ISSN 2444-5002

Volume 6, Issue 17 – January – June – 2020

Journal of Computational Systems and ICTs

ECORFAN®

Journal of Computational Systems and ICTs, Volume 6, Issue 17, January - June 2020, is a Journal edited by ECORFAN - Spain. Matacerquillas Street 38, CP: 28411. Moralzarzal - Madrid. WEB: http://www.ecorfan.org/spain/rj_sistemas_ctics.php, revista@ecorfan.org. Editor in Chief: MIRANDA - TORRADO, Fernando. PhD. ISSN 2444-5002. Responsible for the last update of this issue ECORFAN Computer Unit. Escamilla Bouchán-Imelda, Luna Soto-Vladimir, updated to June 30, 2020.

Journal of Computational Systems and ICTs

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Presentation of the Content

In the first article we present, *Task load in user interfaces on didactic mobile applications for users with ADHD*, by PONCE-MENDOZA, Ulises, GARCÍA-GORROSTIETA, Jesus Miguel and MADRID-MONTEVERDE, José David, with ascription in the Universidad de la Sierra, as the nex article we present, *Design of technological strategy for Big Data with Hadoop software*, by VALDEZ-MENCHACA, Alicia, VAZQUEZ-DE LOS SANTOS, Laura, CORTES-MORALES, Griselda and PAIZ-RIVERA, Ana, with ascription in the Universidad Autónoma de Coahuila, as the next article we present, *Design and construction a didactic vending machine*, by MORALES-AGUILAR, Eric, SANTILLAN-FLORES, Selma E., GONZÁLEZ-LÓPEZ., Juan M. and VILLALVAZO-LAUREANO, Efrain, with ascription in the Universidad de Colima, as the last article we present, *Introduction to the automatization of measurement equipment with Python-GPIB*, by MEDINA-BRISEÑO, Pablo, MOLINAR-SOLIS, Jesus Ezequiel, CHAVEZ-VELARDE, Juan Jose and BRACAMONTES-DEL TORO, Humberto with ascription in the Instituto Tecnológico de Ciudad Guzmán.

Content

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Task load in user interfaces on didactic mobile applications for users with ADHD

Carga cognitiva en interfaces de usuario en aplicaciones móviles didácticas para usuarios con TDAH

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DOI: 10.35429/JCSI.2020.17.6.1.6 Received January 30, 2020; Accepted June 01, 2020

Abstract

Objectives: Measure the task load using the user interface on didactic mobile applications by children with ADHD using the NASA-TLX instrument. Explore the feasibility of using the NASA-TLX instrument to measure task load in users with different abilities. Methodology: Qualitative sample exploratory study with direct application of a NASA-TLX instrument adapted to users with ADHD who use a didactic mobile app who belong to an age group from 5 to 15 years old population in the CAM # 8 in Moctezuma, Sonora. The instrument is applied indirectly, assisted by the educator in order to interpret the subjects' responses. Contribution: It describes the adaptation requirements of the instrument to the study subjects, explores task load indices during the use of user interfaces in subjects with different abilities, indicates the heterogeneity of the population and presents usability requirements and interaction characteristics for users with ADHD that allows to realize a design centered in the user.

Task Load, User Interface, Mobile

Resumen

Objetivos. Medir la carga congnitiva de las interfaces de Usuario en aplicaciones móviles didácticas en niños con TDAH utilizando el instumento NASA-TLX. Explorar la viabilidad de uso del instrumento NASA-TLX para medir la carga cognitiva en usuarios con capacidades diferentes. Metodología. Estudio exploratorio de muestra cualitativa con aplicación directa de un instrumento NASA-TLX adaptado a usuarios con TDAH que utilizan una app móvil didáctica con grupo etáreo de 5 a 15 años en la población del CAM#8 en Moctezuma, Sonora. El instrumento se aplica de forma indirecta, asistidos por la educadora para interpretar las resupuestas de los sujetos. Contribución. Describe los requerimientos de adaptación del instrumento a los sujetos de estudio, explora índices de carga cognitiva durante el uso de interfaces de usuario en sujetos con capacidades diferentes, Señala la heterogeneidad de la población y presenta requerimientos de usabilidad y características de interacción para usuarios con TDAH que permita realizar un diseño centrado en el usuario.

Carga Cógnitiva, Interfáz de Usuario, Móviles

Citation: PONCE-MENDOZA, Ulises, GARCÍA-GORROSTIETA, Jesus Miguel and MADRID-MONTEVERDE, José David. Task load in user interfaces on didactic mobile applications for users with ADHD. Journal of Computational Systems and ICTs. 2020. 6-17:1-6.

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Introduction

In the present project, a cognitive ergonomics study was carried out with the objective of describing the mental load in the use of an educational application (App) for Android, which has eight didactic activities where children with ADHD problems (disorder deficit hyperactivity disorder) can interact, acquire knowledge and reinforce their learning, through simple games and initial level lessons. This application developed at Universidad de la Sierra, has the purpose of reinforcing the activities carried out within the CAME study centers, in particular the one located in Moctezuma, Sonora.

For the evaluation of this study, the NASA TLX Method (Hart & Staveland, 1988) was used as a diagnostic tool to evaluate mental load factors during the performance of a task or manipulation of a system. This method was chosen because it includes a multidimensional assessment procedure that can be interpreted through a general index of said mental load.

Due to the characteristics that children present, we are in a situation in which work performance requires a high level of attention and generates a level of frustration on the part of the user (Arquer & Nogareda, 2000);

General objective

Contribute to the development and learning process that is carried out in the Educational Programs of the Specialized Centers of Multiple Attention (CAME) through the software (App) with which children with different abilities, especially ADHD, can interact, acquire and reinforce your learning through games and activities in an ergonomic way.

Specific goal

Explore mental load indexes that allow designing user interfaces adapted to the cognitive abilities of users to decrease the mental load of use.

Scope

This study is mainly aimed at children with different abilities, specifically children with ADHD belonging to the age group of 5 to 15 years in CAM # 8 of Moctezuma, Sonora.

Methodology

As it is an exploratory project, in this first iteration, it was agreed with the CAM Educators to develop a rapid intervention prototype that allows obtaining study data in a short time. The app requirements analysis was carried out through surveys of educators, who defined the type, degree of difficulty and content of the activities. For the development, the methodology for rapid prototyping of applications (Ponce Mendoza, Yánez Moreno, & Soto Bernal, 2014) with MVC architecture, based on the structure of an Ionic Framework project, was used. The interface design was made following the indications of colors, distribution and iconography suggested by the CAME staff. Figure 1, 2 and 3.

The first study was carried out by applying the NASA TLX evaluation to six children from CAM # 8, in order to identify the levels of effort, performance and frustration when using the application. The NASA TLX evaluation table used is known as the Raw Table, since the weight of the demanding activities is not established by the participants in the study, but by an expert in the area (Sebastián Cárdenas, 2016). In our case, the educator in charge of the group of children. Subsequently, the results were integrated into individual tables to generate the index that shows the correlation. Table 1.

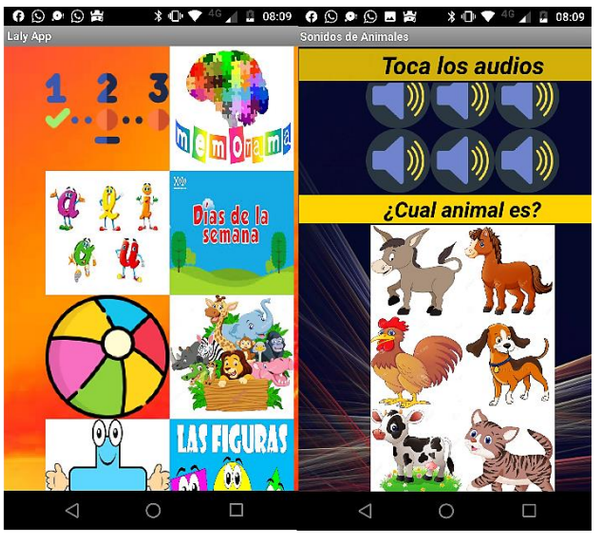

Figure 1 User Interface, first iteration
Source: own elaboration

Variable	(a) Weight	(b) Degree	(c) Conversion (b x 5)	(d) Weighted Grade (c x a)
Mental Burden	5	3	15	75
Physical Load	1	0	0	0
Temporary Load	1	1	5	5
Performance	2	4	20	40
Effort	3	3	15	45
Frustration	3	0	0	0
TOTAL	15	11	55	825

Table 1 Mental Load Medium grade, subject "F"
Source: own elaboration

The activities evaluated were "Identify animals", which consists of identifying visual of the image of an animal and is related in an auditory way with a representative sound. Likewise, a second activity (task) was evaluated with the association of vocal spelling and words that start with it.

The NASA-TLX methodology (Hart SG, 2006) incorporates a standardized evaluation instrument that analyzes six dimensions of activity and effort of the operators, namely: a) Mental Load, which defines the necessary amount of effort of perception and cognition is necessary In activities such as decision making, observation, memory, search and mental calculation, the aim is to identify if the task has been presented in the ranges from simple to complex, simple to demanding and precise or diffuse; b) Physical Load, establishes observations for the physical effort required such as pulling, moving, pushing, turning, among others, in our case we focus on the fine motor effort required by the subjects; c) Temporal load, refers to the mental effort to finish the activity in a certain time (temporal pressure) is measured in ranges of relaxed to fast and frenetic activities, in this study the temporal pressure was given when operating group activities with less devices that participants; d) Performance, establishes a comparison range from good to poor, for the perception that the subject has regarding the achievement of the task objectives by himself; e) Effort, defines how much cognitive and physical effort is necessary to complete the task or activity, it is comparable with activities performed by the subject previously, it is measured in ranges from high to low; and f) Frustration, defines in a low to high range the feelings and emotions related to insecurity, irritation, discouragement, frustration and stress perceived in the performance of the task.

To qualify the levels of effort, the instrument contemplates a 7-point scale ranging from no type of difficulty to very difficult. However, to adapt the test to the Likert scale, the scale was reduced from 1 to 5, remaining as follows: 1.- Low; 2.- Medium-Low, 3.- Medium; 4.- Medium-High and 5.- High. For each of the questions measures an effort that increases and the higher the score, the greater the cognitive load. The only element with inverted graduation is the performance which, the lower it implies the greater the effort, therefore this item was graded in inverted form. This scale can be recognized in the tables in column (b) Degree.

On the other hand, column (a) Weight is a determination of the researcher and the CAM # 8 specialists to point out the most preponderant factor in the total effort to operate the App by the subjects. For this, a Likert scale was also used, but with 5 levels, 5 being the most influential, up to 1 least influential.

The instrument indicates that it must be applied immediately after using the artifact (App) in order to collect the user's impressions regarding the dimensions used. In fact, this is the weakest part since the data collection was carried out with the intervention of a third party since our subjects have levels of deficiencies to null of spoken communication and therefore it is difficult to collect the information directly. The third who supported us in the process is the educator in charge of the group who observed the student in the use of the didactic mobile application and subsequently answered the NASA-TLX questionnaires.

Finally, the expected scale is a minimum of 450 points when interaction with the App is easy in all dimensions and 2250 when interaction with the App is not possible. The intermediate scale has been determined at 875 points.

Sample size

For the sample size, the total population of students from CAM # 8 located in Moctezuma, Sonora was taken. Of which 21% are under 5 years of age which we will discard from the target population, therefore, only 6 of them will be taken into account for the study.

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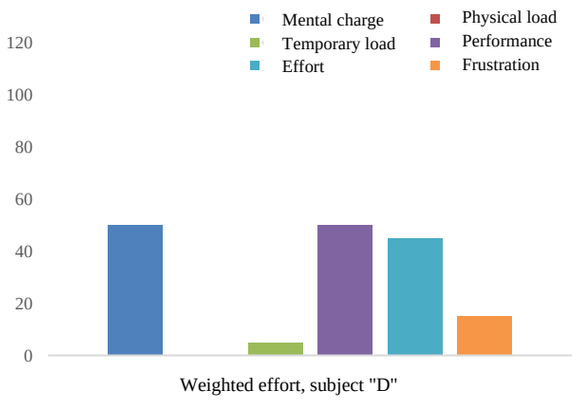
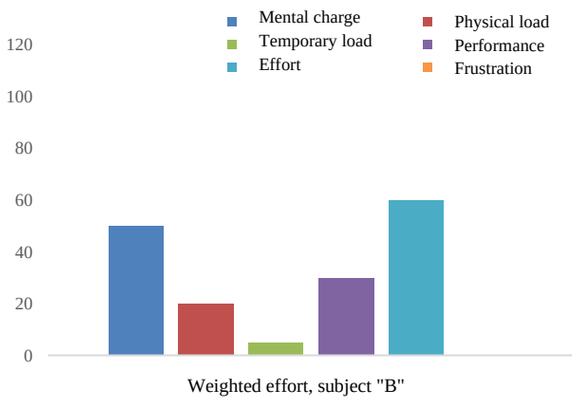
Results

In an interview with the teacher in charge of the group of students under observation, the following qualitative results were obtained: a) Interest in the use of the application in the afternoon as a reward at home was positive for all students; b) The application activities positively reinforce the learning of the students in the CAME to favor the repetition of the activities seen in the classroom; and c) This application is compatible with children with intellectual disabilities to improve the recognition of sounds as with images and to identify figures, colors and letters.

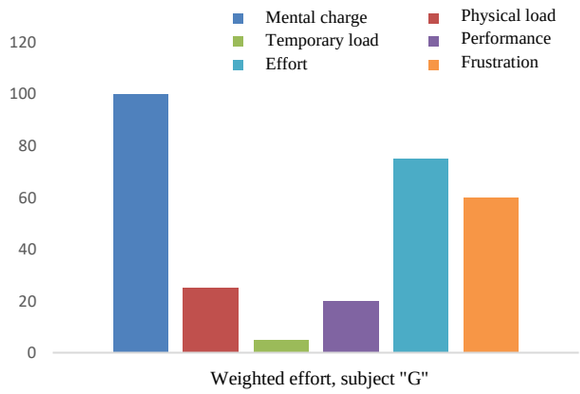
The individual quantitative results of the NASA TLX application (Hart & Staveland, 1988) yielded the following measurement, the measurements are an average of 3 shots each corresponding to the measured activities:



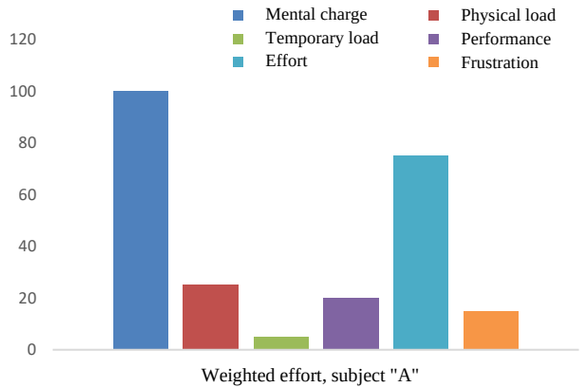
Graphic 1 Mental Load medium grade, subject "D"
Source: own elaboration



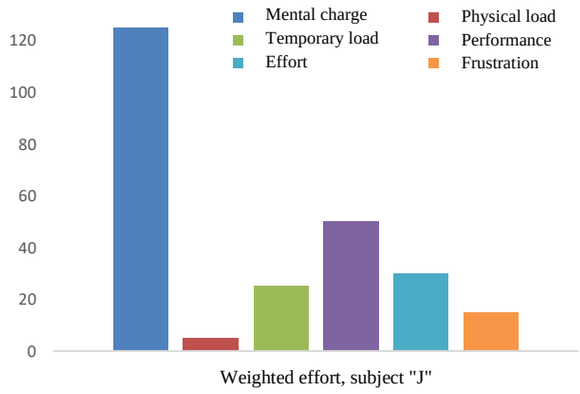
Graphic 2 Mental Load High grade, subject "B"
Own elaboration



Graphic 3 Mental Load High grade, subject "G"
Source: own elaboration



Graphic 4 Mental Load High grade, subject "A"
Source: own elaboration



Graphic 5 Mental Load High grade, subject "J"
Source: own elaboration

Among the interesting elements that we can describe is the level of frustration when using the App and that we can contrast it with the level of Mental Load, in which we observe that despite requiring a high mental load, the use of this type of application Children involved in the study are frustrated only when the app demands their full mental load. Likewise, we can see how decreasing the mental load decreases frustration on a non-linear level, but it has not yet been determined (Graphic 6).

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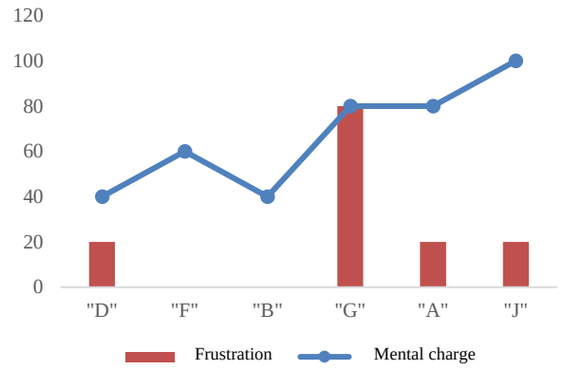
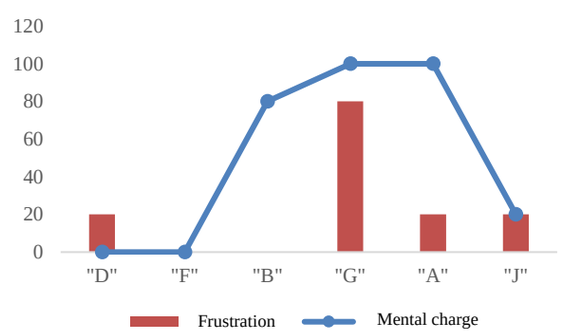


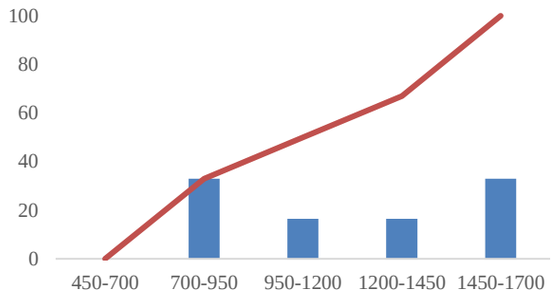
Graphic 6 Comparison between Mental Load and Frustration at the moment of using the App in percentage
Source: own elaboration

In the same way, the physical usability, that is, the ease with which the input methods of the application allow interaction with the elements of the application, has a behavior in which it cannot be related as an element of frustration, that is, , the use of touch input does not seem to be related to the level of frustration as the cases are very diverse, noting that there are cases in which the levels of physical demand are high and those of frustration also up to cases in which the physical demand is very high and the level of frustration null, going through all the intermediate levels (Graphic 7).

Finally, with respect to the levels of cognitive load (Graphic 8) we can observe that despite the high motivation that the studied children show, the levels of cognitive load are High. This is confirmed since 100% of cases are above the Cognitive Load midpoint determined at 875 points. The lowest level detected was 900 points. However, there are good expectations regarding usability since more than 80% of the cases are in the third upper range of four possible, therefore, the cognitive load is demanding but not at levels of frustration. Situation that leaves the door open for improvements in the area of usability of the App.



Graphic 7 Comparison of Physical Load and Frustration at the time of using the App in percentage
Source: own elaboration



Graphic 8 Figure 4. Frequency and Accumulated Frequency in Cognitive Load Ranges
Source: own elaboration

Conclusions

I.- Due to the heterogeneous characteristics of the children evaluated and the small population reached to measure, it is not possible to carry out general statistics, therefore, it is proposed to take as reference the data from the Portal of the Secretary of Education and Culture of the State of Sonora (Planning, General Direction, 2019) in which we obtained a total population of 84 students from CAM # 8 located in Moctezuma, Sonora. Of which 21% are children under 5 years of age, whom we will discard to take 66 children as the target population, for future studies.

II.- It is possible that there is a direct relationship between the condition presented by the child and the mental demand that can be tolerated in the use of the application.

III.- The application requires the addition of visual examples in each of the activities to reduce the initial frustration of not knowing how the selected activity works, which was one of the main items of low performance and high level of effort.

IV.- The NASA TLX tool (Sebastián Cárdenas, 2016) is suitable for measuring mental demand. It is necessary to increase the sample size to identify particularities between each disability or to rule out differences between them.

V.- In accordance with the recommendations issued by the educator and the results of the measurements, modifications will be made in the application to favor a low level of cognitive demand in its operation.

ISSN-2444-5002

VI.- The use of an application to reinforce learning in children with different abilities supports their retention capacity and facilitates teaching, as it is included as a tool based on cognitive ergonomics and provides an alternative that does not require learning new skills for its use.

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ISSN-2444-5002

Article **Journal of Computational Systems and ICTs**
June 2020 Vol.6 No.17 7-14

Design of technological strategy for Big Data with Hadoop software

Diseño de estrategia tecnológica para Big Data con el software Hadoop

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DOI: 10.35429/JCSI.2020.16.6.7.14 Received January 18, 2020; Accepted June 25, 2020

Abstract

The objective of this research project is the design and implementation of a technological strategy for the use of big data technologies as Apache Hadoop, as well as its supporting software projects that allows to prepare medium-sized companies in new innovative technologies. As part of the methodology, an analysis of the best big data practices, analysis of the software for design and configure big data in a linux server for the technological proposal. As a first result, a roadmap for the installation and configuration of Hadoop software running on a Linux virtual machine has been obtained, as well as the proposal of the technological strategy whose main components are: analysis of the technological architecture, selection of processes or data to be analyzed and installation of Hadoop, among others.

Technological strategy, Big data, Hadoop

Resumen

El objetivo de este proyecto de investigación es el diseño e implementación de una estrategia tecnológica para el uso de tecnologías de big data como Apache Hadoop, así como sus proyectos de software de soporte que permitan preparar a las empresas medianas en nuevas tecnologías innovadoras. Como parte de la metodología, un análisis de las mejores prácticas de big data, análisis del software para diseñar y configurar big data en un servidor Linux para la propuesta tecnológica. Como primer resultado, se obtuvo una hoja de ruta para la instalación y configuración del software Hadoop que se ejecuta en una máquina virtual Linux, así como la propuesta de la estrategia tecnológica cuyos componentes principales son: análisis de la arquitectura tecnológica, selección de procesos o datos para ser analizado e instalación de Hadoop, entre otros.

Estrategia tecnológica, Big data, Hadoop

Citation: VALDEZ-MENCHACA, Alicia, VAZQUEZ-DE LOS SANTOS, Laura, CORTES-MORALES, Griselda and PAIZ-RIVERA, Ana. Design of technological strategy for Big Data with hadoop software. Journal of Computational Systems and ICTs. 2020. 6-17: 7-14.

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Introduction

Companies today require strategic solutions to improve their capabilities and respond to the business or technological challenges that today's markets demand. The global economy is focused on a phase characterized by digitization, connectivity, and the trend towards process automation (Basco, Beliz, Coatz, & Garnero, 2018).

Technologies such as internet of things, cloud computing, big data, artificial intelligence and 3D printing, among others; They reinforce the importance of the manufacturing industry through the manufacture of personalized and intelligent products. Data analysis, information exchange and real-time decision making have a positive impact on the efficiency of the entire value chain (Basco et al., 2018).

Technologies such as cloud computing, IoT and big data, among others, further reduce coordination costs. Therefore, other factors linked to competitiveness, such as infrastructure, logistics and the digital connectivity system, the cost of energy and the talent of people according to the requirements of Industry 4.0, once again occupy a important place in location decisions of global companies.

The digitization of the economy changes the rules of the market: companies have more and more information about their customers, but at the same time, they allow new competitors to enter. Therefore, they face the challenge of facing increasing and scalable competition, and making decisions about a large amount of data that they sometimes do not have the capacity to interpret.

Four main business effects have been identified across industries: customer expectations are changing, products are being improved with data, new forms of collaboration between companies, and operating models are being transformed into digital models (Schwab, 2016). Therefore, it is necessary to create new technological strategies for SMEs that allow them to research and assimilate new technologies based on Industry 4.0 to improve competitiveness and productivity.

Fundamental concepts

The term Industry 4.0 refers to a new model of organization and control of the value chain, through the product life cycle and throughout the manufacturing systems supported by information technologies, it is also called "factory smart ”or“ industrial internet ”(Román, 2018); The technologies that support this term are known as pillars of Industry 4.0, among which are:

- Simulation.
- Additive manufacturing.
- Integration systems.
- Cybersecurity.
- Augmented reality.
- Cloud Computing.
- Robotization.
- Industrial Internet of Things.
- Big data and data analysis.

Big data

Since the presentation of the term by the MGI (McKinsey Global Institute) in June 2011, there have been various attempts to limit the concept. MGI define define it as the data set whose size goes beyond the ability to capture, store, manage and analyze database tools (Mayinka et al., 2011).

One of the most complete approaches to Big Data is the one provided by Gartner (Beyer & Laney, 2012): “They are information assets characterized by their high volume, speed and variety, which demand innovative and efficient processing solutions to improve knowledge. and decision making in organizations.”

Big data refers to data characterized by its volume (large quantity), speed (at which it is generated, accessed, processed and analyzed) and a variety of structured and unstructured data (OECD, 2016).

ISSN-2444-5002

This data can be reported by machines and equipment, sensors, cameras, microphones, mobile phones, production software, and can come from various sources, such as companies, suppliers, customers and social networks. The analysis of this data through advanced algorithms is key to making decisions in real time, allowing to achieve better quality standards of products and processes, and facilitating access to new markets. Big data analysis plays a fundamental role in the decision-making process (Lescano, Lot, & Vasquez, 2020). Another use of this tool is to control and improve commercial and manufacturing planning. These data can provide information on hidden patterns, trends, associations, especially for human decision making; The term includes three concepts: volume, speed and variety (Deepa, Zongwei, Shan, Thanos, & Rameshwar, 2017).

Now, how can SMEs benefit from this technology to position themselves at a level that allows them to compete globally?

Various studies, including IBM, have analyzed the large number of big data applications, the scope of this technology is very broad, however, the analysis carried out by IBM shows the 5 preferred guidelines when applying big dates in organizations where 49% of organizations prefer to apply it to focus on the customer, 18% in operational optimization, 15% in financial and risk management, 14% in the new business model and 4% in business collaboration (López, 2012).

The customer-focused processes of manufacturing companies can be considered as: Sales processes, distribution, market analysis, digital marketing, among others.

Based on the foregoing, a strategy is designed to be considered by manufacturing companies, highlighting that certain authors propose the use of an intensive data management platform such as Hadoop, which is a framework that supports applications distributed under a free license. (Sarkar, 2013).

Apache Hadoop software

Hadoop is an open source software framework that supports data intensive use for distributed storage and distributed processing of very large data sets in computer clusters; The Apache Hadoop database (TheApacheFoundation, 2019) is made up of several modules such as: the Apache Hadoop MapReduce application tool for programming and the Hadoop Distributed File System (HDFS) for infrastructure management, Figure 1 show frame components.

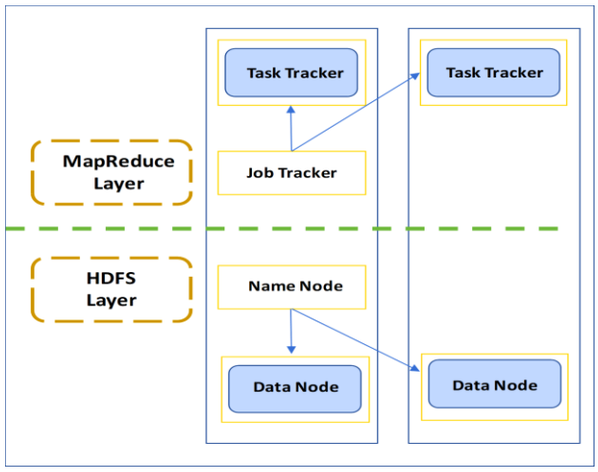

Figure 1 Components of the Hadoop framework
Source: (Sarkar, 2013)

Hadoop building blocks

Name Node: The main node or main node of the cluster, contains the metadata for HFDS during the processing of the data that is distributed among the nodes.

Data Node: These are the systems in the cluster that store the real HDFS data blocks, these blocks are replicated on various nodes to provide high quality solutions.

Job Tracker: Service running on Name node, which manages MapReduce jobs and distributed individual tasks.

Task Tracker: Service running on the data nodes, which monitors the individual MapReduce tasks that are submitted.

There are support projects for Hadoop, which have different roles in the systems, these are:

- Apache Hive: is a data warehouse software that makes it easy to read, write and manage large data sets residing in distributed storage using structured query languages (SQL) through a Java Database Connectivity (JDBC) driver.), which allows users to query data without MapReduce Application Development (ApacheSoftwareFoundation, 2019b).

- Apache HBase - This is the Hadoop database, a scalable, distributed big data warehouse that hosts very large tables (ApacheSoftwareFoundation, 2019a).

- Apache Mahout: is a distributed linear algebra framework designed to implement algorithms (ApacheSoftwareFoundation, 2019c).

- Apache Sqoop: is a tool designed to efficiently transfer data between Hadoop and relational databases; is a command-line tool that controls the mapping between tables and the data warehouse layer, translates the tables into a configurable join for HDMS or Hive (ApacheSoftwareFoundation, 2019d). Figure 2 shows the Hadoop support software.

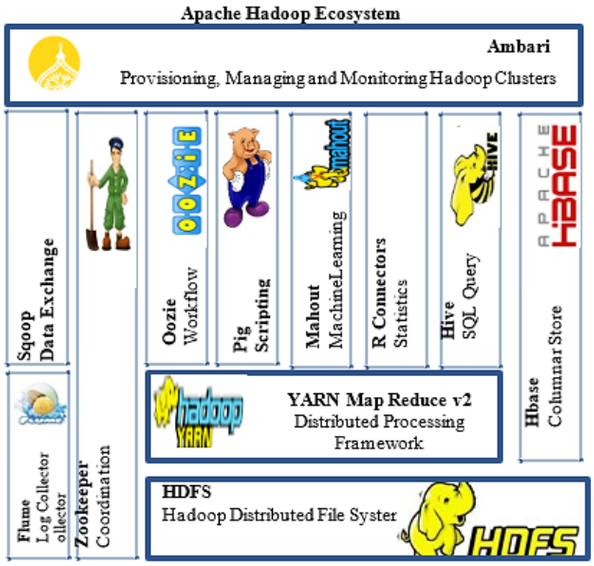

Figure 2 Hadoop Support Software
Source: (Sarkar, 2013)

Once the fundamental concepts on which big data technology is based and the software with which it is managed and managed are known, we proceed to the proposal and discussion of the technology strategy for big data based on Hadoop.

Strategy

The strategy is made up of 5 complex parts that involve different activities in each one. The first part refers to the analysis of the hardware technology required for the installation of the software and the data to be analyzed; A data server with the latest storage capacity and memory is recommended, as well as the computers that will be the client machines.

The second part refers to the selection of company processes that will be analyzed, they can be customer sales processes, production data, equipment failures, etc. From these selected processes, the necessary information and data that will be the raw material for the extraction, transformation and loading (ETL) activities are collected. In this case, it is a manufacturing company with a worldwide turn of suppliers of electronics and robots for industrial automation, located in the city of Acuña, Coahuila.

Subsequently, the strategy focuses on the Hadoop distributed processing platform, on this platform the data will be processed. Emphasizing that the Apache server and later Hadoop must be installed and configured; There are different components of this platform, among which Hive and Sqoop stand out, for the connector between the platform and the MS SQl Server database, which is where the data resides. The next activity deals with ETL activities which will be managed by the MS SQL Integration Services software, a data package will be developed with the Hive ODBC driver and the data model with Analysis services.

Once the activities of components 1 to 4 have been carried out, the following activity deals with data analysis and visualization of the results through Power BI software. This strategy is currently under development by computer systems engineering students and is planned to be applied to a medium-sized manufacturing company using data from the production of three-phase motors. Figure 3 shows the strategy.

Figure 3 Technological strategy for big data
Source: own elaboration

Methodology

The phases of the methodology for the development of the project, in which the activities proposed in the strategy were carried out, these being:

- Analysis of the technological architecture: In this phase the server for big data and the client machines are installed and configured.

- Selection of processes to be analyzed: In this phase, the company's data is collected, which are feasible to be analyzed with big data, and may be structured as well as unstructured data. For the project, the manufacturing process of three-phase motor components has been selected, among which are the plates (Peripheral Component Interconnect), which are assembled and tested according to the client's parameters; This is one of the processes that presents the most failures (42.7%), so when managing the production data with big data, it will provide information on how to improve the process and decrease the rejection points of the tablets. Figure 4 shows the graph of rejections.

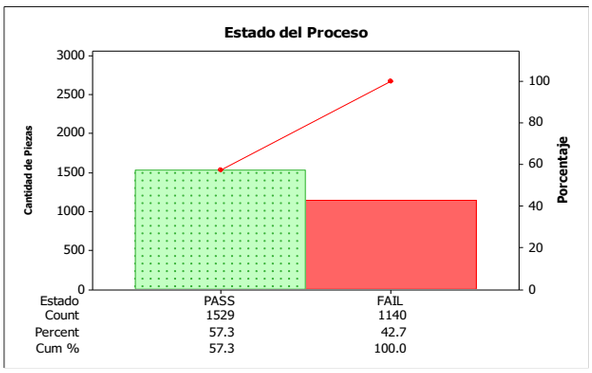

Figure 4 Status of the manufacturing process in a PCI
Source: case study company

- Installation and configuration of the Hadoop platform: This phase has been the one that has consumed the most time and resources since it is required to install the Linux operating system as a virtual machine using Centos Red Hat, virtualization of each node on the network, installation and configuration of Hive, Hbase and Sqoop as part of the software projects supporting Hadoop. Figure 5 shows part of the Hadoop configuration file.

Part of the Hadoop configuration file

```
<configuration>
<property>
<name>
yarn.resourcemanager.opportunistic-container-allocation.enabled
</name>
<value>false</value>
<final>false</final>
<source>yarn-default.xml</source>
</property>
<property>
<name>yarn.ipc.rpc.class</name>
<value>org.apache.hadoop.yarn.ipc.HadoopYarnProtoRPC</value>
<final>false</final>
<source>yarn-default.xml</source>
</property>
<property>
<name>mapreduce.job.maxtaskfailures.per.tracker</name>
<value>3</value>
<final>false</final>
<source>mapred-default.xml</source>
</property>
<property>
<name>mapreduce.job.speculative.retry-after-speculate</name>
<value>15000</value>
<final>false</final>
<source>mapred-default.xml</source>
</property>
<property>
<name>yarn.client.max-cached-nodemanagers-proxies</name>
<value>0</value>
<final>false</final>
<source>yarn-default.xml</source>
</property>
<property>
<name>
```

Figure 5 Hadoop configuration
Source Hadoop configuration program

- Installation and configuration of Data Extraction, Transformation and Loading (ETL) activities using a JDBC and ODBC driver.

- Data analysis and visualization of results: An Access database with 7000 engine production records was used, in Figure 6 a part of the engine data is displayed in a file in .CSV format (Comma Separated Value).

```
1;"18140508";"374";;;;"06/04/2018";"09:03:00 a.m.";"FAIL"
2;"18140508";"3522";;;;"06/04/2018";"09:03:41 a.m.";"PASS"
3;"18140512";"1172";;;;"06/04/2018";"09:04:33 a.m.";"FAIL"
4;"18140512";"2914";;;;"06/04/2018";"09:05:20 a.m.";"FAIL"
5;"18140494";"3398";;;;"06/04/2018";"09:06:06 a.m.";"FAIL"
6;"18140408";"3784";;;;"06/04/2018";"09:06:51 a.m.";"PASS"
7;"18140525";"3773";;;;"06/04/2018";"09:07:35 a.m.";"PASS"
8;"18140445";"3763";;;;"06/04/2018";"09:08:20 a.m.";"PASS"
9;"18140500";"3797";;;;"06/04/2018";"09:09:04 a.m.";"PASS"
10;"18140522";"3769";;;;"06/04/2018";"09:09:47 a.m.";"PASS"
11;"18140496";"3787";;;;"06/04/2018";"09:10:31 a.m.";"PASS"
12;"18140454";"3802";;;;"06/04/2018";"09:11:15 a.m.";"PASS"
13;"18140540";"3789";;;;"06/04/2018";"09:11:58 a.m.";"PASS"
14;"18140516";"2919";;;;"06/04/2018";"09:12:43 a.m.";"FAIL"
15;"18140516";"3802";;;;"06/04/2018";"09:13:33 a.m.";"PASS"
16;"18140493";"3813";;;;"06/04/2018";"09:14:13 a.m.";"PASS"
```

Figure 6 Data file part
Source: own elaboration

Each of the phases is a sequence of the previous one, so the activities of each phase were carried out in the proposed order. Figure 7 shows a PCI engine board.

Figure 7 Parameter programming in a PCI
Source: company case study

Subsequently, the data extraction procedures are executed, obtaining the data from the source, where operational step stores can be installed that function as a bridge between the data source and the final node.

Among the activities to prepare the data package, the identification of the data source stands out, since they can come from different sources such as Oracle databases, Access, SQL Server, Excel or any other data source; so a very important activity is the unification in a single format to be transferred to the final node, provide them with a structure, process and analyze them. In this case it is an Access database, which was converted to CSV format, which can be read by Hadoop.

Once the data packet has been prepared and reviewed, the file is transferred from the user's physical directory to the Hadoop HDFS directory, since they are independent systems.

Once the information is integrated, queries are made on the database, creating and starting a session.

Results

The results obtained from this project have been the following:

- Training in the handling of the Linux operating system, since all the supporting software, as well as Hadoop work in the Linux environment, installation and configuration of Linux on the Proliant Gen 10th server.

- Installation and configuration of Hadoop, with the Linux command wget and configuration of the environment variables associated with Hadoop.

- Hive, Hbase and Sqoop installation and configuration; At this point each software has a different function and configuration, as well as the configuration of the environment variables for each type of software.

- Tests with the entire environment installed and configured with the server and 3 nodes.

- Identification of the manufacturing parameters of the slabs where the highest percentage of failures were concentrated, once the analysis was performed with Hadoop.

Figure 8 shows the graph of the improvement in the production of tablets, after making the changes detected by analyzing the data with big data.

ISSN-2444-5002

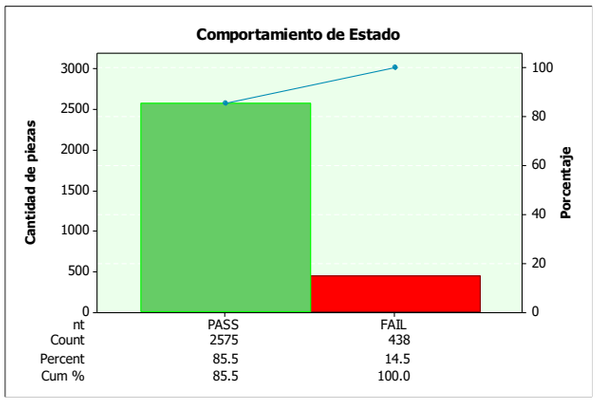

Figure 8 PCI parts state behavior
Source: case study company

Figure 9 shows the analysis processing with Power BI.

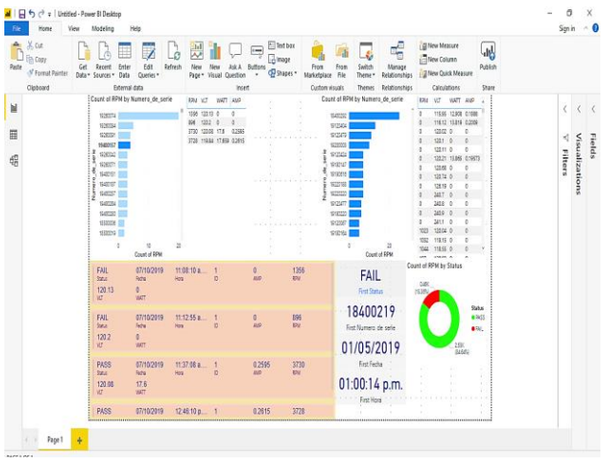

Figure 9 Data analysis with Power BI
Source: own elaboration

Conclusions

The current needs of the manufacturing industry are increasingly influenced by the adoption of new technologies based on Industry 4.0, which will allow them to improve the processes and products they manufacture.

One of the great needs of this industry is to have trained personnel who can design and implement customized solutions based on the new technologies of Industry 4.0.

SMEs are also facing an investment in hardware and software equipment that allows them to implement new technologies, which represents an extra expense in operating costs.

It is expected that in the coming years this technology will be more available to SMEs and that solutions will be focused on the main processes of SMEs.

The challenge is to achieve a roadmap with more detailed activities, especially in the technical aspect of the installation and configuration of the Hadoop and its supporting software projects to achieve effectiveness in the analysis of company data.

This project has been an exhaustive learning process between research professors and students since it works with two different software platforms, Windows and Linux, so making the data and technologies of both platforms compatible has been quite a challenge.

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ISSN-2444-5002

Article **Journal of Computational Systems and ICTs**
June 2020 Vol.6 No.17 15-22

Design and construction a didactic vending machine

Diseño y construcción de maquina vending didáctica

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DOI: 10.35429/JCSI.2020.17.6.15.22 Received January 25, 2020; Accepted June 15, 2020

Abstract

This paper proposes the design and construction of a didactic vending machine, students pretend to be immersed in a work with delivery date as many companies that work for projects do. The project of vending machine to be developed will have as parameters that dispatch four different products, with a control panel, a 16 x 2 LCD screen which shows the cost of the chosen product or product, will have to give change and its data processing is via Arduino, a 3D simulation is carried out to ensure the compatibility of all components, an innovation presented by the prototype to be developed is that it sends a text message when a product is about to run out, with the product description, the number of machine and its location, this provides the supplier with better control over their large-scale machines. A comprehensive financial investment analysis is performed to ensure the viability of the project.

Vending Machine, Arduino, Autonomous Communication

Resumen

En este artículo se propone el diseño y construcción de una máquina vending didáctica, los estudiantes simulan estar inmersos en un trabajo con fecha de entrega como lo realizan muchas empresas que trabajan por proyectos. El proyecto de máquina vending a ser desarrollada tendrá como parámetros que despache cuatro diferentes productos, con un panel de control, una pantalla LCD 16 x 2 el cual muestre el costo del producto o producto elegido, tendrá que dar cambio y su procesamiento de datos es vía Arduino, se realiza una simulación 3D para asegurar la compatibilidad de espacio de todos los componentes, una innovación que presenta el prototipo a desarrollar es que manda un mensaje de texto cuando algún producto está por agotarse con la descripción del producto, el número de máquina y su ubicación, esto le proporciona al proveedor tener un mejor control sobre sus máquinas a gran escala. Se realiza un análisis integral de inversión financiera para garantizar la viabilidad del proyecto. del proyecto.

Máquina Vending, Arduino, Comunicación Autónoma

Citation: MORALES-AGUILAR, Eric, SANTILLAN-FLORES, Selma E., GONZÁLEZ-LÓPEZ., Juan M. and VILLALVAZO-LAUREANO, Efrain. Design and construction a didactic vending machine. Journal of Computational Systems and ICTs. 2020. 6-17: 15-22.

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† Researcher contributing as first Author.

Introdution

The world of vending machines has been a big business since the 1880s, which sold postcards, until today, some have refrigeration and / or internal heaters, which make them able to sell practically anything (Burguete, 2015) Some even have security systems to supply restricted access products by means of digital identification (Calvo & Latorre, 2013), they are manufactured in multiple sizes depending on the expected sales volume or available space (Vendomatica, 2007), you can choose for two sales models: the first is that the machine is operated by the brand owner or the second is that an individual buys and installs a machine in their business, (Chévez & Adrianzén, 2019). Others carry out marketing plans with the aim of opening the market and positioning their brand, strengthening distribution in sales channels, advertising and promotion (Milena García, Monje Maca, & Rodríguez, 2020). Currently, vending machines accept different forms of payment such as coins, bills and even credit and / or debit cards and it is expected that in the near future they will accept payment with smartphone applications (Gavilanes, 2018). Even in some works, the feasibility and business potential provided by small and large-scale vending machines (Carrillo, 2008), (Figueroa, 2018) is minimally reviewed, carrying out an analysis of the area, a study of a machine according to their present needs in the area (Castro Flores & Mejia Vargas, 2020), programming the action in the sale based on defined commercial parameters and their positioning (Innovation and Qualification & Torres Gómez, 2020).

Observing the potential and relevance of the vending machine, works in universities have been developed with the aim that their students develop the potential to build and operate them as a complementary part of their training or as thesis work to obtain a degree, within the Which is included, the approach is given as a business based on a theoretical foundation under established parameters and standards, formulating a situational diagnosis of the emerging needs and requirements in the market (Rojas Cabrera, 2020). Some works propose a project with a commitment to the environment and sustainable development, providing the opportunity for the installation site to educate themselves on knowledge (Romero Pascual, 2020).

On the other hand, currently, several works have been carried out in monitoring vending machines which give various data such as the last recharge date, the number of items sold and the estimated date of next recharge with geolocated GPS applications (Matute & Uday, 2013) , another includes logistic processing with internet via Wifi (Ramírez, 2018, pp. 25-30), including storage in “the cloud”, allowing space to be saved on computer servers (Walid, Sigit, & Sritrusta, 2019) and (Boces & Boces, 2015). The disadvantage of this type of communication is that you do not always have Wi-Fi internet connectivity in the places of installation or it can be expensive to implement your own internet system. On the other hand, storing the data in “the cloud” requires a web page or service provider which requires a monthly or annual rental, which makes monitoring more expensive. In this sense, the prototype set out in this article is to build a didactic vending machine as a complement to the studies in Electronics Engineering, the machine shown here dispatches only four products and can be expanded to an industrial size if necessary, in addition to complying with all the functions of an industrial vending machine.

On the other hand, an innovation that is proposed is the remote monitoring of the product available via text message to the supplier, which incorporates the number of products available, the number of the machine and its location, as it is a text message practically throughout the territory there is a signal provided by Telcel (Mexico) in addition to its relative low cost compared to the machines that occupy satellite internet.

App software

The detailed logic of the implemented program is visualized in the flowchart of Figure 1 and can be briefly described in the following steps:

1).- Active and waiting

2).- Receive money

3).- Product selection

4).- Available product, enough money and enough change?

5).- Dispatch product

ISSN-2444-5002

6).- Deliver surplus money (change).

7).- Go back to step one.

It should be noted that if any of the previous steps is negative, it will return to the previous one showing the reason on an LCD screen located in front of the machine. On the other hand, if there are no exchange currencies in the purse, a legend “insert exact amount” appears, forcing the user to deposit the exact amount calculating change equal to zero and allowing it to continue through the flow chart of Figure 1. A probable external risk is the jamming of the product in the delivery spirals, to avoid this problem, a presence sensor is incorporated where the products fall from the spirals, which detects the fall of the product and sends a signal to continue with the sales process, this step is incorporated into the program within step 5 described in this section.

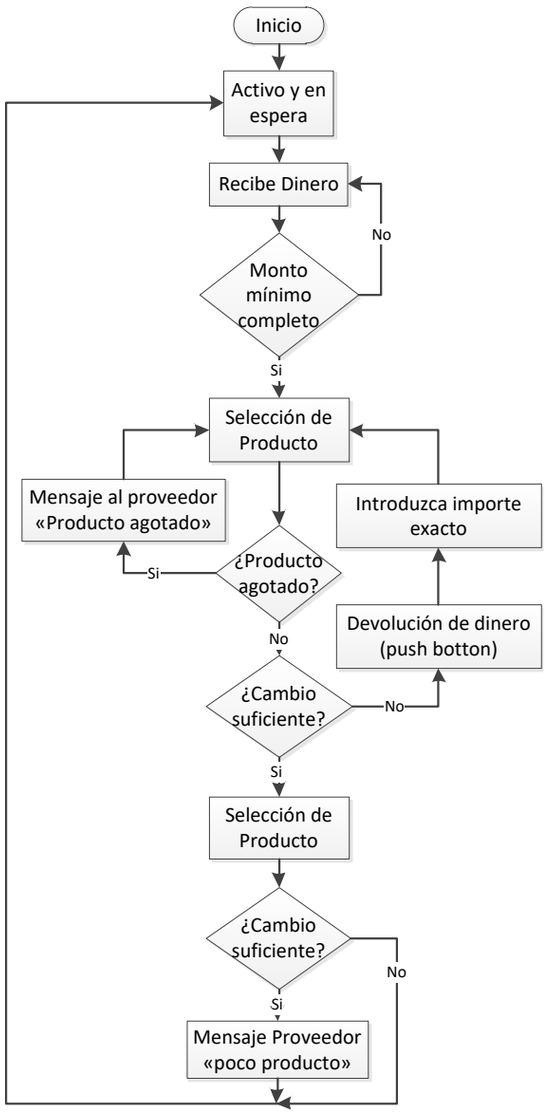

Figure 1 Vending machine operation logic

Internally, the program is designed so that when it has "little" product, it sends a text message with the product description, the machine number and its location, this is done using the "4GS GPSR Module" which is compatible with Arduino and is powered by a SIM card with the company TELCEL de México, it should be noted that this card recharges like any mobile phone. In this case, 2 pieces were determined, although the data can be adjusted according to the supplier's response time and dispatch frequency. The entire program is in an infinite loop so always after a completed transaction you will return to step 1 to wait for another client. In addition, it has an operation cancellation button so that the client can cancel the purchase and obtain the refund of the inserted money.

Next, with the software logic that you want to follow described above, it is programmed in Proteus to perform the complete operation simulation and debug errors, the complete design is shown in Figure 2, it is sectioned into 6 main devices identified by the number circled in Figure 2.

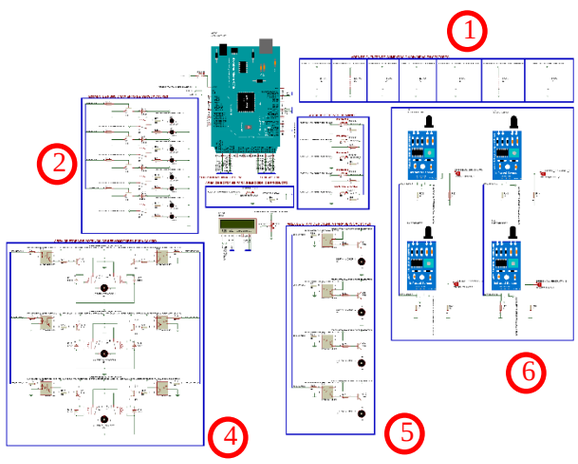

Figure 2 Proteus prototype design

Within Figure 2 the main functions of each section are as follows:

Section 1).- Power supplies for all sections of the vending machine.

Section 2).- Review circuit of the operation of servo-motors.

Section 3) .- Control buttons area.

Section 4) .- Circuit for backward and forward movement of the actuator (Product dispatcher).

Section 5) .- Electronic diagram for motor drive dispatches product

Section 6).- Simulated representation of obstruction sensors for product counting.

Hardware Design

After having tested the logic of the program, as well as its implementation in the virtual environment of the Proteus software, we first proceed to provide a 3D view of the circuit (see Figure 3) to obtain measurements and a preliminary view of the device to be built.

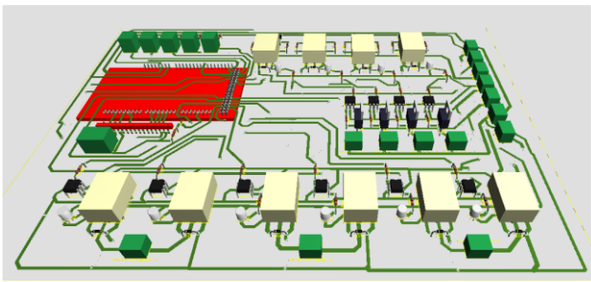

Figure 3 3D view of the circuit to implement

Then the printed electronic circuit shown in Figure 4 is designed with the support of the Lives Wire and PCB Wizard software and printed by the ironing method.

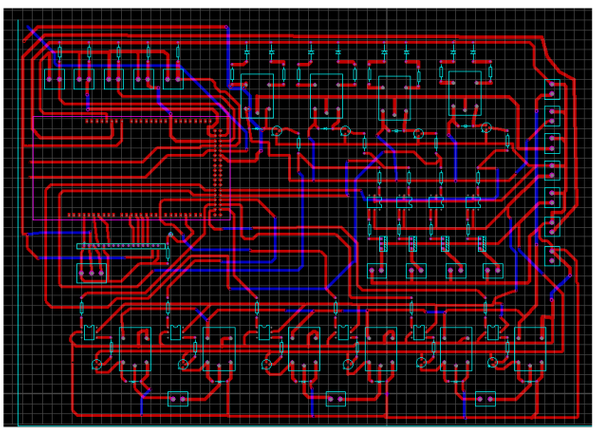

Figure 4 Design of the tracks of the printed electronic circuit

Once the printed circuit is obtained, all the elements are assembled according to the sketch in Figure 3. A view of the final implementation of the circuit is shown in Figure 5.

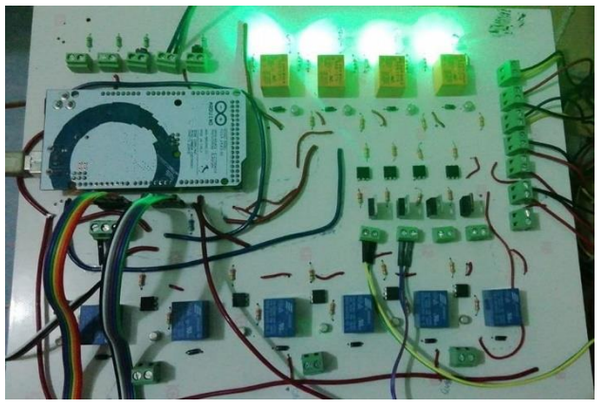

Figure 5 Printed circuit view

On the other hand, the machine casing is designed taking into account all the dimensions of the internal elements, this stage is crucial because if any element does not fit in the intended place, it could lead to a total redesign of the casing. Detailed plans are presented in Figure 6.

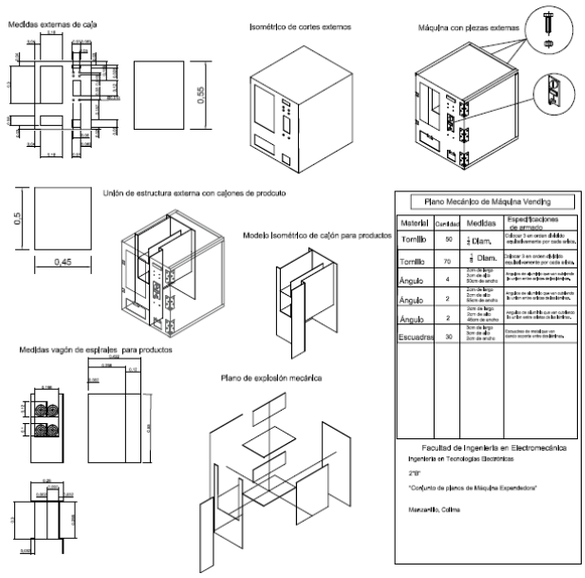

Figure 6 3D plans of the vending machine casing

For a better visualization of the planes exposed in Figure 6 an enlarged view of the 3D design with transparencies in isometric is shown in Figure 7.

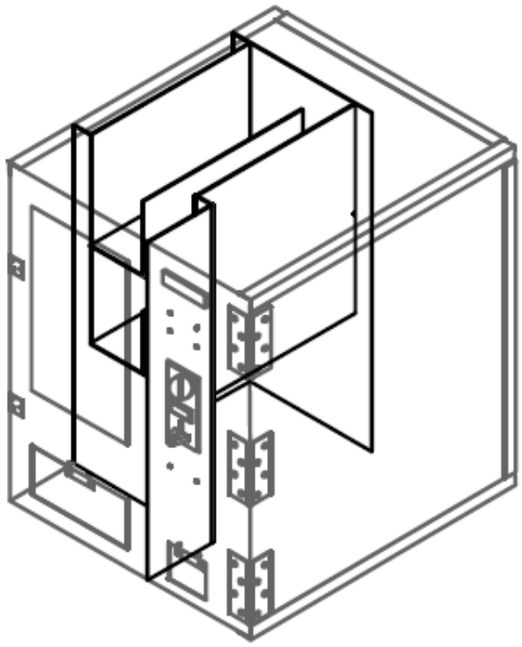

Figure 7 Isometric view with 3D transparencies of the Vending machine

Torque Required in Spirals

To verify that the spirals do not get stuck with the product due to its weight, the minimum necessary torque of the servomotor is calculated considering the following parameters:

- Maximum weight of each product = 0.250 kg
- Maximum number of products per spiral = 6
- Spiral weight = 0.5 kg
- Spiral radius = 5 cm

With these data, the maximum gross weight that is moved when a product is dispatched is calculated using Eq. one.

$$Total\ weigth = Product\ weight * number\ of\ products + weight\ of\ the\ spiral \quad (1)$$

Substituting the data in Eq. 1 we obtain:

$$Total\ weigth = 0.25 * 6 + 0.5 = 2\ kg$$

To calculate the torque force you need for a wheel with a radius of 5 cm and a weight of 2 kg, it can be done using Eq. 2

$$F = \frac{kg}{cm} \quad (2)$$

Substituting the respective values in eq. 2 you get:

$$F = \frac{2}{5} = 0.4\ kg/cm$$

For the development of this project, the commercial servomotor Model MG995 with a torque of 10 kg / cm is selected, which clearly provides a torque greater than the minimum required, thus ensuring proper rotation.

Complete assembly

Finally, it is carried out in assembly of all the internal and external elements of the designed Vending machine, the biggest problem presented was the jamming of the product in the ejector system (an "endless" spiral) which was efficiently solved by increasing the diameter of the mechanism. A final view of the prototype made is presented in Figure 8.

Figure 8 Vending machine designed and built

ISSN-2444-5002

Investment in the Prototype

Hours, man

The prototype presented in this article is made over a semester, on average, 12 hours per week were invested, having a total of 1872 man hours. The students are divided into 3 subgroups that, as far as possible, progressed in parallel to make construction more efficient. These subgroups are:

1) Design and construction of the interior of the machine.

2) Software design in Proteus and Arduino.

3) Quotation, purchases and implantation (hardware) of electronic devices.

Material Cost

Firstly, the complete list of the necessary elements is analyzed, and the most appropriate ones to be implemented are studied: they comply with the requirements of the project at a lower price.

The items generally and in an increasingly globalized world were ordered through the internet with a waiting time of up to a week, which due to the times handled is a good option. It should be noted that an incentive to optimize cats was for students to absorb the initial cost of the materials. Table I shows the complete list of materials used giving a total of $ 8,073.20 Mexican pesos.

Description	Unit	Quantity	P.U	Amount
Aluminum sheets	kg	25	$21.00	$525.00
Spiral wire	Kg		$45.00	$45.00
Reelevator module	Pc	1	$90.00	$90.00
Generic Arduino Mega (wired)	Pc	1	$320.00	$320.00
LCD screen (2x16)	Pc	1	$100.00	$100.00
Aluminum angles	m	8	$28.00	$224.00
TowerPro MG995 15kg / cm servo motor	Pc	4	$160.00	$640.00
Power supply	Pc	1	$250.00	$250.00
Electronic Multicurrency Selector	Pc	1	$750.00	$750.00
SG90 Mini Servo	Pc	4	$65.00	$260.00
Male pin strips	Pc	4	$10.00	$40.00
Potentiometer 1M	Pc	2	$9.00	$18.00
Colored LEDs	Pc	10	$1.00	$10.00
Transistor 2N2222A	Pc	4	$30.00	$120.00
Optocoupler 4N25 NPN	Pc	10	$9.50	$95.00
Compact relay	Pc	4	$30.00	$120.00
Varied resistances	Pc	45	$1.20	$54.00
Terminal Block 3 poles	Pc	22	$9.30	$204.60
26 way cable	m	2	$48.00	$96.00
Diode 1N4007	Pc	4	$3.10	$12.40
Switch Push Button	Pc	6	$35.50	$213.00
MOC 3011 Integrated Circuit	Pc	7	$22.00	$22.00
Terminal Block 2 poles	Pc	20	$9.10	$182.00
Phenolic Plate 30 x 30	Pc	1	$199.50	$199.50
Circuit transfer sheets	Pack.	1	$75.00	$75.00
Mini drill bits	Pack.	1	$99.00	$99.00
Normal drill bits (assorted size)	Pc.	8	$10.00	$80.00
PBC tubes (assorted size)	m	2	$18.00	$36.00
Riveter	Pc	1	$90.00	$90.00
Silicone placement gun for aluminum	Pc	1	$50.00	$50.00
Silicone	Pc	2	$35.00	$70.00
Rivets	Pack.	3	$20.00	$60.00
Hinge	Pc	3	$20.00	$60.00
Brackets	Par	12	$3.00	$36.00
Nuts	Pc	30	$0.30	$10.00
Screws	Pc	30	$0.50	$15.00
Painting	Can	7	$55.00	$385.00
Metal cutting discs	Pc	3	$15.00	$45.00
Sandpaper	Pc	5	$8.00	$40.00
Black tape	Pc	1	$15.00	$15.00
TCRT5000 infrared light sensor	Pc	4	$35.00	$140.00
Electric actuator	Pc	3	$38.00	$112.00
GSM GPSR 4G module	Pc	1	$660.00	$660.00
Phenolic Plate 30 x 30	Pc	1	$199.5	$199.5
Aluminum foil	kg	1.4	$18.00	$25.00
Potentiometer 1M	Pc	2	$9.00	$18.00
Colored LEDs	Pc	10	$1.00	$10.00
Transistor 2N2222A	Pc	10	$25.00	$250.00
Compact relay	Pc	10	$22.00	$220.00
Varied resistances	Pc	46	$.5	$23.00
26 way cable	m	4	$25.00	$100.00
Diode 1N4007	Pc	12	$3.10	$31.20
Optocoupler 4N25 npn	Pc	10	$12.00	$120.00
Screws, nuts, angles, tin, paint etc.	Various	NA	NA	$280.00
Ferric Acid	Pc	1	$40.00	$40.00
Terminal block	Pc	10	$4.00	$40.00
Compressed cardboard (30x40) and (25x30)	Pc	2	$35.00 $23.00	$58.00
Tip 41	Pc	4	$8.00	$32.00
Metal prisms	kg	1	$60.00	$60.00
Arduino Mega	Pc	1	$300.00	$300.00
Duponds male-male, male-female	Pack.	3	$45.00	$135.00
Total				$8,073.20

Tabla 1 Material Requerido para La construcción de Máquina Vending

Acknowledgments

The authors thank the Faculty of Electromechanical Engineering of the University of Colima, Manzanillo campus for granting the facilities for the presentation of this work.

ISSN-2444-5002

Conclusions

The design and construction of a Teaching Vending Machine is presented in this work which shows to be of great help in expanding and implementing the knowledge acquired in classrooms such as project management, economics, electronics and / or programming.

Students develop their ability to work under objectives by dates, which is common in industries or better still, be an entrepreneur in project development.

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ISSN-2444-5002

Article **Journal of Computational Systems and ICTs**
June 2020 Vol.6 No.17 23-29

Introduction to the automatization of measurement equipment with Python-GPIB

Introducción a la automatización de equipos de medición con Python-GPIB

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DOI: 10.35429/JCSI.2020.17.7.23.29 Received February 01, 2020; Accepted June 10, 2020

Abstract

This article provides a quick introduction to the automation of measurements using a public domain language such as Python. We bring references for the used libraries and the basic commands for manipulating the GPIB port. Some examples are provided.

GPIB-USB, automatic measurement system, GPIB port, Python

Resumen

Este artículo brinda una rápida introducción para la automatización de mediciones utilizando un lenguaje de dominio público como es Python. Se hace referencia a las librerías utilizadas y los comandos básicos para la manipulación del puerto GPIB. Se brindan algunos ejemplos de uso.

GPIB-USB, Mediciones automaticas, Puerto GPIB, Python

Citation: MEDINA-BRISEÑO, Pablo, MOLINAR-SOLIS, Jesus Ezequiel, CHAVEZ-VELARDE, Juan Jose and BRACAMONTES-DEL TORO, Humberto. Introduction to the automatization of measurement equipment with Python-GPIB. Journal of Computational Systems and ICTs. 2020. 6-17: 23-29.

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Introdution

In electronic characterization and research laboratories, it is very common to require automation of measurement and test equipment, such as; multimeters, signal generating sources, oscilloscopes, among others. In such a way that, in order to obtain these data, the user can work easily and quickly with electronic equipment.

The GPIB [1] or General Purpose Interface Bus, (Figure1 bus), supports the communication standard: IEEE 488.1, IEEE 488.2, which allows you to connect up to 15 devices and be able to control them with your bus of communication through the PC, Figure 2. There are commercial cards that allow the connection between the PC's USB port and the GPIB bus, such as the Keysight 82377B and ADLINK 3488A card. However, this work uses the PROLOGIX GPIB-USB card as it represents one of the cheapest on the market.

The Python programming environment facilitates automation because it is intuitive programming and it has many libraries that make it a versatile and very useful environment, in addition to being free [2], it is possible to use other languages, such as C, C ++, Visual BASIC, Labview among others, but Python offers many advantages over the previous ones, ease, versatility, friendly and free environment

The SCPI (Standard Commands for Programmable Instrumentation), are standard commands for the programming of the instruments, the advantage is that they replace the programming drivers that each instrument had, in such a way that several of them had to be installed. That is why they were adopted by the most recognized and important brands in the manufacture of measuring equipment such as:

- Agilent: Agilent Technologies
- Cec: Capital Equipment Corporation
- Iotech: IOTech hardware.
- Keithley: Keithley
- cc: Measurement Computing Corporation
- Ni: National Instruments.

These commands are important, since they are the ones that manipulate the instruments in particular. They comply with a coding standard and such commands are different between brands.

a) *b)*

Figure 1 GPIB bus, a) GPIB connector available in measurement equipment. b) PROLOGIX business card – USB

Figure 2 GPIB cable, female / male at both terminals

Python installation and library for GPIB

Python is a language that has gained territory in the programming world, it is intuitive, easy and dynamic. The Python community has managed to make a series of libraries, in such a way that it becomes a very complete language. In this work, it is important to install some of them, with which we will achieve the connection between instruments.

The Python IDLE (Integrated DeveLopment Environment for Python) is a graphical environment for elemental development, it allows you to edit and run programs. For its installation we have to go to the official Python page [3]. The latest version is 3.7.4 for 64-bit Windows [4] or choose for 32-bit Windows [5]. The Python “pip” or Preferred Installation Program [6] is a tool that allows you to install, reinstall, or uninstall PyPI packages.

ISSN-2444-5002

This program executes the installation commands for all the libraries. If it has one, it can be updated by executing the command "-m pip install –upgrade pip", from the Windows command interpreter (CDM) or command prompt, Figure 3.

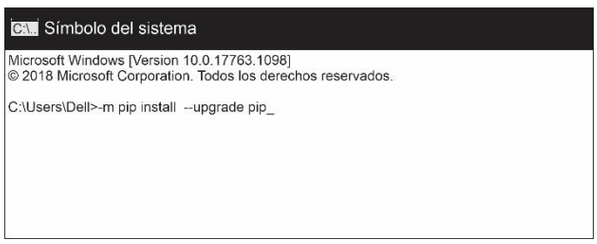

Figure 3 Python pip update

It is essential to Install the necessary Python libraries. These will allow us to communicate with the instrument, so that we can operate and control it. Such libraries are:

Pyvisa	[7]
Pyvisa-py	[7]
Pymeasure	[8]
pyUSB	[9]
pyserial	[10]
pyinstruments	[11]

Libraries are easily installed from CDM, with the command pip install Figure 4.

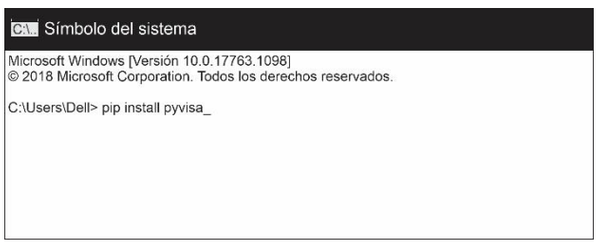

Figure 4 Command to install pyvisa

We list below the commands to install the libraries using pip.

Pip install pyvisa-py

Pip install pymeasure

Pip install pyUSB

Pip install pyserial

Pip install pyinstruments

To do the first communication tests, the instruments must be connected, there are two ways to connect the equipment, star and serial. In Figure 5, reference is made to the serial connection with the device to be measured or characterized (DUT).

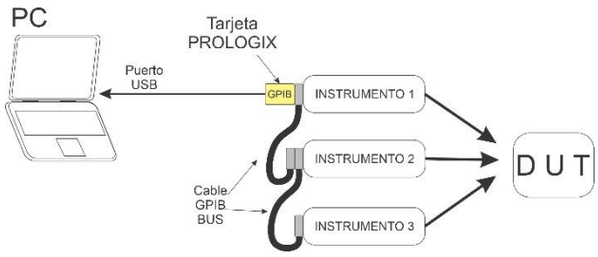

Figure 5 Conventional way of connecting equipment to the device to be measured

Installation of prologix gpib configurator

The Prologix GPIB Configurator application [12] is a user interface to test the communication of the CPU with the equipment, Figure 6. This can execute the SCPI commands of the instruments directly, which is recommended for preliminary tests. The interface shows us crucial data such as the "COM" port number of the PC to which the equipment was connected (shaded area). It also shows the GPIB address, which is a decimal number that each instrument has assigned to establish communication. In this way, this instruction "++ addr" must be executed followed by the address number every time an instruction is given to a particular computer. Such address in some cases is displayed when the instrument is turned on and others can be programmed from the options menu of the same equipment. In this document we will use a 6 1/2 digit Agilent 34410A equipment, which shows us the number 5 as the address.

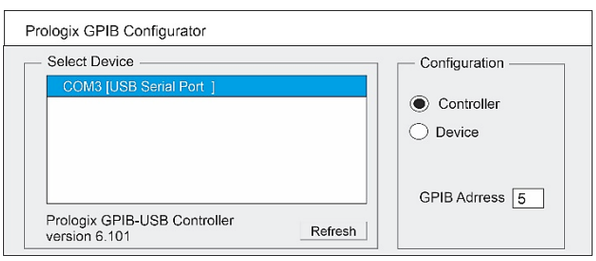

Figure 6 Prologix GPIB Configurator, user interface

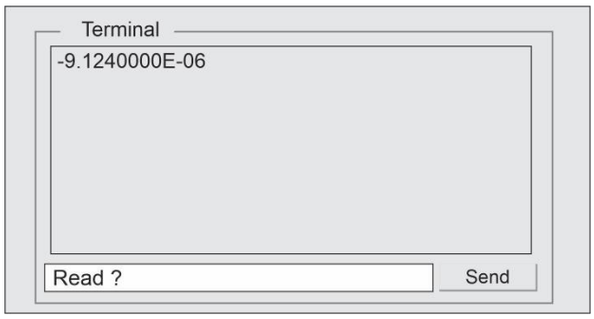

Figure 7 Prologix GPIB Configurator Terminal

At this point we are ready to test the SCPI commands of the measuring instruments, in the dialog box of Figure 7, we write the command READ ?. This is a SCPI command, whose function is to read the data displayed on the multimeter screen. When sending the instruction, it returns the reading shown on the instrument's display, this reading is displayed in the "Terminal" part, in this case the data 9.12400000E-06. In this way, it is possible to verify the communication between the PC, the GPIB card and the instrument.

It is important to know the commands of the PROLOGIX GPIB – USB card [13]. These commands are particular, like: ++ addr; ++ auto; ++ clr; ++ read, among others. They have important functions, which help define your settings.

SCPI commands

The SCPI language is based on the IEEE 488.2 standard, which is defined for the commands and their syntax. The main advantage of SCPI is that it reduces the time used to create an application, which allows controlling the different computers. Since prior to its appearance, the programmers directly used the drivers of the measuring instruments. SCPIs have two types of commands, these are: Common commands, those that come preceded with an "*" as an example, * CLS; * OPC; * RST; * IDN ?, among others. And the specific commands, those that use the instruments in particular for their operation, automation and control. The latter depend on the purpose and characteristics of each team, they are made up of 3 to 4 letters and are combined with others to perform specific actions. Example:

- MEASure:VOLTage:DC?
- TRIGger:MODe NORMal
- CONFigure:VOLTage:DC (@2)

These commands are explained in the user manuals of each instrument, where some even have programming examples.

Establishing Python and gpib communication

To establish communication between the PROLOGIX GPIB-USB and the equipment using Python, the following steps are listed:

1.- The PROLOGIX GPIB-USB card, the measuring instrument and the PC are connected.

2.- In the Python IDLE the visa library is imported >>> import visa

3.- Establish a variable "rm" that calls the communication resources and prints them. >>> rm = visa.ResourceManager () >>> print (rm.list_resources ())

For this case, the result it returns is as follows:

('ASRLCOM3::INSTR',)

With the complete command ('ASRLCOM3 :: INSTR',) to establish communication between the program and the instrument, we start with the coding of the program.

The following code is an example that allows us to read the voltage values of a multimeter.

```
P1  import visa
    rm=visa.ResourceManager()
    rm.list_resources()
P2  inst=rm.open_resource('ASRLCOM3::I
    NSTR')
P3  print(inst.write("++addr 5"))
P4  print(inst.write("CONF:VOLT:DC 10,
    0.003"))
    for i in range(5):
P5  print(inst.query("READ?"))
    time.sleep(1)
    print()
P6  rm.close()
```

P1.- Visa libraries are imported to use all their resources.

P2.- A “inst” variable is created that keeps the communication command open ('ASRLCOM3 :: INSTR').

P3.- The input / output of the instrument is addressed “++ addr” followed by the number assigned to the equipment, in this case 5.

Q4.-Using the corresponding SCPI command, the equipment is configured to measure voltage, direct current, maximum value 10V. with 0.003V resolution.

Q5.- The measured value is requested; it prints it in the Python Shell.

P6.- Close the communication port.

Programming of several equipment

To program several devices with the PROLOGIX GPIB-USB, it must be connected through the communication cables as shown in Figure 2, and Figure 6. It is necessary to remember that each instrument will have a different address.

P1	import visa
	import time
	Import matplotlib.pyplot as plt
	Import numpy
	Import pandas as pd
	rm=visa.ResourceManager(‘@py’)
	rm.list_resources()
P2	inst=rm.open_resource ('ASRLCOM3::INSTR')
P3	vin2=0
P4	vfin2=3
P5	pasos=10
P6	var1=(vfin2-vin2)/pasos
P7	x=[]
P8	y=[]
P9	print(inst.write("++auto 1"))
P10	print(inst.write("++read"))
P11	archivo=open(“mediciones.csv”,”w”)
P12	for i in range (pasos):
P13	v2=vin2+i*var1
P14	print(inst.write("++addr 4"))
P15	print(inst.write("OUTP ON"))
P16	print(inst.write("CURR .125"))
P17	print(inst.write('SOUR:VOLT {}'.format(v2)))
P18	print("voltaje"+str(v2))
P19	x.append(v2)
P20	time.sleep(1)
P21	print(inst.write("++addr 5"))
P22	print(inst.write("CONF:CURR:DC AUTO"))
P23	num=(inst.query('READ? ')
P24	print("medicion"+str(num))
P25	y.append(num)
P26	archivo.write(" , "+str(num)+str(v2))
P27	print(inst.write("++addr 4"))
P28	print(inst.write("OUTP OFF"))
P29	rm.close()
P30	archivo.close()
P31	plt.xlabel('BARRIDO DE VOLTAJE. -0V. A 2.0V.')
P32	plt.ylabel('CORRIENTE MEDIDA -DIODO-')
P33	plt.plot(x,y,".")
P34	plt.grid(True)
P35	plt.show()

Table 1

P1.- The following libraries are imported:

Visa: To establish communication with the instrument.

Time: With the function time.sleep (). We handle waiting times in the execution of the program.

Mathplotlib: Your resources help us generate the graphs with which we visualize the measurements.

Numpy: Fundamental parcel for handling scientific data.

Pandas: with this library we can manipulate number tables and time series.

P2.- A “inst” variable is created that keeps the communication command open ('ASRLCOM3 :: INSTR').

P3.- Variables are declared to be able to calculate the values for the DC voltage sweep, which is from 0V to 3V. The variable "vin2" starts the sweep at 0V.

P4.- This variable vfin2, defines until which value the sweep ends, which in this case is at 3V.

P5.- The steps is the number of voltage increments for the sweep, here the voltage interval is divided into 10 steps.

Q6.- The formula “var1 = (vfin2-vin2) / steps” calculates the value of the voltage increments that the instrument will put on its terminals.

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Q7.- “x” is given a list of empty spaces to be filled with assigned data, in this case, the 0V voltage sweep. at 3v.

Q8.- “y” is given a list of empty spaces to be filled with assigned data, in this case, the measurement values.

Q9.- The command "++ auto 1", enables or disables the "read-after-write". This enables reading to be done after sending an instruction.

P10.- The “++ read” command allows us to read data from the instrument in use.

P11.- In this programming line, a variable called “file” is declared, it contains a command called open, and within this, the creation of a csv file is declared, which will be named measurements, the “w” stands for write, that is to say; We create a measurements.csv file, which we open to write to it.

P12.- The for cycle makes a series of iterations on the assigned variable “i”, and iterates the number of times the variable steps has been designated. For this example, there are 10 iterations. Once the iterations are finished, the cycle stops.

P13.- In the formula, v2 = vin2 + i * var1, the variable v2, receives a value, and changes according to var1, which marks the increase in voltage.

P14.- Communication is opened with the instrument that has address 4 "++ addr 4", in our case it is a voltage source AGILENT E3645A.

P15.- This SCPI command causes the source output to be enabled.

Q16.- We assign a current limit of 0.125A.

P17.- The instrument is asked to put the voltage value of the variable v2 at its terminals.

P18.- Converts the value of the variable "v2" to a data of string form and prints it in the Python Shell. That is the voltage value that the instrument displays on its screen.

P19.- This command causes the values generated by the cycle for the sweep to be added one by one to the variable x, in the empty list defined in P7.

Q20.- A pause of one second of time is assigned.

P21.- Communication is established with the instrument that has address 5 “++ addr 5”, in this case it is an AGILENT 34401A multimeter.

P22.- The multimeter is configured to measure DC current, in auto scale.

P23.- The variable “num” is declared. This variable obtains the value of the measurement that is requested from the instrument using the “READ?” Command.

P24.- The measured value of the variable "num" is converted into a string value which is printed in the Python Shell.

P25.- This command causes the values measured by the instrument to be added one by one to the variable “y”, in the empty list that was defined in P8.

P26.- Write the data acquired by the variable "num" and "v2" in the file measured.csv that was declared in P11, write it in different columns.

P27.- Communication is opened to the address ++ addr 4 which is the voltage source.

P28.- The source is asked to be disabled after finishing the cycle. This in order that no voltage value remains on the device at the end of the measurement.

Q29.- the variable “rm” declared to open the port, is asked to close the communication port.

P30.- The file “measurements.csv” that was opened to write data in P11 is closed.

P31.- Plt.xlabel, allows us to put text on the x axis to denote references, in this case; VOLTAGE SWEEP. -0V. At 2.0V.

P32.- Plt.ylabel, allows us to put text on the y-axis to denote references, in this case; 'CURRENT MEASURE -DIODE-

Q33.- Python graphs the data stored in “x” and “y”, and it is asked that, for each corresponding value of x, and a point be put, to visualize the graph.

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P34.- A maya or grid is requested

Storage of data and graphics

Most of the time when making measurements, the data should be saved for analysis. There are different ways to save them, here are some options. Plain text file .txt, file .csv (comma separate values) comma separated values, and even the use of a database such as MySQL or ACCES among others.

Generating a graph of measurements with Python is possible using the matplotlib [14], and numpy [15] libraries. With these libraries you can make graphs of the measurements for the visualization of the data.

Conclusions

Python's versatility makes it a powerful and freely accessible tool that in this case makes it easy to use the GPIB port for synchronization and manipulation of measuring instruments. This paper presents a quick introduction that serves as a start for those who want to make more complex measurements using various instruments.

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[1]http://prologix.biz/?gclid=CjwKCAjw29vsBRAuEiwA9s0BzFFgwD7sBRmjJxGBIxVy9cNmP__uJhYyXmAddR9KypBsUuUzuuonRoCCOQQAvD_BwE

[2]https://github.com/pyvisa/pyvisa/blob/master/LICENSE

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[9] https://pypi.org/project/pyusb/

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[13]http://prologix.biz/downloads/PrologixGpibUsbManual-4.2.pdf

[14] https://matplotlib.org/

[15] https://numpy.org/

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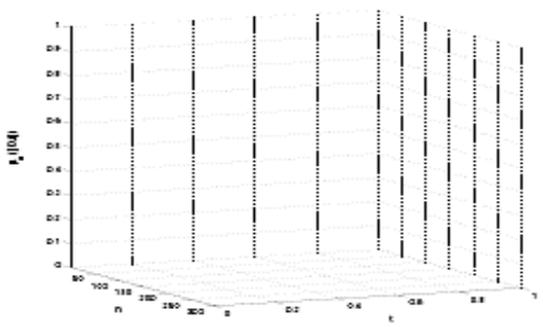

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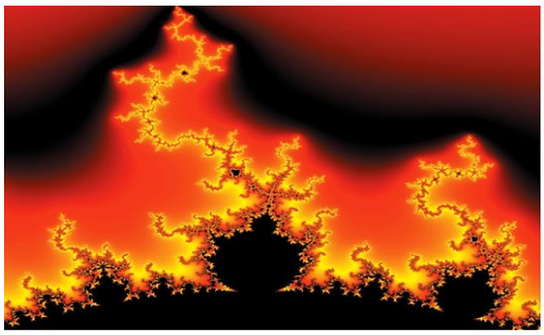

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