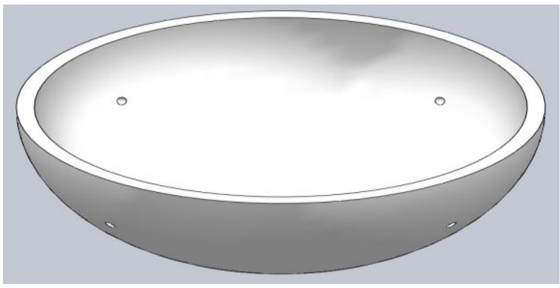

Figure 14 Protective Drone Dome

Ratchet : In order to be able to hold the dome to the base of the drone, a clamp is designed to perform this function. The designed clamp is divided into 3 parts for better device maneuverability. The 3 clamp sections are described below:

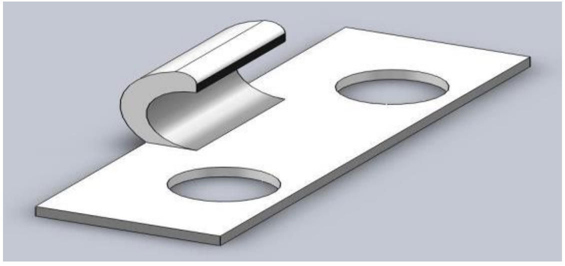

Figure 15 Base Support Ratchet

Ratchet part 2 : A bracket is designed that can be easily installed in the dome and resists pressure to prevent the dome from changing its position. It has a weight of 3.31 g made of ductile iron. See figure below.

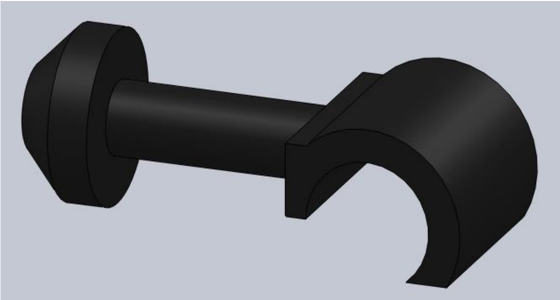

Figure 16 Dome Support Ratchet

Ratchet part 3

In order to be able to join the first two parts of the ratchet, a link is designed that joins these two components together so that the protective dome can be anchored to the base of the drone. It has a weight of 23.7g made of ductile iron. See figure below.

Figure 17 Bonding Ratchet

Support : In order to minimize the weight of the equipment, a tank support is designed but is also part of the landing gear. This support is made of aluminum and has a weight of 110.net See figure below.

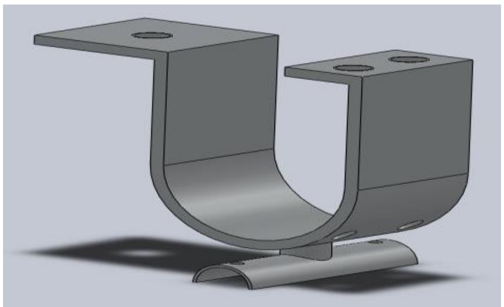

Figure 18 Tank Support

Tank : The plant protection element container is designed so that it can be filled without having to remove from the drone, it also has an opening through which the liquid is extracted. Its material is made of chrome stainless steel with dimensions deΦ50mm x 200mm in length, with a storage capacity of 377ml. See figure below.

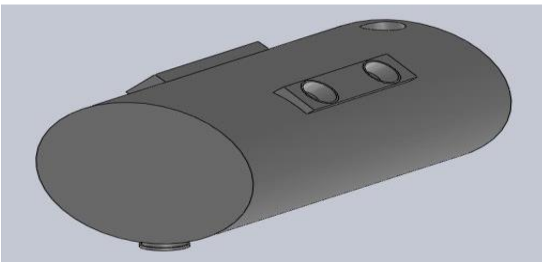

Figure 19 Tank

Landing bar : On the landing gear, a bar is selected so that it can support the full weight equipment in addition, to avoid runoff at both take-off and landing. It is Φ14mm x 280mm in length. See figure below.

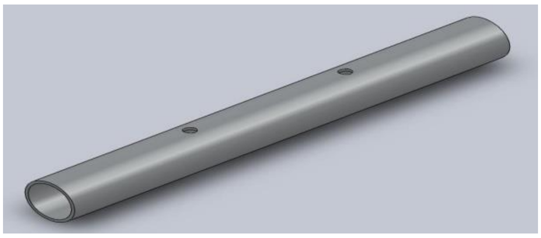

Figure 20 Landing Bar

Hoses : Custom-designed hoses are used to send the plant protection fluid from the tanks to the engine pump. For each side of the designs a hose because the position is not the same. Its material is made of EPDM durometer, and the weight is 1.r.g. See figures shown below.

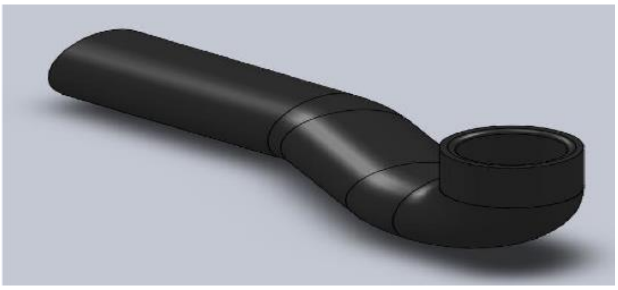

Figure 21 Right Hose Figure 22 Left Hose

Output T : Because the device is designed with two tanks, it is necessary to design a joint for both tanks, for this reason this TE is designed, for the circulation of the liquid from the tanks to the pump. It has a weight of 9.0 in PVC plastic See figure below.

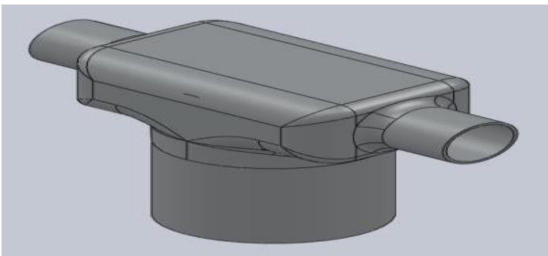

Figure 23 T motor pump

Motor pump : The pump is one of the most essential parts of the equipment, but it is an element that does not need to be designed, it was selected according to commercial availability and is downloaded directly from the GrabCAD page. See figure below.

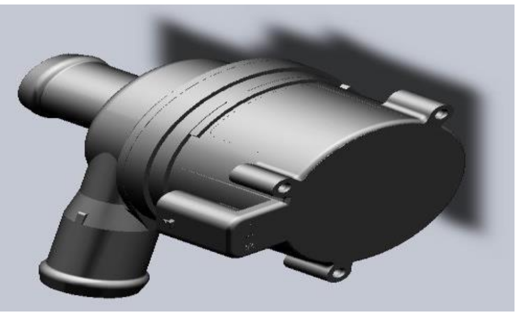

Figure 24 Motor Pump

Elbow : Given that the spray of the liquid must be done vertically and downwards, an elbow is designed to meet this need. Its weight is 2.6mg in PVC plastic See figure below.

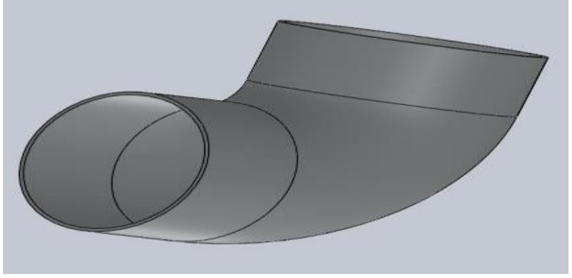

Figure 25 Spray Elbow

Mouthpiece : It is designed according to the specifications of the 0.1 GPM fan nozzle. See figure below.

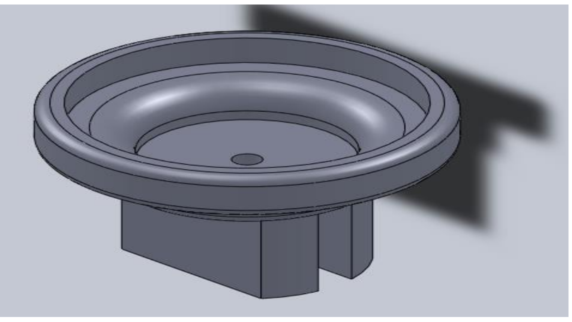

Figure 26 Mouthpiece

Final Assembly : With all the selected and designed elements, they are assembled, obtaining the complete drop. The placement of the panels is misted to generate the necessary voltage for its operation. The complete assembly is shown in the figure below.

Figure 27 Final Assembly

POINT OF APPLICATION IDENTIFICATION SYSTEM : To identify the point of application, latitudinal and longitudinal coordinates are used; this process is carried out in different phases, described below:

Delimitation of the point of application : The delimitation consists of making a virtual fence that encloses the area where the fumigation is to be performed, for this, four coordinates are measured with a global positioning system which represent the vertices of the desired zone, for these points, the system draws imaginary lines forming a polygon, then calculates the distance and angle between each of the points in an orderly fashion, i.e. from the first point to the second point, from the second point to the third point,from the third point to the fourth and from the fourth point to the initial.

Definition of the fumigation route

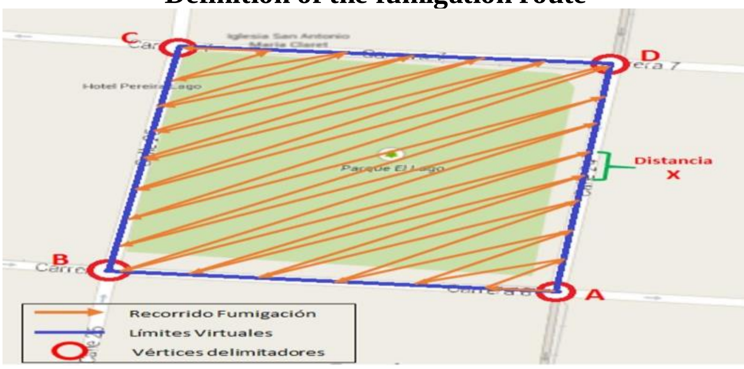

Figure 28 Fumigation route

The fumigation path is the way the device should travel the area to be fumigated, it is determined that the equipment zigzag between the boundaries, the system starts at vertex A, then a point on the AB line and from there it passes to a point on the DA line as shown in figure 28 above. The zigzag path is defined as it allows the area to be completely sprayed. it avoids sudden changes of direction and the implementation is not as complex as it is with other ways of traversing the target field.To determine the route, the system after measuring the distance and angle between each of the vertices obtains a new coordinate from a starting point, the angle found, and an X distance (as shown in Figure 28) With which you want to divide the boundary line between two vertices, the smaller the distance X, the more intense the fumigation will be because the device will pass fumigating between very close areas.

IV. CONCLUSIONS

• Making the relevant reviews it is determined that the most effective flight equipment is a drone for the purpose of the project that is fumigation, since this equipment presents the best cost-benefit comparison, it allows a load capacity according to the requirements and also has as its purpose the use of clean energies, in this way we avoid the consumption of polluting batteries.

• In the development of the project, the decision was made to use an Arduino development system as a controller, due to the many benefits it brings compared to other controlled micros, as is reprogramming in the work area without dismounting the system that allows the controller to be reprogramed quickly and safely,Multiple two-way communication ports having proper communication with each sensor and actuator in the system plus low power consumption and high processing speed which allows for a greater amount of power in the actuators, having even the most optimal performance of the controller.

ACKNOWLEDGMENTS

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