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Journal of Computational Technologies

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Presentation of the content

In the first article we present, *Data visualization tools applied to the analysis of school dropout at higher-level institution* by MORALES-HERNÁNDEZ, Maricela, DIAZ-SARMIENTO, Bibiana, RAFAEL-PEREZ, Eva and VELASCO-HERNANDEZ, Uzai, with adscription in the Tecnológico Nacional de México/Instituto Tecnológico de Oaxaca, in the next article we present, *Web system for the control of the forest fire process in eastern Michoacán* by GONZÁLEZ-RAMÍREZ, Claudia Teresa, PALAFOX-MACEDO, Baltazar, GUTIERREZ-NÚÑEZ, Antonio and RUIZ-GARDUÑO, Jhacer Kharen, with adscription in the Tecnológico Nacional de México/Instituto Tecnológico de Zitácuaro, in the next article we present, *Mobile application for the care and monitoring of plants at home "Applantar"* by GARCÍA-HERNÁNDEZ, Rodrigo, MARÍN-COHETO, Luis Ángel and MORALES-ZAMORA, Vianney, with adscription in the Tecnológico Nacional de México Campus San Martín Texmelucan, in the last article we present, *Automated Irrigation System, AIS: Technological Development* by DÍAZ-ORTEGA, Angel Ulises, BRAVO-BRAVO, Brisa Lucero, RODRÍGUEZ-PÉREZ, Emiliano and MARTÍNEZ-TORRES, Rosa Elia, with adscription in the Tecnológico Nacional de México, Instituto Tecnológico de San Luis Potosí.

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Data visualization tools applied to the analysis of school dropout at higher-level institution

Herramientas de visualización de datos aplicadas al análisis de la deserción escolar en una institución de nivel superior

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Abstract

School dropout at a higher level is a problem that afflicts all higher education institutions in all countries of the world, in Mexico, and in particular in the state of Oaxaca. At the present work, data visualization tools are applied to analyze a data set of students who dropped out of the Computer Systems Engineering career at TecNM/I.T. of Oaxaca, with the objective of finding the relationship that the variables of such a data set have. To achieve this, the data analysis methodology proposed by Google is applied, as well as the Tableau and Orange tools for visualizing trends, relationships between variables, etc. of the data set. This research contributes to the instances that make decisions about the strategies to follow to prevent school dropout to some extent. In the same way, it also contributes as a guide for the application of the tools that exist under a free and not free license to carry out similar analyses, so that those interested can start their own analyses.

Analysis, Visualization, University dropout

Resumen

La deserción escolar a nivel superior, es un problema que aqueja a todas las instituciones de educación superior de todos los países del mundo, de México, y en particular del estado de Oaxaca. En el presente trabajo se aplican herramientas de visualización de datos para analizar un conjunto de datos de estudiantes desertores de la carrera de Ingeniería en Sistemas Computacionales del TecNM/I.T. de Oaxaca, con el objetivo de encontrar la relación que tienen las variables de tal conjunto de datos. Para ello se aplica la metodología de análisis de datos que propone Google, así como las herramientas Tableau y Orange para la visualización de las tendencias, las relaciones entre variables, etc. del conjunto de datos. Con la presente investigación se contribuye con las instancias que toman las decisiones sobre las estrategias a seguir para prevenir en cierta medida la deserción escolar. Del mismo modo, también contribuye como una guía para la aplicación de las herramientas que existen de licencia libre y con licencia para la realización de análisis similares, para que los interesados puedan iniciar sus propios análisis.

Análisis, Visualización, Deserción universitaria

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Introduction

In different countries around the world, school dropout at all educational levels is a constant concern, since, by Law, education is a right that must be guaranteed to citizens. It is known through different reports from international organizations such as UNESCO, the United Nations, among others, that the percentage of citizens who access education decreases as the educational level increases. According to the report of the National Institute for the Evaluation of Education (2019), in Mexico, at the beginning of the 2016-2017 school year, the school dropout rate was 5.3% in secondary education and reached 15.2% in medium superior education.

An important finding in this report is that, in general, men drop out more than women do. On the other hand, the INEGI (2022) reports a dropout of 8.8% at the national level, at the higher level in the 2020/2021 school year, which includes a degree in Teacher's College, University and Technological Education, and excludes Postgraduate Studies.

While in the state of Oaxaca, specifically in that same school year it presents 12.2% above the national average.

The state of Oaxaca has been classified by INEGI as one of the most lagging states in terms of education at the national level, and although it currently has 103 higher education institutions (HEIs), according to COEPES (2020), the Student retention rate at this level remains low.

Kuz and Morales (2023) state that dropout, retention and attraction of students are key indicators, forming part of the sustainability of educational institutions through an approach based on data analysis decision making. This idea reinforces the present research; since it precisely seeks that, the results support decision-making through student retention strategies. Therefore, for the Oaxaca's Technological Institute, which is one of the eleven higher education schools of the Mexico's National Technological subsystem that exist in the state, it also represents a latent problem, because, statistically it has a worrying school dropout rate, specifically in the Computer Systems Engineering career.

Only in the August-December 2022 School period, according to the Mindbox Information System (2023), there was a dropout rate of 10.35% compared to the previous period, February-June 2022.

The dropout of university students, according to Zimányi *et al* (2022), is a problem that persists in Higher Education Institutions (HEIs), affecting the terminal efficiency and the graduation rate of educational programs. Indicators that every HEI uses to measure the achievement of institutional goals. According to SEP (2022), school dropout is defined as "school dropout," which is the number of students who leave school in the school year, for every 100 students who enrolled at the beginning of courses at that same educational level. That is, it interprets it as a percentage of the total number of students who started the school period. In the case addressed in this work, the school period is defined by semester.

The objective of this work is to analyze the school dropout data from the years 2020 to 2023 of the Computer Systems Engineering degree offered at the Mexico's National Technological /Oaxaca's Technological Institute, and visualize the relationship between the selected variables with tools such as Tableau or Orange.

To this end, it is important to be clear about what data analysis is. According to Stevens (2023), any company collects data that by itself means nothing; however, with data analysis, significant and actionable information is obtained that subsequently informs and leads to an intelligent decision-making.

Amazon (2023) defines data analytics as the conversion of raw data into actionable insights. With data analysis, you can find trends, solve problems, and thus make institutional or business decisions.

The tools used in the data analysis of this research work are Tableau and Orange. The official Tableau website (2023) defines it as a visual analytics platform that transforms the way data is used to solve problems, allowing people and organizations to get the most out of their data. It is important to note that this tool has a cost, but you can register for free to try it for 14 days and, it offers various products, including desktop and online version.

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The second visual tool used for data analysis is Orange, according to Hoyt (2022) it is a free educational data science platform created by computational biologists at the University of Ljubljana, Slovenia. In the background, it uses Python to process the required operations, although users do not need to know programming in said language. Orange is client-based and runs on the most widely used operating systems such as Windows OS, MacOS and Linux.

The results of this investigative work will provide relevant information to take actions in the institution, focused on student retention, in order to make decisions aimed at retaining students in the Computer Systems Engineering career.

The paper consists of nine sections, the introduction, the developed methodology, the development, obtained results, acknowledgments, findings, conclusions, future work and references.

1. Developed methodology

There are different data analysis methodologies; for example, Gautam (2021) shows the six phases of Google data analysis, as seen in Figure 1.

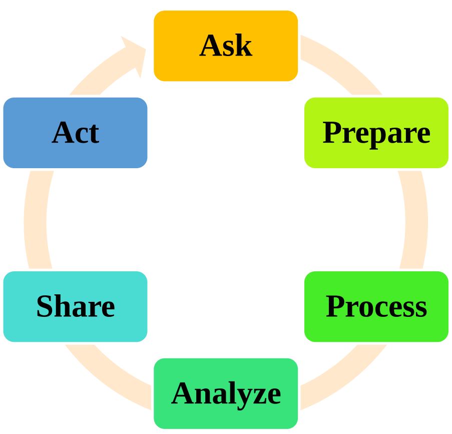

Figure 1 Data analysis phases
Gautman (2021)

On the other hand, BPB Online (2021) considers that data analysis mainly involves six important phases that are carried out in a cycle, as you can see in Figure 2.

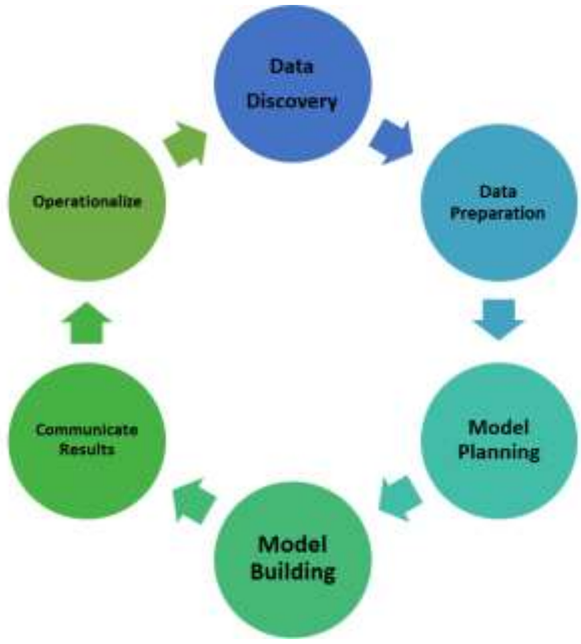

Figure 2 Phases of data analysis
BPB Online (2021)

For his part, Hillier (2023) explores the main steps in the data analysis process, as illustrated in Figure 3, and although it is apparently a linear process, the author emphasizes that it is really an iterative process.

Figure 3 The Data Analysis Process
Hillier (2021)

Each of the methodologies offer similar phases, and the variation between them is minimal, for this reason in this work, the methodology proposed by Google has been taken as a basis, in accordance with the article by Gautam (2021), since it is important for the institution to know the possible causes of dropout and make decisions about it.

2. Development

For this document, the methodology described by Google is used, which phases are listed below:

1. Ask
2. Prepare
3. Process
4. Analize
5. Share
6. Act

The following sections explain the procedure followed in each phase listed previously.

2.1 Ask

In this first phase, it is about asking the right questions to understand the problem you are trying to solve. For this case, the problem addressed is school dropout from the Computer Systems Engineering (ISC) degree at TecNM/ITOaxaca. The analysis of the data available is carried out to identify the causes that lead the student to abandon their professional studies, in order to deliver a report to the corresponding instances of the institution. And, in turn, an intervention proposal is made to avoid desertion as much as possible.

To do this, the Department of School Services is requested to provide the information it has about students in different school status, specifically from the years 2020 to 2022, that is, three years that correspond to six semesters. It is important to note that this Department is in charge of safeguarding student data; therefore, the data requested does not have the names of people; the records provided contain the columns shown in Table 1.

Column Number	Column Name
1	Control Number
2	Gender
3	Birth Day
5	Career
6	Curriculum
7	State
8	Semester number
9	Campus
10	Internship
11	Specialization
12	Electronic Mail
13	Entry period
14	Aproved credits
15	Credits taken
16	Credits loaded
17	Medical Service Unit
18	Medical Service Key
19	Last period average
20	Certificate average
21	Arithmetic average
22	Personal Phone Number
23	Job Phone Number
24	Last period average

Table 1 Original columns from the database of Computer Systems Engineering students at TecNM/ITOaxaca
Mindbox (2023)

The database contains 3863 records, which are in any of the statuses shown in table 2.

No	Status
1	Active
2	Active with a special course
3	Activo with special courses
4	Permanent dropout, due to internal career validation
5	Permanent dropout for reaching the maximum number of semesters allowed
6	Permanent dropout, due to failed special course
7	Voluntary permanent dropout
8	Graduated

Table 2 Different statuses of Computer Systems Engineering students at TecNM/ITOaxaca
Mindbox (2023)

2.2 Prepare

For the present investigation, in the data preparation phase, the first thing that was carried out was a selection of columns, of the 24 columns that were originally available, only the 10 columns listed in table 3 were selected.

No	Selected Column
1	Control Number
2	Gender
3	Birth Day
4	Status
5	Semester Number
6	Entry period
7	Aproved credits
8	Credits loaded
9	Promedio aritmético
10	Último Periodo Inscrito

Table 3 Selected columns
Mindbox (2023)

2.3 Process

Once we had the database with only ten columns of data from the 3683 records, a filtering process was carried out to obtain only those that matched statuses 4, 5, 6 and 7 of table 2, which were those who represent the students who drop out of the ISC program. When filtering the data, the working group noticed different anomalies in the database, such as null data, repeated data, incomplete data, for this reason, reviews of the data were made in order to get a list of the missing data, again requesting the Department of School Services that will provide a second block of information.

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Likewise, the work team took on the task of filtering the repeated records, using the student's control number, and with this, the database was reduced to 198 records with ten columns of data.

2.4 Analyze

For this phase, two tools were used: Tableu and Orange, which have already been briefly described in previous paragraphs.

Analysis with Tableau

The first aspect that is analyzed is the relationship that exists between the gender of the students and their dropout. When the tool is applied, the first result shows a table like the one illustrated in table 4.

	Estatus			
Gender	**1**	**2**	**3**	**4**
Female	11	3	18	7
Male	25	14	88	31

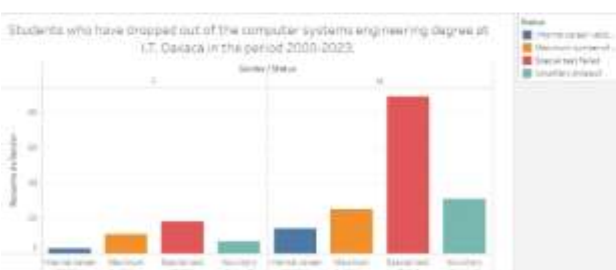
Table 4 Dropout students grouped by gender
Own creation with Tableau.

The status is coded as follows:

1. Permanent dropout for reaching the maximum number of semesters allowed
2. Permanent dropout, due to internal career validation
3. Permanent dropout, due to failed special course
4. Voluntary permanent dropout

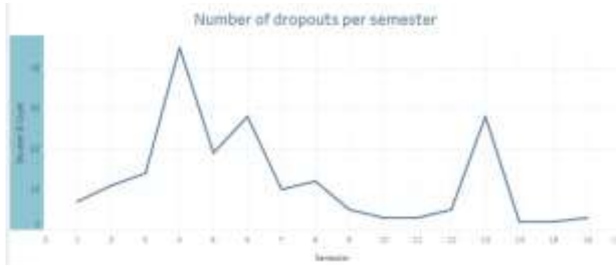
Table 4 is projected in graph 1, where the same information can be observed, but with greater visual impact.

As can be seen, the information is clarified when visualized graphically.



Graph 1 Dropout students grouped by gender
Own creation with Tableau

On the other hand, the number of dropouts per semester completed was also analyzed; graph 2 shows the information obtained.

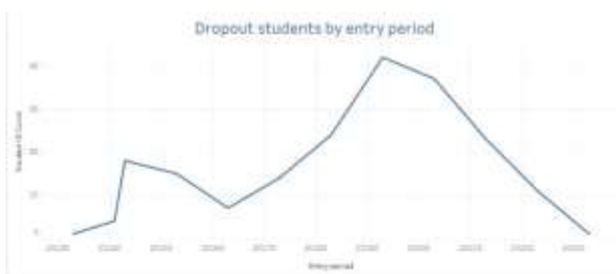


Graph 2 Dropout students per semester
Own Creation with Tableau.

In graph 2, it is noticeable that in the 4th semester the highest dropout occurs with 45 occurrences, in the subsequent semesters it decreases and increases again in the 6th and 13th semester with 28 occurrences. With this information, it is possible to propose strategies that support students to be successful in the subjects they take in those particular semesters.

An analysis is also carried out on how many students dropped out per admission period; the school periods identified are 3 per year.

For example, the first semester of the year is identified as 20201, the summer course that takes place during the month of July is identified as 20202, and the second semester of the year is identified as 20203, there is regularly a new admission only in 3 periods of each year. However, there may be some students, who join from other institutions in the first period of the year (for example, 20201). Therefore, a graph is prepared where it is observed in which period the dropout students entered and how many of them dropped out, as illustrated in graph 3.



Graph 3 Number of students who dropped out of each admission period
Own creation with Tableau

It can be seen from the graph that the highest number of dropouts in the 3 years analyzed was among students who entered the institution in the August-December 2019 semester, this data may be related to the coronavirus pandemic, since the following semester of their entry, on-site classes were interrupted to continue virtually. During this period, the enrollment of all the careers at the institution decreased significantly.

Analysis with Orange

Using the Orange tool, the possible relationship between the students' arithmetic average and the reason for their dropout (status) was analyzed. The tool uses visual elements called widgets, to find if this relationship exists, different widgets were applied such as: file, data table, select columns, tree and tree viewer, as seen in Figure 4.

Figure 4 Flowchart to contrast the arithmetic average against the reason for dropout
Own creation with Orange.

The flowchart visualization is shown in Figure 5.

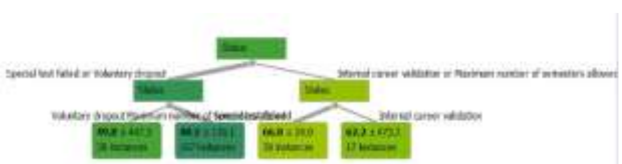


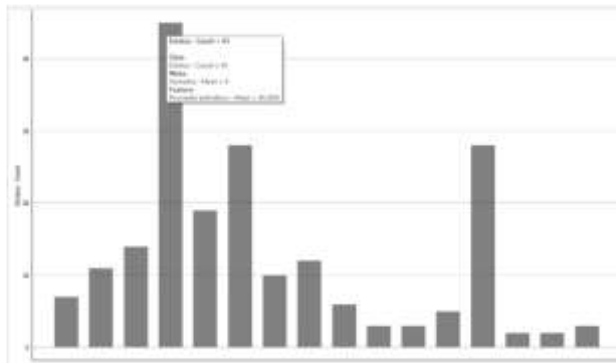
Figure 5 Number of dropout students due to desertion cause
Own Creation with Orange

It is observed that there are 107 students who permanently dropped out due to failing a special course with an arithmetic average of 40.5 (the minimum passing rate is 70), from which it follows that poor performance leads the student to drop out.

Another analysis that is carried out with Orange is how many students dropped out in each of the semesters, and what average grades they have. For this, the flowchart in Figure 6 is constructed.

Figure 6 Dropout students, for dropout reasons and arithmetic averages
Own Creation with Orange.

The result of processing this flowchart with the dropout database is shown in graph 4.



Graph 4 Number of students per semester completed and with arithmetic average
Own Creation with Orange

In graph 4, three variables are related: the arithmetic average, the status and semester that the dropout student was studying. The information found in Tableau is corroborated, the largest number of students drop out in the 4th semester. And, the group of them, has an average grade of 36, a very low average if it is known that the minimum passing grade is 70, thus putting It is evident that poor academic performance leads to dropout, and this occurs to a greater extent in the first semesters.

2.5 Share

The information obtained from the analyzed data is presented in a report to the Department of School Services of the I.T. of Oaxaca, where there is a student support office for obtaining scholarships.

It is also shared with the Department of Academic Development, who is responsible for proposing institutional strategies to prevent school dropouts. For example, the tutoring program, psychological support, vocational guidance, academic advice, among others.

It is also important to share the findings with the directors of the Institution, both the Academic Subdirector and the Campus Director.

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The visualization of the data becomes highly relevant when presenting the information found in the behavior of the school dropout phenomenon, since the graphs more clearly project the dropout trends, the main causes and the probable relationships between the ten variables explored, according to table 3.

Within the information found, it can be observed that there is a relationship between failure and dropout. Since, in the data analyzed, 106 dropouts were found due to failure of a special exam, which implies that the student takes the subject 3 times and does not accredit in none of the 3 opportunities. Which is associated with poor academic performance.

For all of the above, it is important to share with the relevant internal bodies, so that, where appropriate, the best decisions can be made in order to retain the greatest possible number of students, improve the quality of professional education and, consequently, achieve terminal efficiency goals.

2.6 Act

In this phase, the graphs obtained with the data visualization tools will be very useful, since visually they have a greater impact on the people who can make decisions in the institution. In this work, only some of the possibilities of relating the variables of the analyzed data set are presented.

The internal bodies in the institution, with the information found in this research, will be able to propose strategies aimed at reinforcing the permanence of students in the institution before they drop out. And, rethink the strategies that are currently being developed such as the institutional program of tutoring, vocational guidance, change of career, academic advice in subjects with a high failure rate, among others that can be implemented not only for the ISC career but for the 10 careers that are offered at the Institution.

3. Results

The information found as a result of the application of the data analysis methodology proposed by Google, and visualization tools such as Tableau and Orange, is presented in the following paragraphs, where an interpretation is made of each of the graphs of the section "2.3 Analyze".

Table 4 shows how many men and women dropout according to the four statuses found in the data set:

1. Permanent dropout for reaching the maximum number of semesters allowed
2. Permanent dropout, due to internal career validation
3. Permanent dropout, due to failed special course
4. Voluntary permanent dropout

What is observed in table 4 is that the highest dropout occurred in men due to a failed special exam. And, in general, the trend shows that more men drop out than women, which indicates that there may be an important relationship between gender and possible dropout from the Computer Systems Engineering career.

Graph 1 contains the same information as table 4; however, it has a greater visual impact and the comparison between the dropout rates of men and women can be established very quickly. It follows that men drop out more than women do, the largest number of dropout students is 88 and they are men. While, the lowest number of dropouts is 3 and corresponds to women, the cause being the change of career in the same institution.

Likewise, it is also observed that the cause of the highest dropout has been due to failing special courses, a special course is the third opportunity that the institution gives the student to pass a subject. From the above it can be deduced that failing subjects is a factor that strongly affects student dropout.

Graph 2 shows the number of students who dropped out and in which semester they did so, that is, how advanced they were in the curriculum at the time of dropping out.

According to the data set analyzed, dropout is presented from the first to the 16th semester. Graph 2 indicates that the highest peaks of dropout occur in the 4th semester with 45 occurrences, which indicates that another important factor in dropout is the difficulty represented by the subjects of the first half of the curriculum plan. Other semesters where there are also peaks in dropouts are the 6th and 13th semesters with 28 dropouts.

Dropout approximately in the middle and at the end of the curriculum plan gives rise to considering some support program for students before they complete half of the curricular progress, as well as in the last semesters, since important factors could be found that contribute to the dropout figures.

Graph 3 shows how many dropout students there were for each admission period, observing the highest peak in the August-December 2019 period, where there were 42 dropout students from that cohort. This dropout affects the terminal efficiency of the career. It is observed that after this period dropout decreases and contrary to what might be thought during the pandemic period, dropout decreased. The information found in this graph is interesting for the research work, since it seems that the period in which the students entered does not have a significant impact on their dropout.

Figure 5 shows a tree resulting from the flowchart in Orange (see Figure 4). It is observed that there are 107 students who permanently dropped out due to failing a special course with an arithmetic average of 40.5 (the minimum passing rate is 70). In contrast, with the rest of the reasons for withdrawal, it is the highest. 38 students due to voluntary permanent dropout and 36 students who dropout due to having reached the maximum number of semesters allowed (12 semesters allowed) follow them. Therefore, the low-grade average affects desertion.

Another interesting fact is that those who voluntarily withdrew permanently had a grade average of 49.8. Finally, 17 students dropped out due to a change of major. Although, they dropped out of the computer systems engineering career, but they continued at the institution in another career, which according to the definition given by the SEP, is not considered dropout.

In graph 4, as mentioned in previous paragraphs, three variables are related: the arithmetic average, the status and semester that the dropout student was studying. The information found in Tableau is corroborated, the largest number of students drop out in the 4th semester, and the group of them has an average grade of 36, a very low average if it is known that the minimum passing grade is 70. With these visualizations, it can be observed that the variables that have a strong weight in dropout are reprobation and low school achievement.

4. Acknowledgments

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5. Findings

Once the data analysis has been made and the visualization tools Tableau and Orange have been applied, the following findings are obtained.

5.1 Tableau

There are important factors that affect the dropout from the Computer Systems Engineering degree at the Technological Institute of Oaxaca such as:

- The failure of the subjects, which can be a precedent that could lead with a high probability to students dropping out of their higher level studies, since in the same regulations of the Mexico National Technological, when the student fails a special course, it causes definitive dropout from the system.

- The gender of the students, since it is observed that men are the ones who drop out the most and in general their academic performance is lower than women, which would have to be studied more thoroughly to know if it is a determining factor in the dropout phenomenon.

- The number of semester in which students drop out, in this case, there is important information, the highest dropout occurs in semester 4, where there are 45 dropouts and is reduced by approximately half in semesters 6 and 13 where they occur 28 deserters. This indicates that it is important to develop a strategy that allows students to remain during the first semesters of the degree.

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– The period of student entry does not seem to have much relevance in dropout, since it only shows that in a particular year – 2019 – there is the highest number of dropouts in the data set analyzed.

5.2 Orange

– Similar aspects were found regarding the variables with the greatest weight in dropping out of the Computer Systems Engineering degree, which are: failure of subjects in special courses; as well as low academic performance defined by the accumulated arithmetic average of the studied subjects.

– Likewise, it is observed that the semesters in which the highest number of dropout incidents occur are the 4th, 6th and 13th semesters, noting that the delay in reticular advancement is also a reason for dropout. It is relevant to note that semester 13 is outside the permitted range in terms of the maximum number of semesters taken. Given this finding, it would be important for the entities involved to propose a plan to prevent students from reaching semester 13.

6. Conclusions

After having carried out the analysis of a set of real data provided by a public higher education institution, it is concluded that among the relevant factors of dropout is the subject's reprobation. However, in the data there is a cause for dropout classified as "definitive voluntary withdrawal". It contains other unknown factors, and although there are 38 in total, it is considered that it would be important to investigate the causes that do not have to be do with their school performance, but they are generating 19% of dropouts in relation to the 198 that are in the analyzed data set. Another important factor is gender; it is visible in the graphs obtained with Tableau that there are more male dropouts than females.

Although to have clearer evidence, it would be necessary to establish a real proportion of the gender of deserters, since there is a smaller population of women compared to men. Apparently, gender is an influencing factor, since in two graphs where this characteristic is related, a greater dropout is observed in men.

Data visualization tools are great support in data analysis, and even more so in decision making, since they attractively present information that cannot be seen in the original data shown in tables. In the case of this research, two specific tools were used: Tableau and Orange.

In the case of Tableau, it was very useful since it has various options to present the information extracted from the data. Although it is worth making the observation that when learning it, it took time to achieve the first results. Tableau has enormous potential for presenting executive dashboards that show only important and previously classified information, which will support the right people to make informed decisions.

On the other hand, the application of the Orange tool allowed us to corroborate the hypotheses that were had about the factors with the greatest impact on dropping out of the Computer Systems Engineering degree. Among which we found again that they are: failure of subjects between the first and fourth semester, as well as the failure of courses in particular, which implies that the student has poor academic performance, having failed the same course on 3 occasions.

7. Future Work

A next research will be to expand the range of periods to have a greater amount of data, applying a contrast between the analysis of raw data and preprocessed data using some Big Data technique.

Thus, it is also possible to establish direct contact with deserters, to get more data about the causes of "voluntary permanent dropout." This can be done through an online questionnaire.

Likewise, other visualization tools can be applied to establish comparisons about which of them can respond more clearly to the needs of the institution in the early prevention of school dropouts.

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Web system for the control of the forest fire process in eastern Michoacán

Sistema web para el control de proceso de incendios forestales en el oriente de Michoacán

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Abstract

During the last decade, web mapping systems or geographic information systems have had a great advance in development, being widely used today, this project shows the main elements for achieving the objective of generating a geographic information system for the organization and Fire registry management, which facilitates all of its management processes for the fire command centers in the Eastern region of Michoacán. Web mapping systems have become easier to use by having data management compatibility with normal database managers and/or spatial data and expanding its use in various platforms such as mobile applications. In the development, the implementation of open source maps prevails, obtaining geospatial data, registration and user permissions, drawing and modification of polygons, consultation for documentation of preliminary reports and editing of final reports, with future growth, since with this system, it is possible to have better control and quick management of action on the areas affected by fires, as well as saving time and better management of resources by the different companies associated with this project.

Geospatial, Generator, Facilitates management

Resumen

Durante la última década, los sistemas de mapeo web o sistemas de información geográfica han tenido un gran avance de desarrollo siendo muy utilizadas actualmente, éste proyecto muestra los elementos principales elementos para el logro del objetivo de generar un sistema de información geográfica para la organización y gestión de registro de los incendios, mismo que facilitan a los centros de mando contra incendios de la región Oriente de Michoacán todo sus procesos de gestión. Los sistemas de mapeo web se han hecho más fáciles de utilizar teniendo compatibilidad del manejo de datos con gestores de bases de datos normales y/o datos espaciales y amplian-do su uso en diversas plataformas tales como son las aplicaciones móviles. En el desarrollo impera la implementación de mapas de código abierto, obtención de datos geoespaciales, registro y permisos de usuario, tra-zado y modificación de polígonos, consulta para docu-mentación de reportes preliminares y edición de reportes finales, con un crecimiento futuro, ya que con este siste-ma se puede tener un mejor control y rápido manejo de acción sobre las áreas afectadas por incendios, así como el ahorro de tiempo y mejor manejo de recursos por parte de las distintas empresas asociadas a este proyecto.

Geoespacial, Generador, Facilita la gestión

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Introduction

Nowadays forest fires are more frequent and have affected a large part of the protected natural reserves, so organisations dedicated to the conservation of the environment are looking for technological options that help them to visualise the magnitude of the affected areas in order to make a better distribution of resources and put out the fires that sometimes, due to the type of scenario, are difficult for fire control teams, affecting not only the flora, wildlife and sometimes even human life. Forest fire is a term used to define an uncontrolled fire that spreads, spreads freely and also consumes the different types of combustible materials existing in the forest. A forest fire is impacted by climatic conditions such as fuel moisture, wind speed, air temperature, among others [1]. Some organisations dedicated to the care of the environment and the environment are concerned about the impact of wildfires.

Some organisations dedicated to the care of the environment keep records of these natural disasters in documents that are created manually with the data collected from the affected area, making this an arduous task of obtaining information, because it is difficult to know the exact area in which the fire is occurring and it takes too long to make the records to attend and take action on it in an effective way.

Based on the above, it is considered of utmost importance to develop a web system for the control of forest fire management processes that are generated in the eastern zone, which Biocenosis A. C Zona Monarca, an organisation committed to the environment, as well as Fondo Monarca, intend to take immediate action on the management of fires knowing exactly where the fire is taking place and thus obtain information more quickly in order to speed up the report and have better control over the resources that will be used during the process of action on the disaster.

Answering the question, what are the deficiencies in the management and protection against forest fires in the eastern part of Michoacán, Mexico? This will allow us to have a clear objective to generate a geographic information system for the organisation and management of the registration of fires and to generate a report with the information obtained [2].

Methodology to be developed

The method to be used is in phases.

Phase 1. Fire detection is an important part of an effective fire management programme. It can be done in a variety of ways: with satellite imagery, fire observation towers, aerial surveillance and lightning detection systems, or fire monitoring and reporting by local people. When local residents understand the risk and damage of serious unwanted fires and participate in a community-based fire management programme, they are a very effective part of the overall system.

Once fires are detected, effective communications are needed to provide fire fighters and managers with information on the location, size and condition of the fire. Media dispatch centres, equipped to operate from auxiliary power sources, receive information on fire outbreaks and locations, alert firefighting personnel and dispatch them to individual fires. Dispatchers provide regular communications to the fighters on changes in weather forecasts, fire behaviour, strategy and emergency management structure.[3] The fire managers are also responsible for the fire management structure.

Phase 2. Efficient fire management involves various mechanisms that facilitate the development of the planning, programming, direction, execution and control processes of the projects. The management mechanisms for fire management are designed to maximise the functioning of the established organisation. They approach fire management from different points of view, in a coordinated manner, in order to clarify and order the various activities.

The most important management mechanisms for the implementation of the Fire Management Programme are: Plan System, Organisational Scheme, Instruction System and Information System. The plan system is the one used by the commune; from it, the development plans, operational plans, special plans and property plans are differentiated.

Phase 3. Design. Visualising active fires on the map: obtaining the location, information and images of the fire in order to plot them on the map: Creation of affected area polygons; Display of polygons; Assignment of permits by users; Update of fire traffic light; Registration of fire assignments.

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Fire date control: registration of start, action and end dates of the fire; Types of views; Measurement tool.

The relevant framework is scrum: it is simple in itself. The rules, artefacts, events and functions are easy to understand. Its semi-prescriptive approach actually helps to eliminate ambiguities in the development process:

- Sprint 1: Creation of the user interface: Handling of the main user menu with the use of the different protected areas and the login.

- Sprint 2: Insertion of the main map and layer types: implementation of the main layer showing the map and its different types of layers or terrains.

- Sprint 3: Creation of the database: design of the entity-relationship model of the database and implementation in the database and implementation within the online web system.

- Sprint 4: Obtaining selected data for graphical sampling: insertion, modification and deletion of the different types of geospatial data to be displayed graphically on the map.

- Sprint 5: Creation of measurements necessary for polygon sampling and measurements: obtaining locations for the plotting of distance, perimeter and area of the polygon and saving in a single data type all the attributes that build it for later handling within the base to be manipulated and displayed graphically.

Phase 4. Development. For the development of the web system for the control of biocenosis processes in the Monarca area, we took into account the needs of the client and the general aspects of management systems such as: leaflet, JQuery, Ajax, MySql, JavaScript, PHP, CSS, Bootsrap and Scrum.

Phase 5. Testing. The system will be in the testing and implementation phase in the second half of 2023.

Results

Functionality. On the main screen of the system, you can see the global map with the location of the fires of the fires.

Figure 1 Initial screen of the web system

The design of the main page shown in figure 1, was generated following the specifications and comments of the organisations involved, also taking into account the needs that they had for the problematic of this one with the intention of having an easy understanding and handling of the system.

Figure 2 Login

Pressing the button in figure 2 opens a floating window for entering the user name and password.

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Conclusions

The final result of this early warning system project was satisfactory, fulfilling the expectations, since the deficiencies in the management and protection against forest fires in the eastern zone of Michoacan, Mexico were identified, for which a tool such as geographic information systems was used, which facilitates the processes in an efficient way in decision-making, since it allows to collect, store, process and visualise geographic information through simple elements such as: points, lines and polygons that together represent geographic entities and measurable and geo-referenced spatial variables. This technology made it easier to meet the characteristics requested and to surpass them before the organisations. The system was developed with future growth in mind, since with this system it is possible to have a better control and quicker management of action on the areas affected by fires, as well as saving time and better management of resources by the different companies associated with this project.

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Mobile application for the care and monitoring of plants at home "Applantar"

Aplicación móvil para el cuidado y seguimiento de plantas en el hogar "Applantar"

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Abstract

The objective of this project is to promote a more sustainable and environmentally conscious lifestyle through the implementation of modern technologies and a user-friendly interface. This mobile application aims to facilitate plant care and make it accessible to everyone, regardless of their level of gardening experience. This article presents the development and functioning of this plant monitoring application, outlining its key features and the technology used in its creation. By providing an overview of this plant monitoring application, we hope to inspire more people to connect with nature and enjoy the benefits that plants can bring to their lives. Additionally, the application allows users to keep track of plant care, including relevant information such as the plant type, specific care instructions, watering and fertilization dates, among other important data.

Application, Plants, Monitoring, Users

Resumen

El objetivo de este proyecto es promover un estilo de vida más sostenible y consciente del medio ambiente, a través de la implementación de tecnologías modernas y una interfaz amigable, ya que esta aplicación para dispositivos móviles busca facilitar el cuidado de las plantas y hacerlo accesible para todos, sin importar su nivel de experiencia en jardinería. En este artículo, se presenta el desarrollo y funcionamiento de esta aplicación de monitoreo de plantas. Estableciendo las funcionalidades clave que ofrece, así como la tecnología utilizada en su creación. Al proporcionar una visión general de esta aplicación de monitoreo de plantas, esperamos inspirar a más personas a conectarse con la naturaleza y disfrutar de los beneficios que las plantas pueden aportar a sus vidas, además de llevar un control del cuidado de estas, incluyendo información relevante como el tipo de planta, sus cuidados específicos, fechas de riego y fertilización, entre otros datos importantes.

Aplicación, Plantas, Monitoreo, Usuarios

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Introduction

We currently live in a society where mobile and web applications are very important in our daily lives. We increasingly use new technologies, especially mobile phones, to facilitate our daily lives (instant messaging, GPS, email, etc.). All these services have been a logical evolution of the Internet (Jiménez, 2016).

This application, designed with a user-friendly interface, offers users a series of functionalities that will facilitate plant tracking and allow them to interact with other gardening enthusiasts.

The first outstanding feature of this application is the ability to register and modify user information. This will allow each individual to personalise their experience on the application and tailor it to their needs and preferences.

Once registered, the customer will be able to use the application to register the flowers and plants they have in their home. This functionality will allow them to keep detailed track of each one of them, including relevant information such as the type of plant, its specific care, watering and fertilisation dates, among other important data.

In addition, the application encourages interaction between users by providing the option to create virtual gardens. Once a user has created his or her garden, he or she can connect and share experiences with other users who are also part of the same garden. This virtual community will allow users to exchange tips, ideas and experiences related to plant care, thus creating a learning space.

Development

The SCRUM methodology was applied in the development of the plant control and monitoring application to ensure an efficient and successful implementation.

Scrum is one of the most widely used methodologies, not only in the area of software development, but also in fields such as manufacturing, education, among others (Rodríguez & Vicente, 2015).

The Scrum activities that were carried out are detailed below:

Project planning: In this stage, the project objectives were defined and the Product Backlog was established, which is a list of all the functionalities and requirements that must be implemented in the application. Priorities will be determined and goals will be set for each iteration.

Daily Scrums: Daily meetings of short duration were held so that the development team could synchronise and share their progress, identify possible obstacles and plan the day's tasks. This allowed for fluid communication.

Sprint Planning: Prior to the start of each sprint, a planning meeting was held to select the Product Backlog features and tasks to be addressed in that sprint.

Iterative development: Development was carried out in short iterations called sprints, usually lasting two to four weeks. During each sprint, the team worked on the implementation of selected features.

Reviews and retrospectives: At the end of each sprint, a review meeting was held in which the completed work was presented to the team and stakeholders for feedback.

Continuous delivery: As features were completed, partial deliveries of the product were made to get early feedback and allow users to use the product.

Applying the Scrum methodology in the development of the plant control and monitoring application allowed for efficient project management, ensuring timely delivery of functionality and user satisfaction.

Figure 1 shows the user registration, by entering their email address and a password, which must include a number, a capital letter, and at least 8 characters.

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Figure 1 User registration screen
Source: Own Elaboration

Figure 2 shows the login interface where users must access the application using their email address and previously registered password.

Figure 2 Login screen
Source: Own Elaboration

Once the application has started, users can update their information, including their full name, date of birth and whether they need to be a public or private user, the first user can interact with other users of the application and the private user will only have access to their own information.

Figure 3 Profile information editing screen
Source: Own Elaboration

Figure 4 shows a search engine where the user can search for the plant he/she wishes to register for monitoring.

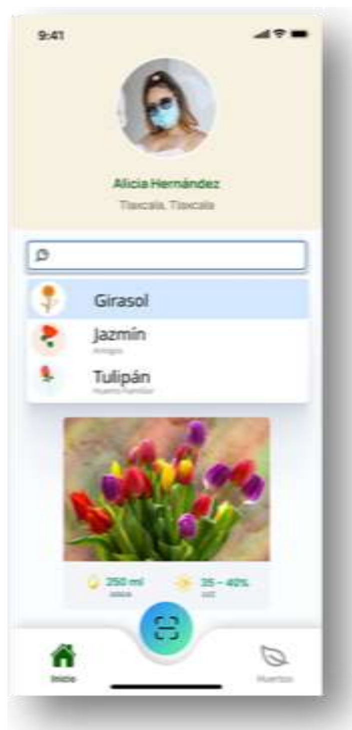

Figure 4 Plant search screens
Source: Own Elaboration

If it does not exist, it can be added, adding a scientific name, common name, temperature, amount of fertiliser per plant, a nickname, amount of water, days of irrigation, and the orchard to which it belongs (see figure 5).

Figure 5 Plant registration screens
Source: Own Elaboration

Family gardens can be created by indicating the name, description, adding an image that distinguishes it, selecting whether it will be public or private, or even seeing which plants have been registered by friends (see Figure 6).

Figure 6 Orchard registration screen
Source: Own Elaboration

Once the garden has been registered, it can be viewed according to whether it is public or private. If it is private, only the user who created it can view it, and if it is public, other registered users located nearby can view it.

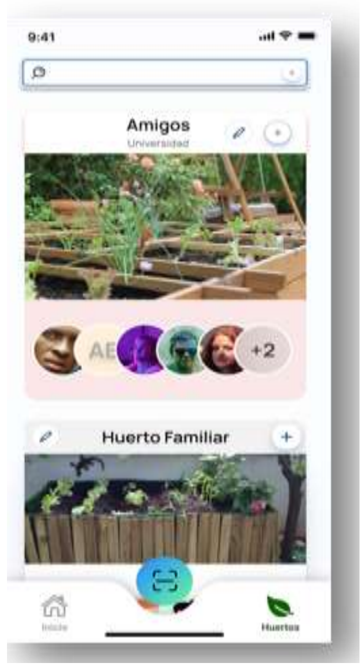

Figure 7 Orchards visualisation screen.
Source: Own Elaboration

Results

The development of the plant monitoring application represents a significant advance towards the optimisation of plant care in domestic environments.

The aim is for the application to be a tool for users to improve the care of their plants thanks to the notifications and reminders that will be programmed into the application, such as watering or fertilising plants, keeping track of their growth and health, and thanks to the creation of gardens, it will be possible to share information about the plants, including advice and recommendations from other users.

It should be noted that the interfaces have been evaluated by people caring for plants at home and have been accepted and given feedback by real users of different ages in the range of 20-50 years.

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Conclusions

The project can not only be applied to people with plants at home, but can also be applied to growers. On the other hand, thanks to the use of the chosen tools it is possible to have a higher scalability of the app, in case it is required. In conclusion, the development of the plant monitoring app has been a significant step towards the optimisation of plant care in domestic environments. Through this initiative, it has been possible to provide users with an accessible and effective tool to monitor and maintain the well-being of their plants.

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Automated Irrigation System, AIS: Technological Development

Sistema de Riego Automatizado, SRA: Desarrollo Tecnológico

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Abstract

As a natural resource, water is vital for the development of human life and economic development in any region of the world. Although this resource is renewable, it is also finite, which is why its conservation is important; Within the agronomy process, water waste in Mexico, amounts to 57% of the total used, mainly due to inefficient irrigation infrastructures. In relation to mechatronics, it is possible to develop devices that dose consumption through an automated control system. The objective of this document is to present the technological development built based on mechatronic elements, of an AIS, automated irrigation system, which integrates solar panels to make it self-sustainable, humidity and temperature sensors programmed by a microcontroller and control of the on/off when detecting indicated levels; It is monitored in real time through a human-machine interface, being the main visible element that will be responsible for managing all functions remotely by implementing the IoT, for the user's convenience.

Technological Development, Automated Irrigation System, Renewable energy, Internet of things

Resumen

Como recurso natural, el agua es vital para el desarrollo de la vida humana y el desarrollo económico en cualquier región del mundo. Aunque este recurso es renovable, también es finito, es por eso que toma importancia la conservación del mismo; dentro del proceso agrónomo, el desperdicio de agua en México asciende a 57% del total utilizado, debido principalmente, a infraestructuras de riego ineficientes. En relación con la mecatrónica, es posible desarrollar dispositivos que dosifiquen el consumo a través de un sistema de control automatizado. El objetivo de este documento es presentar el desarrollo tecnológico construido con base en elementos mecatrónicos, de un sistema de riego automatizado SRA, que integra paneles solares para hacerlo autosostenible, sensores de humedad y temperatura programados mediante un microcontrolador y, control del encendido y apagado al detectar niveles indicados; es monitoreado en tiempo real por medio de una interfaz humano-máquina, siendo el principal elemento visible que se encargará de gestionar todas las funciones remotamente implementando el IoT, para facilidad del usuario.

Desarrollo Tecnológico, Sistema de Riego Automatizado, Energía Renovable, Internet de las Cosas

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Introduction

Water is a vital resource for the development of human life and economic development in any region of the world, although it is renewable, it is also finite, which is why strategies for its conservation take on importance in established global programmes. According to the UN (2016), 36% of the world's population lives in water-stressed regions and 52% will experience serious water shortages by 2050. The consequences of this are reflected both in the development of nations and in the quality of life of the population, since poor water quality, inadequate sanitation and, above all, insufficient water supply have a negative impact on educational opportunities for families, livelihoods and the availability of food, leading to increased hunger and malnutrition in the poorest countries (UN, 2016).

Irrigation is one of the activities with the greatest impact on water wastage worldwide, according to Comisión Nacional de Agua, (2018). Estadísticas del agua en México. México. CONAGUA, in Mexico 57% of the water used for this activity is wasted by inefficient irrigation systems and structures; in addition to agriculture, irrigation systems are used for other purposes, one of the main ones being the maintenance of ornamental green areas, which also require cleaning and guaranteed light for their continuity.

Given this need, both green areas in the landscaping industry and the agricultural sector, the theoretical foundation shows Sustainability as responsible for reducing the environmental impact generated by the lack of effective use of the liquid resource; through the 2030 Agenda, the Sustainable Development Goals are known, of which SDG 6, Clean water and sanitation, SDG 7, Affordable and clean energy, and SDG 9 Industry, innovation and infrastructure, contemplate areas of opportunity in which they can converge in technological developments (UN, 2016).

In relation to the innovation promoted in the implementable suggestions of the SDGs, it is considered that mechatronic contributions can present developments that channel their effectiveness in the dosing of water consumption through an automated control system.

In addition to this, it contributes to society in terms of water care, as it is generated through collaborative and simple strategies that contribute to awareness, such as irrigation, an activity where this natural resource is most consumed.

Theoretical Basis

Renewable Energy

Currently, many of these energies are a reality, and they also contribute to reducing greenhouse gas emissions, as well as the energy supply, mainly oil and gas. Since they do not release polluting emissions in the generation of energy, renewable energies are sustained by natural resources that are constantly regenerated and inexhaustible (Machado, Lussón, Leysdian, Bonzon and Escalona, 2015).

Internet of Things

The Internet of Things and Industry 4.0 are changing the design, manufacturing, and monitoring of different projects. According to Ladino, García and Zamudio (2023), it is predicted that, by 2025, more than 75 billion IoT devices will be connected to the Internet. This technology contributes to the intelligent construction of applications and tools that contribute drastically to control and monitor variables. IoT applications can be implemented in various spaces, one of the areas in which it has begun to have and is predicted to have great relevance, is environmental sustainability. This type of applications allow the user to interact with the system in an easy way, because, from the state of variables, structured records can be generated, which generate changes from the information obtained by processing data (Rodríguez, López, Vega and Flórez, 2017)

IoT visualises images and videos for processing data stored on the internet, links and monitors aspects of the environment, ensuring that a process is fulfilled according to a pre-established approach, interconnected devices only provide relevant content in real time to users. The main benefit of this technology is an effective reduction in wiring and maintenance costs, and by collecting real-time information directly from the control system, this integration allows for improved forecasting and process monitoring. (Alvear, Rosero, Peluffo y Pijal, 2017).

Automation

Control for optimal autonomous execution in a system is considered as the management of information for decision-making in real time, minimising direct intervention. The application of electromechanical and electronic devices allows the automation of repetitive activities, thus increasing the control of physical quantities in a more precise way and, as a whole, productivity levels. More precise quality control in conjunction with the integration of different systems, repeatability, increased productivity, reduced incidents and greater efficiency are some of the advantages of automating a process (Pérez, 2015).

With the need to minimise human intervention in direct processes to reduce labour effort, automatic systems have been implemented that ensure optimisation without direct intervention, so production acquires an automatic cycle course that manages to reorganise itself quickly and efficiently. According to Cordoba (2006), automation is the convergence of three technologies: mechanics, electronics and computing, although it has gradually been unified specifically with mechatronics, in the same way, in order to improve production processes, the industry adopts the Internet of Things.

Methodological Bases

With a mixed research approach, and explanatory information management, a methodology based on the practice of knowledge and scope of the area of mechatronics (Hernández, 2014) is implemented; the general objective presented for this technological development is to build an automated irrigation system, which integrates a control and monitoring structure, programmed with microcontrollers and sensors, to optimise and reduce water consumption.

In its executable format, this objective presents a methodology based on the science of mechatronics, presented in phases to structure and programme the effective construction of the device. This involves the design of a model in CAD software, taking into account the operating principles of the irrigation system.

The programming of the microcontrollers, sensors and other system components to detect the level of humidity in the soil and ambient temperature, the assembly of external and internal electronic and mechanical components of the system that contribute to automatic operation.

It also considers the integration of solar panels to make use of renewable energy in the system and make it self-sustainable and, as a fundamental part, the implementation of an IoT platform, responsible for monitoring variables in the system facilitates the deployment of information for intelligent control and a clearer visualisation for the user, by monitoring the data from the sensors used in the irrigation system.

Methodological Development

The systematically implemented methodology is expressed in five phases, which individually pursue goals that allow specific activities to be programmed to form the physical and operational structure of the RAS.

In the first stage, a model of the prototype was developed in CAD software in which the electrical and mechanical components were integrated, taking into account the dimensions. For the choice of these elements, general and technical characteristics were taken into account, as well as the cost.

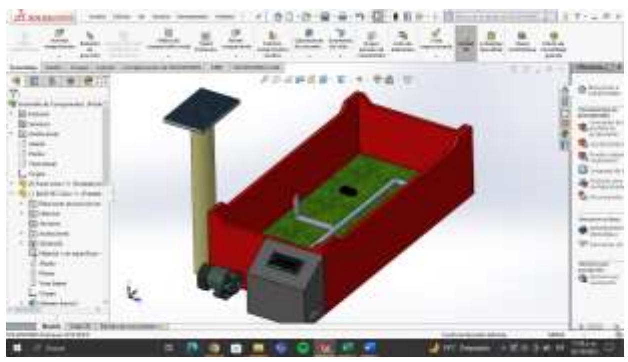

Figure 1 Prototype design
Source: Own Elaboration

In the second stage, the components that were established in the design of the prototype were analysed, comparing physical and operational characteristics. In the third stage, the construction of the prototype was carried out, including the mechanical and electronic elements, taking as a reference the previously elaborated designs and the acquired materials.

As part of the construction process, modifications were made to the design, according to the elements, aesthetics, design and operation of the system.

Figure 2 Component assembly
Source: Own Elaboration

Starting from the environment prepared in order to obtain a complete visualisation of the circuit, in the fourth stage, the simulation of this was carried out to verify the behaviour in order to elaborate the electronic assembly. The information of the technical characteristics of each element that integrates and the adequate simulation was fundamental in the success of this stage.

Figure 3 Simulation of the environment
Source: Own Elaboration

For the fifth and last stage, two IoT platforms were configured within the system for the interconnection of interfaces with the components, the electronic and mechanical elements used to send and receive signals via a WiFi network were programmed.

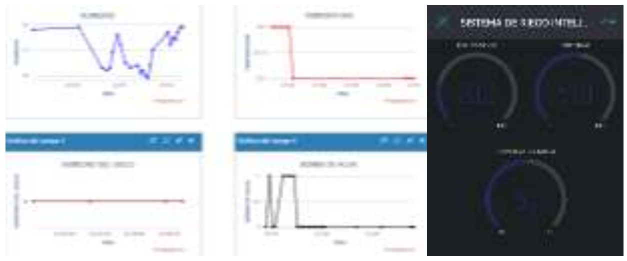

Figure 4 a, b IoT platforms
Source: Own Elaboration

Results

The field work resulted in the articulation of sustainable principles and the application of scientific knowledge in terms of mechatronics, expressed in a technological development called SRA.

The automated irrigation system is developed from the simulation by means of CAD software, which allowed the prototype to be projected in a virtual environment, where there is the option to make modifications and adaptations of materials and detailed visualisation of electrical connections, so that there was effectiveness in understanding the diagram during the stage of connecting various sensors to the microcontroller, also allowed a preview of what was going to be built, mitigating errors at the time of assembly.

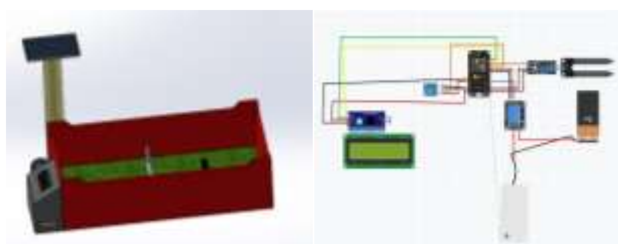

Figure 5 a, b Simulation
Source: Own Elaboration

This programming, became a substantial part since it generated the opportunity to establish the parameters with which the microcontroller operates according to the humidity and temperature sensors connected.

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In the same way, by means of the programming, the data to be shown on the screen are established, making this system have HMI - Human Machine Interface -, in this way, the user has access to the state of the system.

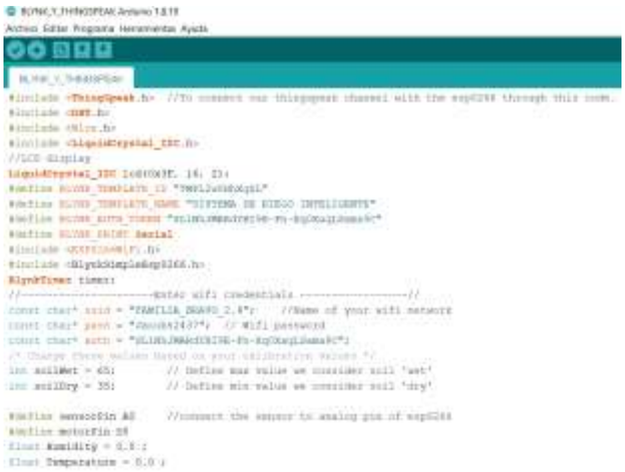

Figure 1 Component programming
Source: Own Elaboration

The HMI is the main source of visualisation of performance and data, thus helping users to extract measurements in real time. The design of the interface is simple in its operation and understanding, this in order to have access to the anomalies that arise and facilitate the operational adjustments of the system.

Figure 7 HMI interface
Source: Own Elaboration

Monitoring is crucial in RAS, as it is necessary to have control over water use, both to avoid waste and to meet the water needs of the crop. For the monitoring of this system, the IoT -Internet of Things- was integrated, which allows access to the status of the system by linking the data provided by the sensors to a web page, in the same way, to have monitoring from a mobile device, since an application was programmed simultaneously.

Figure 8 IoT monitoring
Source: Own Elaboration

The use of sunlight allows the irrigation system to be its own source of energy supply; calculations of the orientation and inclination of the solar cell will avoid or reduce the loss of efficiency caused by shadows generated due to external factors. San Luis Potosi is located in the northern hemisphere, where the proper placement of a solar panel is towards the south, which will result in a peak production around midday.

Figure 9 Solar cell assembly
Source: Own Elaboration

Conclusions

The results obtained corroborate the validity of the hypothesis since the automation of an irrigation system has been carried out. This implementation has made it possible to optimise irrigation control by reducing water consumption and guaranteeing an adequate supply according to the water needs of the plants, thus contributing to obtaining the best quality plants. In addition, the integration of a solar panel in the system supplies energy, ensuring that the system is self-sustainable by providing the energy necessary for its operation in an ecological and sustainable way.

Iot is one of the cutting-edge technologies that not only offers convenience to humans, but also allows for detailed statistical monitoring. This technology allows to obtain information based on data, which favours productivity, efficiency and at the same time the prevention of technical failures. However, it is necessary for the data linked to the network to be accurate and faithful to the real data, which required the right choice and connection of the electronic elements.

Although the electronic components are responsible for the control of the system, the mechanical elements that make the system perform its function cannot be left out. For the assembly of the electronic and mechanical components, the specifications and function of each one of them were considered, taking into account these aspects to determine the distribution and position within the system.

The good design and assembly of the system promote its optimal functioning, however, this is not its only purpose, but the design of the system, in addition to having a relatively simple operation, also allows access for repairs or modifications, depending on the required specifications.

The validity of the hypothesis raised about the possibility of building an integral device that under the characteristic of automation, doses the water consumption and guarantees the adequate supply according to the water needs of the flora, contributing to obtain the best quality in these. As an added value, a solar panel was integrated into the system, which supplies energy, ensuring that it is self-sustainable.

The continuity of this technological development establishes the protection and implementation in pilot space within the facilities of the Instituto Tecnológico de San Luis Potosí.

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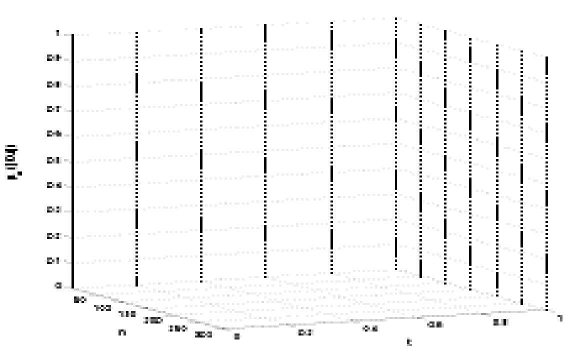

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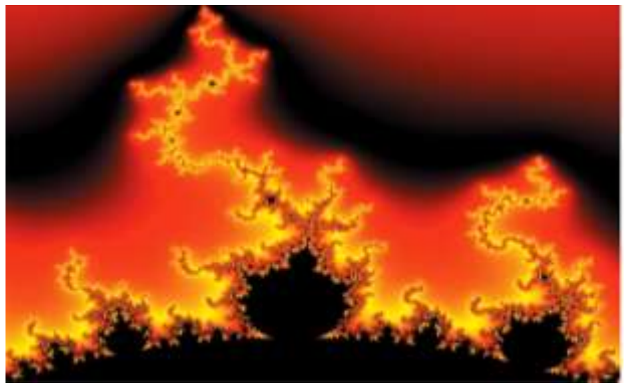

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