Drones for Inspection and Control in Industry 4.0

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***Abstract*—This paper presents a brief idea of drones, their technology and can be used for different purposes. New technologies such as machine learning, Artificial Intelligence (AI), the Internet of Things (IoT) and drones are transforming the workforce. Major aim of this project is for surveillance, inspection. The most important feature of the drone is the transmission of images and video in real time (FPV). They highlighted the safety areas, as risky tasks such as thermometry and specific tool maintenance can now be performed without exposing workers. Finally, more than 40 cases of use have been validated, mainly for the security of assets, for the areas of exploration, projects, engineering, construction, planning and logistics, maintenance, quality and environment, production and above all, personnel safety.**

Keywords— surveillance drone, FPV drone, energy efficient drone, less noise, Industry 4.0.

I. INTRODUCTION

The 2016 was a drone's year, a true revolution occurred in terms of the hardware and software used in both the manufacturing process and in controlling drones. This has made these devices easier to maneuver, able to fly more, be safer and able to obtain video footage and high-resolution photos at a professional level. In recent research it is clearly observed that drones are about to create a revolution in human life and industry. The most important aspect is that it can be used for effective surveillance at places where human being can't reach. To reduce the cost of the drones, Low cost avionics System Prototypes are made. It makes the structure light as well as strong.

The paper deals with a drone which has its location being directed by GPS giving its exact location. The most important aspect of this paper deals with the detection of unidentified obstacles which tend to create disturbance in the normal environment. Capturing and reporting all minute details as the camera associated with it moves as per our direction. Using of GPS for automatic mission planning, the stabilization of the drone for proper surveillance and the FPV part are the advantageous where we can control it through the remote.

In our capture of models and alternatives for our company or industry we are going to raise a comparative of certain models of Drones with certain characteristics and using TOPSIS we will be able to arrive at our ideal solution.

The TOPSIS method has been selected because it is one of the most widespread and applied methods of operational research in the industry. It was developed by Hwang and Yoon (Technique for Order Preference by Similarity to Ideal Solution, 1995) based on the concept that it is desirable for a given alternative to be located at the shortest distance from an ideal positive solution and at the longest distance from an ideal negative solution.

The Ministry of Environment and Water in Dubai has started using drones for monitoring the work of crushers and quarries. Nokia [2] plans to use flying drones as a public safety system for cities. PrecisionHawk [3] has been offering remote sensing and data processing services using drones for various applications such as infrastructure monitoring and search/rescue.

Recent advances in sensor and embedded device technologies are also pushing the pervasive data acquisition and processing capabilities in different city infrastructures such as roads, traffic signals, sidewalks and bridges to monitor.

II. MODELS OF THE INTERFACE

Each of the screen will have relationship with the different module of the intelligent dashboard.

The next window will show the first module called "Agregar" in this module you can add an alternative by the name of the product and 5 of their characteristics included the price, this is with the purpose to add the most characteristics for compare the alternatives.

The variables of each *Self.Entry* is declared as *StringVar()*. When you introduce the information they go to the DataBase.

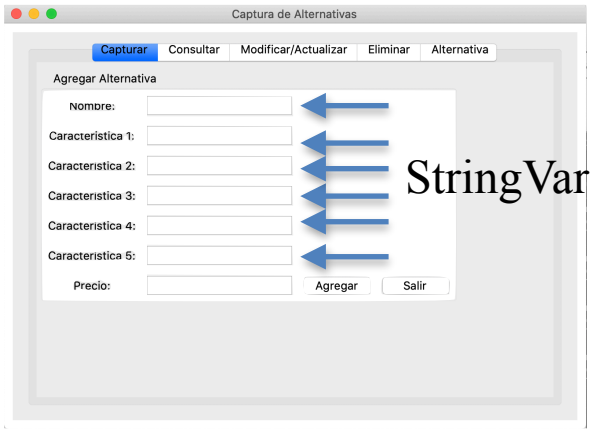


Figure 1 Source own elaboration.

In the second module called "Consultar" you can view all the alternatives saved in the BD separated by categories. If you need to check any data these module are the indicated.

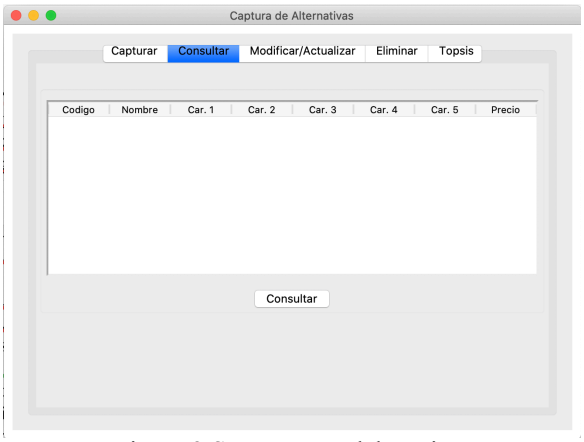


Figure 2 Source own elaboration.

The third module is called “Modificar/Actualizar” in this module you can modify or update the attributes of you alternatives only if you need to make some corrections before the program create the TOPSIS method. The correct form to use this module you need to write the code generated when you add any alternative on the BD, when you write the code all the fields gonna be full with the information.

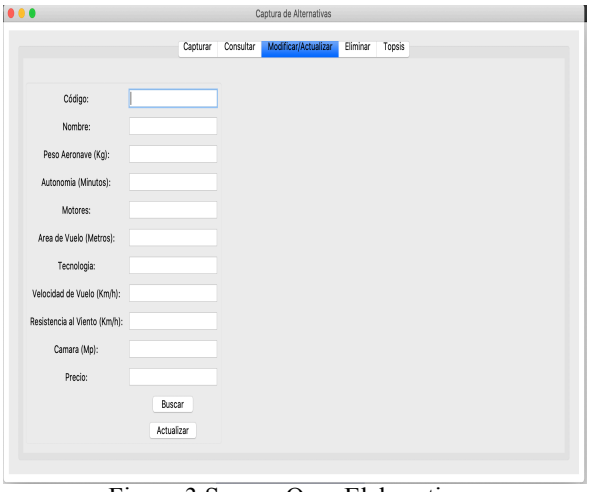


Figure 3 Source Own Elaboration

Fourth module is very simple due you only need to write the code of the alternative to eliminate by 1. Be careful of digit the correct code.

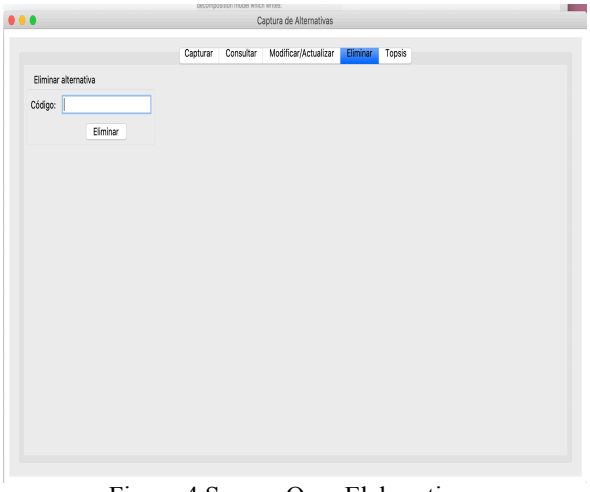


Figure 4 Source Own Elaboration

III. DRONE APPLICATIONS

Drones can be used for many applications but we will focus mainly on those in Industry 4.0. We will analyze Thermography, Photogrammetry, Scanning (point cloud), Inspection of power lines, Inspection of infrastructure, Inspection of wind turbines, Inspection of chimneys and gas leaks, Inspection of pipelines, tanks and reservoirs, Inspection of oil platforms, Energy efficiency.

The objective of the use of this new technology is to facilitate the work of companies in the industrial sector as well as to minimize expenses and risks, reducing the use of personnel, the time of execution of the work and as a consequence the cost.

Thermography

Thermography is a technique that allows calculating and determining the surface temperature of objects at a distance, without the need for physical contact with the object being studied. Thermography allows the capture of infrared radiation of the electromagnetic spectrum, using thermographic or thermovision cameras. We can carry out both qualitative (by comparing temperatures) and quantitative (by giving numerical values) inspections, incorporating qualified thermographs in the template.

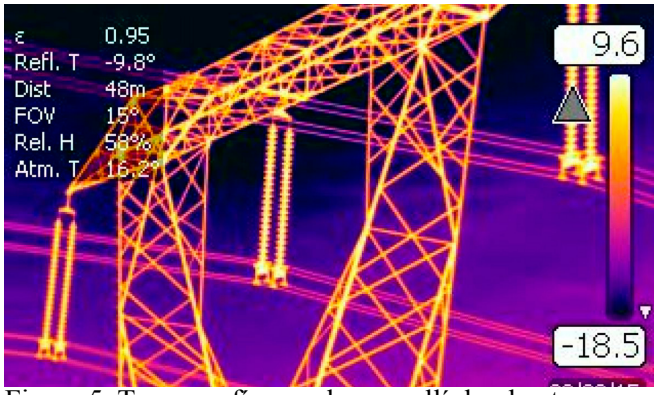


Figure 5 Termografía con drones, allí donde otros no llegan.

Photogrammetry

Photogrammetry is a technique to determine the geometric properties of objects and spatial situations from photographic images by obtaining 3D models and/or maps from the generated point clouds. With it and with our drones equipped with GPS, the georeferencing of the objects and points scanned is obtained. In the same way, by exchanging different cameras we can generate thermal or visible spectrum maps.

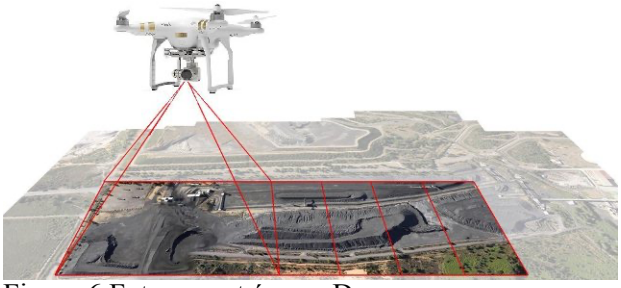


Figure 6 Fotogrametría con Drones

Scanning (point cloud)

By combining traditional scanning techniques, such as three-dimensional laser scanners, and the point clouds generated by our drones, we obtain a data file with a totally complete point cloud, avoiding blind spots in the facilities.

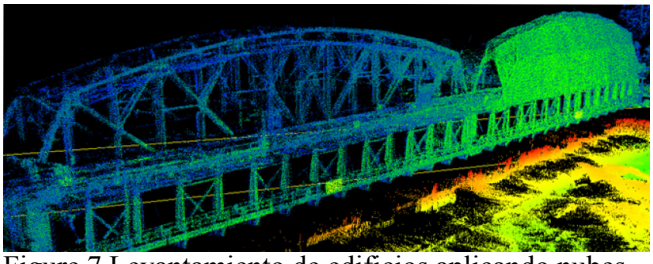


Figure 7 Levantamiento de edificios aplicando nubes de puntos

Inspection of power lines

Exhaustive visual and thermographic inspection of the electric, low and high voltage lines. The drones prevent workers from climbing the tower and traveling long distances for the execution of our projects, delivering higher quality data by not running the risk of taking information. Inspections are speeded up and power cuts are avoided, executing this, right at the time of the execution of the work.

Figure 8 Expansión de la Inspección de las Líneas Eléctricas con la Tecnología de Drones

Infrastructure inspection

Safety inspection of buildings, structures and cranes, by means of a periodic review. It allows us to detect and measure corrosion, deformation and cracks. Traditional methods are often risky, slow, expensive and involve closing lanes, using truck cranes, walkways, etc.

Figure 9 Inspección y auscultación de infraestructuras

Inspection of wind turbines

Inspection of shovels, main hub and blades. Inspection of mast, hub and blades in both visual and thermal spectrum.

Figure 10 Eólica y energías renovables: nuevo sistema de inspección de palas de aerogeneradores

Inspection of chimneys and exhaust gases

Visual inspection for corrosion, deformation, surface treatment and possible cracks. Detect hot spots in an exhaust stack and cold spots from gas leaks. It is not necessary to stop production to carry out the inspection.

Figure 11 Altura minima de chimeneas industriales

Inspection of oil platforms

Visual inspection for corrosion, deformation, surface treatment and possible cracks. Inspection of structures at great heights and areas close to contact with the sea.

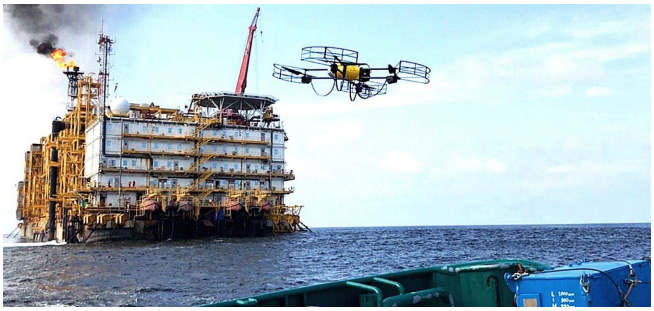
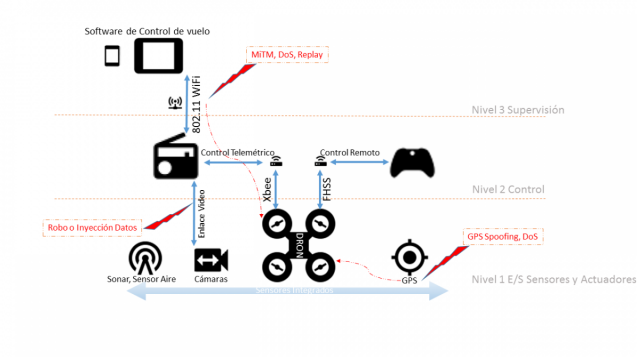


Figure 12 Plataformas petrolíferas

But before we go into detail, let's see how a drone works



How it can be shown in the image we see that the drone can be operated in different ways, remotely with a control or with the application for mobile devices.

The only disadvantage that the drones have, is the WIFI connectivity, they need to have a very good antenna to not have interference when receiving images or live video.

Here is a graph showing the drone market by sector

Chart 1: Drone Market by Sector

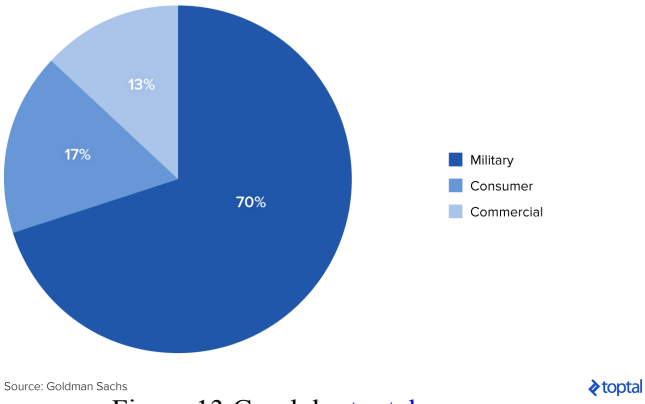


Figure 13 Graph by toptal.com

According to Gartner market research, the market size for commercial drones in 2016 was 2.8 billion with only 110 billion units sold. In 2017, it is estimated that commercial drone sales will grow by about 60% to 170,000. While personal drones dominate unit sales in 94% of the market, they comprise only 40% of the market's revenue share. Commercial drones account for only 6% of the market but their price tags of around $100,000 are projected to account for 60% of the industry's revenue.

Qualcomm Ventures	3DR AIRMAP Flirtey RedZone Robotics SKYCATCH swift
GV	Airware SKYCATCH Hivemapper zipline
intel Capital	Airware PRECISIONHAWK YUNEEC

Table 1 Most Active Corporate Ventures in the Drone Industry

Qualcomm Ventures, the most active venture capitalist, making six investments to date in companies focused on mapping, pipeline inspection, delivery, 3D mapping, stand-alone solutions and business solutions Qualcomm also acquired Kmel Robotics to expand its cellular technologies within the drone operations, launching its own commercial robotics solutions.

Google Ventures, which has also been actively investing in long-distance delivery, commercial end-to-end solutions and 3D mapping. Google Ventures has developed 63 patents related to drones through various drone capabilities.

Intel Capital, which has invested in a complete end-to-end business solution, an analytics solution and a hardware company. They have also acquired two companies, including Ascending Technologies, which is developing "sense and avoid" algorithms, and MaVinci, which is developing flight planning software. These acquisitions and investments have helped Intel develop its own solutions for commercial drone applications.

IV. THE TOPSIS METHOD

In our application to use the topsis method we are going to break it down part by part.

Let's first select our alternatives and then separate them by attributes, giving a weight to each attribute.

Alternatives: These are the options which are to be evaluated for selection of the best.

Attributes: These will impact the selection of alternatives.

Weight: These estimates relative importance of attributes.

Atributo	Peso	Autonomia	Motores	Distancia	Tecnologia	Velocidad	Resistencia	Camara	Precio
Peso	5	8	4	8	7	4	8	7	6

Rating Scale 1 Not Important - 10 Very Important

Attribute	Weight	Rating Scale
Peso	5	1 None - 10 Very Important
Autonomia	8	1 None - 10 Very Important
Motores	4	1 None - 10 Very Important

Attribute	Weight	Rating Scale
Distancia	8	1 None - 10 Very Important
Tecnologia	7	1 None - 10 Very Important
Velocidad	4	1 None - 10 Very Important
Resistencia	8	1 None - 10 Very Important
Camara	7	1 None - 10 Very Important
Precio	6	1 None - 10 Very Important

Once we select our attributes and the weight of each of them we will proceed to the decision matrix for each of the alternatives.

When we have the ideal matrix we will use the topsis methodology. Technique for Order Preference by Similarity to Ideal Solution. TOPSIS selects the alternative that is the closest to the ideal solution and farthest from negative ideal solution.

In this Method two artificial alternatives are hypothesized:

Ideal Alternative: One which has the best attributes values.

Negative Ideal Alternative: One which has the worst attribute.

A. *Authors and Affiliations*

The template is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

1) For papers with more than six authors: Add author names horizontally, moving to a third row if needed for more than 8 authors.

2) For papers with less than six authors: To change the default, adjust the template as follows.

a) Selection: Highlight all author and affiliation lines.

b) Change number of columns: Select the Columns icon from the MS Word Standard toolbar and then select the correct number of columns from the selection palette.

c) Deletion: Delete the author and affiliation lines for the extra authors.

B. *Identify the Headings*

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named “Heading 1”, “Heading 2”, “Heading 3”, and “Heading 4” are prescribed.

C. *Figures and Tables*

a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation “Fig. 1”, even at the beginning of a sentence.

I. TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	***Subhead***	***Subhead***
copy	More table copy[a]		

a. Sample of a Table footnote. (*Table footnote*)

1. Example of a figure caption. (*figure caption*)

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

ACKNOWLEDGMENT *(Heading 5)*

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

REFERENCES

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

1. G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
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