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Presentation of the Content

In the first article we present, *Practices for the development of applications (Apps) that contribute to the generation of data banks for use in Health*, by ORTEGA-LAUREL, Carlos, PÉREZ-MARTÍNEZ, Francisco, SIMENTAL-FRANCO, Víctor Amaury and LÓPEZ-MALDONADO, Guillermo, with ascription in the Universidad Autónoma Metropolitana, as the nex article we present, *Application to monitoring a SNes control with Ruby in Windows, Linux Ubuntu, OS X El Capitan, and Raspbian GNU/Linux 10*, by ESPARZA-CASTILLO, Ramón Ángel, LÓPEZ-ROMO, José Alonso, CAZAREZ-CAMARGO, Noe and ABRIL- GARCÍA, José Humberto, with ascription in the Universidad Tecnológica de Hermosillo, as the next article we present, *Block programming to develop interactive activities in the analysis of passive filters using an RC circuit for distance classes*, by GONZÁLEZ-GALINDO, Edgar Alfredo, CARRILLO-MORENO, Aldo Omar, DOMÍNGUEZ-ROMERO, Francisco Javier and PÉREZ-GARCÍA, Jorge, with ascription in the Universidad Nacional Autónoma de México, as the last article we present, *Microcontroller lab with remote connectivity and control of virtual instruments*, by ISLAS-CERÓN, Alejandro, MARTÍNEZ-HERNÁNDEZ, Haydee Patricia, CORTES-MALDONADO, Raúl and MORALES-CAPORAL, Roberto, with ascription in the Tecnológico Nacional de México/Instituto Tecnológico de Apizaco.

Content

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Practices for the development of applications (Apps) that contribute to the generation of data banks for use in Health

Prácticas para el desarrollo de aplicaciones (Apps) que abonen a la generación de bancos de datos para uso en Salud

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Abstract

Nowadays it is perceived necessary that, for the deep understanding, prevention and solution of health problems, the generation and collection of data, regarding their health, of the population in general, and those of the study in specific. Such that such data eventually facilitate decision-making, based on quantitative and qualitative information, to local, regional and / or global health organizations. At the same time, information and communication technologies, and computing, through technologies such as smartphones and applications, present opportunities to facilitate the generation and collection of data, of a diverse nature, except for those concerning health, to be useful for addressing and solving problems related to health, such as social, economic, cultural and health issues. Under these premises, we propose, and consider, the good practices for the development of applications (Apps), based on the experience documented in the literature, and our own, in the development of applications, such that these experiences enable the generation and data collection related to health, such that, by following them in app development projects, it becomes possible to have data in a standardized way, so that in the future they are analyzed and transformed into useful, accessible and understandable information for the benefit of the health of human beings. This is because local, state, federal and global organizations, such as the World Health Organization, seek to have data on diseases, such as, to name a few examples: non-communicable (chronic) Diseases (CNCDs) and Mental Health (NMH) or others.

Applications, Smartphones, Databases, Health, Data, Programs, Information

Resumen

Hoy día se percibe necesario que, para la comprensión profunda, prevención y solución de problemáticas de salud, se demanda la generación y acopio de datos, en cuanto a su salud, de la población en lo general, y los de la en estudio en lo específico. Tal que dichos datos eventualmente faciliten la toma de decisiones, con base en información cuantitativa y cualitativa, a los organismos de salud locales, regionales y/o mundiales. A la par, las tecnologías de la información y comunicaciones, y la informática, a través de tecnologías como los teléfonos inteligentes y las aplicaciones, presentan oportunidades para facilitar la generación y acopio de datos, de naturaleza diversa, no siendo la excepción los concernientes a la salud, con la finalidad de ser útiles para el abordaje y la solución de problemáticas vinculadas a la salud, como lo son las sociales, económicas, culturales y las propias de salud. Bajo estas premisas, proponemos, y se plantea, algunas buenas prácticas para el desarrollo de aplicaciones (Apps), con base en la experiencia documentada en la literatura, y la propia, en el desarrollo de aplicaciones, tal que dichas experiencias habiliten la generación y acopio de datos relacionados con la salud, de manera que, al seguir u orientarse con las mismas en proyectos de desarrollo de apps, se alcance a obtener y/o conservar datos de manera normalizada, para que en lo futuro se analicen y transformen en información útil, accesible y comprensible en beneficio de la salud de la población y los seres humanos en general. Esto en atención a que organismos locales, estatales, federales y mundiales, debieran, tal como sí lo hace la Organización Mundial de la Salud, buscar tener datos sobre enfermedades, como pueden ser, por mencionar un par de ejemplos: las Enfermedades (crónicas) No Transmisibles (ECNT) y las de Salud Mental (NMH por sus siglas en inglés) u otras.

Aplicaciones, Teléfonos inteligentes, Bancos de datos, salud, Datos, Programas, Información

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Introduction

As part of a study of smartphone penetration worldwide, for the period 2016-2020, it was found that, as a percentage of the world's population, the global smartphone penetration rate was predicted to exceed 44 percent for the first time by the end of 2020. With 3.2 billion smartphone users worldwide and a global population of approximately 7.7 billion, global smartphone penetration by the end of 2020 is thought to reach 44.9 percent, which implies that today about 44.9 percent of cell phones in use around the globe are precisely smartphones or smartphones, which opens up and enables further expansion in the use of applications (Apps) developed for specific purposes. This is derived from the fact that, in addition to enabling the use of telephony, smartphones integrate both a user-friendly graphical interface and a variety of sensors available to perform different measurements or metrics for specific purposes (Statista, 2020), (O'Dea, 2020). In this sense, a number of potential applications are opened, to make use of the diversity of available sensors, among which is the development of applications for health purposes, i.e., to propose them for medical and clinical use. For example, as an example of the present research, there is the study of Non-Communicable (chronic) diseases (NCDs) and Mental Health (NMH) (World Health Organization, 2020).

In fact, it is relevant to mention that the World Health Organization maintains an "organic group" of Noncommunicable (chronic) diseases (NCDs) and Mental Health (MHD), to cover and follow up international actions on NCDs and mental health disorders, in addition to others such as malnutrition, violence and injuries, and disabilities. Thus, for the WHO to be able to cover and monitor international actions, it requires hard, raw and processed data that are information for the purposes it has set (World Health Organization, 2019).

Nowadays, when the development of an application or system is considered, the specifications are universally thought of in terms of what the user who is requesting the development demands, covering the user's expectations in terms of data and functionalities, building it, in the best of cases, based on standardized development practices and, if not, in terms of the experience of the person in charge of the task, at the free will of the developer.

While this may be the case for general purpose systems or specific purpose proprietary systems that generate their value through such systems, because they seek to meet an information need of equal intention, when it comes to applications or information systems such as the one in question, that is, to meet the demand for the generation and collection of data, This has to change, because the data generated or collected in health-related systems should be put to use for the prospection of the health conditions of the populations in which they are obtained. For this reason, it is necessary to think about the use and management of data, the governance-management of data, which is necessary so that, when viewed in an integral manner, as an ecosystem in which the asset is data, the governance-management model structures the proper functioning of the health data ecosystem.

However, given the connectivity and sensitivity of the data to be processed (health data), it is possible to foresee the potential malicious intention of compromising them, which would result in not sharing them, so it is necessary to generate management-structure mechanisms to articulate the task without violating or compromising privacy. Therefore, a "governance-management model" is proposed for this purpose, which will become part of the "good practices" that will also be outlined.

Under these premises, this paper proposes to conceptualize a model that enables the availability of data, but preserves privacy, in order to capture the information of populations to be studied, in general or specific populations, through applications (Apps) and "good practices" to put the model into use. As an example to show the usefulness of the proposed model, the assumption of use for the collection of NCD and NHM data is presented, from the diagnostic approach with psychiatric instruments (batteries) applied via App. This is because it is clear that questionnaires can be answered from any smartphone, either to obtain diagnoses and/or to generate data that can be collected, with the intention of having present opinions, or to form databases with statistics (historical databases, with specific regularities), which enable the necessary input to conduct in-depth research of NCDs and NHM, which are mentioned as an example.

This would lead to the generation of massive databases that in turn would allow searching for possible socio-environmental and/or heritable risk factors associated with the prevalence of NCDs and NMHs, or others.

Theoretical considerations for the proposal

It has been proposed to describe the practices, to know the evolution and trends of relevant data management, since, from them, in addition to our experience in the development of information systems, good practices will be proposed, so that they represent guidelines for action, that is, guidelines or recommendations based on the evolution, development trends and practical experience.

In the current existing digital ecosystem, there is a separation between the data generated as part of specific purpose applications, in many cases of commercial use for the purposes of the application, with copyrights on data structures, i.e., on data dictionaries, table structure and their relationships (Altman et al., 2007), (Groth et al., 2014). In another aspect, data generated as a result of the publication of academic data (Bourne et al., 1997), (Benson et al., 2013), (Callaghan et al., 2014), (González-Beltrán et al., 2014), (González-Beltrán et al., 2015) and in a last one, the data generated through initiatives under the Creative Commons license, (Berman et al., 2003), (Bauch et al., 2011), (Crosas, 2011), (Velankar et al., 2014), (Starr et al., 2015), (Papoutsoglou et al., 2020). From these three main aspects it can be seen that far from unifying, they cause the circumstance that unfortunately prevents extracting the maximum benefit from investments in the generation and collection of data, especially in health, whatever the purpose from which they were derived (Kjetil-Sandve et al., 2013), (Casino, 2019), (Alterovitz et al., 2020), since depending on the aspect in which the data of a given application is framed or boxed, will be the feasibility of identifiability to make them massively sharable or not.

Exploring and critically analyzing what is related to the identifiability of data, which is what potentially makes them available as an "informational asset", metadata is considered in the literature as an engineering resource, and there is a diversity of works in which obstacles are reflected and highlighted, both technical, behavioral, and governance, that affect the quality of metadata and propose possible solutions, either to mitigate the issue of metadata quality, or even the lack of metadata, especially in public data repositories-resources (Harland, 2012), (Kinjo et al. , 2012), (Lecarpentier et al., 2013), (Martone, 2015), (Musen et al., 2015), (Roche et al., 2015), (Rose et al., 2015), (Szostak, 2019), (Kaliyaperumal et al., 2020).

Certainly, what is not found is any protocol on the important role concerning the government-management, for purposes of preservation, data conservation, present and subsequent statistical collection for its use and exploitation, on populations in general or specific. In fact, if the government is not considered essential for data purposes of a general nature, less specifically in health. Perhaps this is because this could well be considered a management issue, that is, data management, which would lead to move from an engineering role to a data management role (data stewards) (Wenger et al., 2000), (Wolstencroft et al., 2015), (UniProt, 2015), (Ohno-machado et al., 2015), (Susanna-Assunta et al., 2012). Perhaps even, the lack of literature regarding the subject is because such a role is often underappreciated, whose concern is to make traceable statistics of everything, health statistics, we consider that it should be the occupation and concern, in the case of health, of local, regional and/or global health agencies.

Metadata, which are the data about data, the descriptions of the data themselves, are the essential component to enable the collection of data as an asset, for NCDs, NMH or health, they are the core of any data exchange system. It is this metadata that can potentially drive the discovery of unobvious associations and link seemingly unrelated datasets. It is even the metadata itself that provides the essential context, describing with data what the data collector defined, for example, who generated the dataset, in what time period, in what population and how, which is certainly a data management or data governance task that someone must take on.

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The important role of curation and stewardship of health or other data should be appreciated, even though it often is not. Generating a collection of metadata, which would identify the collection of databases available for exploration and analysis, would provide visibility of the richness of the data asset, which would provide a basis for critically linking related and unrelated topics. The lack of metadata and/or the quality of this data is not overlooked, hence it is considered that local, regional or global health agencies should take care to generate rules that address the identification of the real asset "data". Such rules should make it possible to overcome technical and behavioral obstacles, as well as those affecting the quality of metadata, in order to collectively contribute to the construction of solutions for the enrichment of health "data" for humanity.

Proposed model

Given that the main requirement is to obtain quantitative data for the deep understanding, prevention and solution of health issues, a problem for which it is proposed to contribute with the generation of guidelines that promote the conservation and management of health data, from the development of Apps that enable the promotion of survey, observational, prospective and longitudinal studies, with total privacy, thus making the handling of sensitive information confidential, this contribution is considered highly valuable.

In this sense, the collection of data, of what represents information or personal data, with respect to what are diagnostic data and results, relevant data that provide guidance on health, must be segregated, so that, in a data analysis (observation), these are not mixed, with the intention of avoiding at all costs that if data are compromised, it is not feasible to disseminate personal data with diagnoses of the particular health of any individual. If the above is achieved, then, what will be feasible is the dissemination, as wide as possible, of the health data of the population or populations in the specific, in order to develop strategies for prevention, diagnosis and treatment of NCDs and NMH in general, or even monitoring them as already proposed by the World Health Organization (World Health Organization, 2019), (World Health Organization, 2020), without particularizing in any person, since it may be considered victimization.

Thus, in response to this generic but crucial requirement, a tripartite data management-governance model is proposed as shown in Figure 1, to contribute data in the absence or insufficiency of such data:

– A first instance, acting as controller, which will be in charge of determining what to present "from the data instance", to the users, because this would be the data and access control. This will enable the segregation of the personal data that would live in this instance, with respect to the data of the observation or observations, which will be deposited at all times in the data instance.

– A second instance of the model, the data instance, which would contain the data obtained through the Apps, such as: variables and constants, as in the case of NCDs and NMH, some clinimetric batteries, specifications, among others.

– A third instance, of visualization or view, in a graphical interface, which would be in charge of showing only what the controlling instance orders.

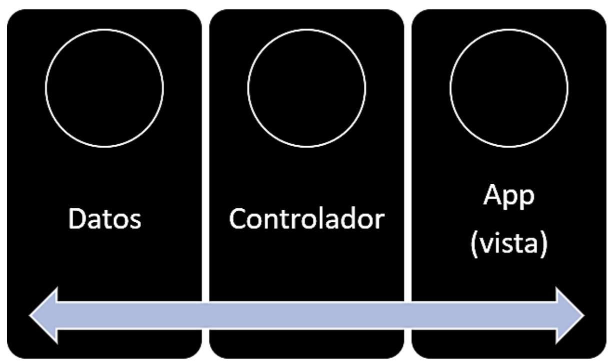

Figure 1 Proposed tripartite governance-management model (to ensure the preservation and management of health data)
Source: Own elaboration

With the proposed model (Figure 1), given the approach of indirect controller-data and controller-view interaction, communication between the data and the view, ideally will never occur and therefore is not contemplated, because the data are independent of the user view-interface, which enables total anonymity, a functionality that is highly desired, although not necessarily materialized, in this type of applications.

Certainly, what the model offers is to articulate, for the purpose of preserving and managing health data, the instances/programs/projects to generate health data via Apps, which will have to take the model as a guideline to follow, and thus harmonize all development efforts through the model. In such a way that the "active data" is stored with total anonymity, and is the one that is preserved over time, so that it is integrated into the available data via the metadata of the data, so that at the required time it can be processed, analyzed and interpreted and information can be extracted.

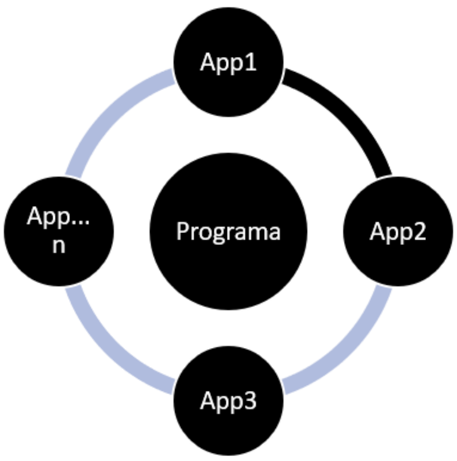

Figure 2 Program or portfolio that, through projects (of Apps), generates affinity - data collection
Source: Own elaboration

The above models (Figure 1 and Figure 2) can feasibly be proposed as framework schemes for structuring the development of applications for use in health, and even, in a future work, as a de facto format guideline for data and metadata in health (only in the logical design part and storage objects, Figure 1), for the purpose of obtaining standardized survey, observational, prospective and longitudinal data, and for the development of orchestrated apps (Figure 2).

Even the same model (Figure 2) can orchestrate programs and projects for the development of databases, in terms that the model can be the structuring scheme (of use), which will give applicative independence, that is, of view or face to the user, and fully structured in the part of the conformation of the databases, which will enable more data, by adding projects that can share data among them, and within the program or portfolio of projects.

Furthermore, the proposed model will ensure that the data generated, regardless of the instance that generated them, will be analyzed and transformed into useful, accessible and understandable information for those interested in the analysis of the databases that can be built, and the phenomena that the data contained therein may describe (complex or not).

The model, given the anonymity scheme of health data, can be used for data collection, allowing the monitoring, evaluation and analysis of the health situation, in relation to a particular disease, a campaign in action or any other health analysis need that is sought to be computed. Similarly, for surveillance, research and control of general and specific risks, in explicit contexts. In addition, it can also provide data to know the social participation in health, imposing the use in general or specific populations, which through invitation or obligation must respond through the Apps. Finally, it can contribute to the development of policies, regulation and compliance with them, as it can constitute a monitoring tool, which through the model guarantees privacy.

Good practices

These practices are written with the intention that they can act as a guideline for those who wish to contribute to obtaining quantitative data for the deep understanding, prevention and solution of health problems, through standardizing the structuring of the approach of the program or specific project, so that from the beginning good data management is considered, and managed data and metadata standardization, for the reuse of the data that can be generated. In this sense, the practices outlined, product of both the evolution and trends of government-data management, as well as our experience in the development of information systems, are the following:

– Propose the development of programs or project portfolios, at the local level (at the level of municipalities), regional (at the state or federal level) or global level, in the medium and long term, that generate data with statistical (historical) trend, with well-defined periodicities. Within the programs, it is imperative to contemplate projects as short term as feasible, such that these projects allow obtaining, as a dividend, data on a medium and regular basis (Figure 2).

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– It must be ensured that the information generated in each of the projects participating in the program can be processed and integrated into a local, regional or global database repository, and ensure its accessibility, interoperability, efficient use, visualization, communication and dissemination through standardized metadata.

– For implementation, the data will have to be collected through the use of multiplatform mobile device applications (App), which make use of the proposed model based on the privacy of the patient being studied (Figure 1), whose information is anonymous, confidential, and used exclusively for study and statistical purposes.

– It is expected that the data will allow the identification of correlations, for example, to determine whether there is a relationship between behaviors such as substance use and NCDs in a generational way, in addition to their comorbidity with mental disorders, so as much data as possible should be collected, regardless of whether or not a use has been assigned to them at the outset, through, for example, survey-type clinimetric scales.

– Use general guidelines for the construction of databases, such as those presented in the FAIR Principles Guide (Wilkinson et al., 2016), for data management (Kaliyaperumal et al., 2020), with the relevant dimension for health data, among which the following stand out:

– Findability. That is, the data and the databases where they live must have the appropriate and relevant format, which guarantees that they can be found, located or retrieved.

– Accessibility. This in terms of enabling the right to enter, providing, if necessary, sufficient access credentials and authorizations for such purpose, in terms of guaranteeing access to the databases or data, to whoever must have access.

– Interoperability. For which it is proposed that, within the scheme of government-management of health data, the WHO take the lead for global data, and the federation, states and municipalities do the same for data at the country-region level, so that the standard to be followed for health data is defined. This would ensure that the metadata, data and their repositories comply with the standards defined by the governing body in question, and thus achieve the widest possible interoperability with other databases generated at the local, regional or global levels. In the absence of a global steering committee or one centered on federal bodies, it is feasible to establish local steering committees at the state or municipal level to remedy the general deficiency, but to provide guidelines, albeit at the local level.

– Reusability. In the same case as the previous one, it is necessary to establish guidelines and define the standard to be followed for health data in terms of reusability. Data and their repositories must comply with standards that allow their use for different but related purposes, and even very different from those for which they were originally intended, with the intention of achieving intensive use, i.e., the widest possible use, so as to obtain the greatest benefits from the informational asset: data.

Conclusions

There is a clear need for the integration, processing, analysis and visualization of health data, as well as for local, regional and global statistics, and the development of applications (Apps), which contribute to the generation and collection for the incubation of data banks for use in health, is a viable alternative in the face of this need. It is foreseeable that, through the Apps developed, taking as a guide the good practices proposed here and the proposed model, the study of general or specific populations can be carried out, from the diagnostic approach, with psychiatric instruments (batteries) or others, giving certainty of not violating the privacy of the user who makes use of the App, when putting into practice the "model" at the moment of the implementation of the system, which will keep the anonymity.

It is also predictable that the use of Apps will lead to the generation of massive databases, which in turn will allow searching for possible socio-environmental and/or heritable risk factors, for example, associated with the prevalence of NCDs and NHM, of general or specific populations, through periodic and ordered statistical data, which are not available today.

The fact that the scales, for the example or another, would be raised through the use of applications on smartphones / mobile devices (Apps), multiplatform, whose information will be anonymous and confidential, will encourage the use, since it must be remembered that today many smartphone users give companies like Facebook or Google data and information like never before, over what the same populations are willing to deliver to the governments-managements of different nations or global agencies such as WHO. Given the reluctance to deliver data to the government, and not so to social networking companies or others, despite the fact that they would be used exclusively for public health, academic and statistical purposes, being the Apps the viable and suitable means of capture/diagnosis to promote the collection of data in which there may be opposition from the population, for the communication of these, being part of modern technologies it is expected they can also make the delivery for the purpose of health, by the simple fact of being an attractive technology.

By having data, in bases such as those described, it is to be expected that through such it is possible to determine if there are relationships or correlations between behaviors such as substance use, NCDs and NHM generationally, in addition to their comorbidity with other mental disorders or other indoles.

Undoubtedly, thinking about medium and long term programs, from the integration and analysis of one or several databases, it will be possible to obtain information that will be useful for local, regional and/or global decision making, in addition to providing feedback on the action-reaction effects. The fertilization, through programs with projects that make use of Apps as a tool, with a view to building large health databases, would contribute to support a quantitative overview of the general local, regional and/or global health situation, and/or specific scenarios such as NCDs and NMHs in the same orders.

The democratization and transparency of health data for the generation of useful, accessible and understandable information for the benefit of local, regional or global health is plausible with the use of technological tools such as Apps. But it is unavoidable and necessary to use government-management schemes for data management, to promote the conservation and administration of health data, to promote articulation, to avoid the generation of "data silos" that do not allow integration, the model and the good practices proposed being an approximation.

As a subsequent application work, the proposed model and the described practices will be implemented in a program, with its relevant projects of local or regional scope. In this sense, in order to be able to execute it, we will seek to obtain the pertinent funds that will allow the execution of the program.

One line of work that we can visualize for the WHO is the normative definition and worldwide implementation of government-health data management. This is to circumvent and meet the need for data generation and collection, with this world body as the governing body, in addition to establishing the technical guidelines for metadata, logical design and storage objects, and the guidelines regarding the risks derived from the quality, security and life cycle of health data, which will enhance the use of these in processes, systems and operation of institutions locally, regionally or globally.

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Application to monitoring a SNes control with Ruby in Windows, Linux Ubuntu, OS X El Capitan, and Raspbian GNU/Linux 10

Aplicación para monitoreo de un control USB con Ruby en Windows, Linux Ubuntu, OS X El Capitan y Raspbian GNU/Linux 10

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Abstract

This paper shows the development of a Ruby application to detect the actions carried out on an USB control, with the goal of achieving the coding of multiplatform application that can be used as a basis for the creation of projects with larger scope and impact in this fiel, such as videogame development, and device control systems. The 'prototype models' methodology was the approach for this project. In the first prototype a CLI program was written that prints out messages in the terminal depending on the buttons that are simulated based on the keys pressed on the keyboard, and so on until the end of the project, in which a final application is delivered, in compliance with the necessary tests. This application code was published in a GITLAB repository for reference and future use. The application was developed to be compatible with Windows, Linux, macOS, and Raspbian operating systems to test Ruby portability.

Ruby, Gosu, Windows, Linux, Mac OS, Raspbian, USB gamepad

Resumen

El presente trabajo muestra el desarrollo de una aplicación en Ruby para detectar las acciones realizadas sobre un control USB, con el objetivo de lograr una aplicación multiplataforma que puede ser usada como base para la creación de proyectos de mayor alcance, como el desarrollo de videojuegos y control de dispositivos. La metodología utilizada fue 'modelos de prototipos', en el primer prototipo se escribió un programa de para CLI que imprime mensajes en terminal simulando que sepresionan botones en el mando, dependiendo de las teclas que se presionen en el teclado. El proyecto fue evolucionando hasta llegar finalmente a tener una sola aplicación, cumpliendo con las pruebas necesrias y se publicó el código en un repositorio GITLAB para referencia y uso futuro. La aplicación fue desarrollada para que sea compatible con los sistemas operativos Windows, Linux, macOS y Raspbian para probar la portabilidad de Ruby.

Ruby, Gosu, Windows, Linux, Mac OS, Raspbian, USB gamepad

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Introduction

Today the use of Ruby to develop several kinds of applications is growing at a high rate, we can use Ruby for Web and Internet Development, scientific, education Desktop GUIs, software development, video games and e-commerce systems, are examples of the multiple uses of Ruby. In this work we present an application to monitor a SNes control with Ruby in Windows, Linux Ubuntu, OS X El Capitan, and Raspbian GNU/Linux 10. Our aim in this paper is to develop an application that can be used like a starting point in more complex and robust aplications. Figure 1 shows the general diagram of the project.

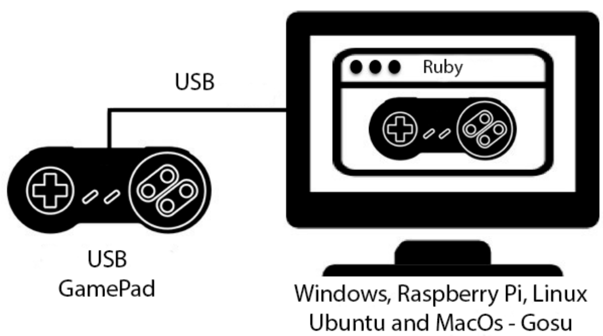

Figure 1 Diagram

Tools description

Ruby (Cooper, 2007) (Mahadevan, 2002) is a language of careful balance. Its creator, Yukihiro “Matz” Matsumoto, did a mix of several parts of his favorite languages (Perl, Smalltalk, Eiffel, Ada, and Lisp) to create a new language that did balanced functional programming with imperative programming.

He has often said that he was “trying to make Ruby natural, not simple,” in a way that mirrors life.

Since its public release in 1995, Ruby has drawn devoted coders worldwide. In 2006, Ruby achieved mass acceptance, with active user groups formed in the world’s major cities and Ruby-related conferences filled to maximum capacity. Ruby-Talk, the primary mailing list for discussion of the Ruby language, climbed to an average of 200 messages per day in 2006. This fluency has dropped in recent years, as has the size of the community, and thus it has pushed discussion from one central list into many smaller groups.

Ruby is ranked among the top 10 programming lenguages on most of the indices that measure the coding leguanges growth and popularity worldwide (TIOBE <the software quality company>, 2022). A large parth of this growth is attributed to the popularity of software written in Ruby, particularly the Ruby on Rails web framework.

Ruby is also completely free. Not only free of charge, but also free to use, copy, modify, and distribute.

RubyGems is a Ruby packaging system designed to facilitate the creation, sharing and installation (in some ways, it is a distribution packaging system like what, apt-get is to debian linux distribution, but targeted at Ruby software). Ruby comes with RubyGems by default since version 1.9, previous Ruby versions require RubyGems to manually.

The main place where Ruby packages are hosted is RubyGems.org, a public repository of gems (a package of Ruby code release to public via RubyGems.org) (RubyGems, 2022) that can be searched and installed onto your machine. You may browse and search for gems using the RubyGems website or use the gem command on the terminal with the CLI.

Gosu (Julian Raschke, 2020) (Sobkowicz, 2015) is a 2D game development library for Ruby and C++. It’s available for macOS, Windows, Linux (including Raspbian), and iOS. Gosu is focused, lightweight and has few dependencies (mostly SDL 2). It provides: a window and a main loop 2D graphics and text, powered by OpenGL or OpenGL ES sounds and music. keyboard, mouse, and gamepad input.

Gosu is mostly used to teach or learn Ruby or in small game development competitions. It’s also a great prototyping tool and even it has been used for indie game development.

About the development environment, VSCode has been used to code the project described in this article. VSCode is a free source code editor made by Microsoft for Windows, Linux and macOS.

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Its Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git commands (git is a distributed version control system). Besides that, VSCode users can change the theme, keyboard shortcuts, preferences, and install extensions that add additional functionality. VSCode source code comes from Microsoft's free and open source software VSCode project released under the permissive Expat (vscode/LICENSE.txt at main · microsoft/vscode · GitHub, 2022), but the compiled binaries are freeware (License - Visual Studio Code, 2022) for any use.

GitLab is a web-based DevOps lifecycle tool that delivers a Git-repository manager providing wiki, issue-tracking and continuous integration / continuousdeployment pipeline features, using an open-source license, developed by GitLab Inc. GitLab software was created by the Ukrainians Dmitriy Zaporozhets and Valery Sizov.

Hardware and Software specificications

The hardware used in this project was:

- Intel(R) Core(TM) i34025U CPU @ 1.90 GHz, 6 GB RAM, 64 bits.

- Intel(R) Core(TM) i3 CPU M 370 @ 2.40 GHz, 4GB RAM, 32 bits.

- MacBook Pro (Retina 13-inch, Early 2015), Procesador: 2.7 GHz Intel Core i5, Memoria 8 GB 1867 MHz DDR3, Macintosh HD, Intel Iris Graphics 6100 1536 MB.

- Raspberry PI Model 3B+ V1.3, RAM 1024Mb.

- Generic SNES USB Controller Gamepad.

The software used in this project:

Windows 10 Home

- Ruby 2.7.1p83 (2020-03-31 revision a0c7c23c9c) [x64-mingw32]

- Gosu (0.15.2 x64-mingw32)

- Visual Studio Code version 1.45.1

Linux Ubuntu 20.04 LTS

- Ruby 2.7.0p0 (2019-12-25 revision 647ee6f091) [x86_64-linux-gnu]

- Gosu (0.15.2)

- Visual Studio Code version 1.46.1

OS X El Capitan Version 10.11.6

- Ruby 2.7.1p83 (2020-03-31 revision a0c7c23c9c) [x86_64-darwin15].

- Gem 3.1.4.

- Gosu (0.15.2).

- Visual Studio Code Version: 1.47.3

Raspbian GNU/Linux 10 (buster)

- Ruby 2.5.5p157 (2019-03-15 revision 67260) [arm-linux-gnueabihf]

- Gem Version 2.7.7Gosu (0.15.2)

- Gosu (0.15.2)

- Visual Studio Code Version: 1.45.0

Methodology

After installing all the tools required to develop on Ruby and using Prototyping Model; A first GUI prototype was developed that prints on the console the buttons of the GUI screen that are simulated on the keyboard.

Figure 1

In the second GUI prototype, it has the same functions as the first, adding a display to the buttons on the screen image, so now, apart from printing the buttons pressed on the console, it also shows a green box on each button indicating which one or which ones. they are pressured.

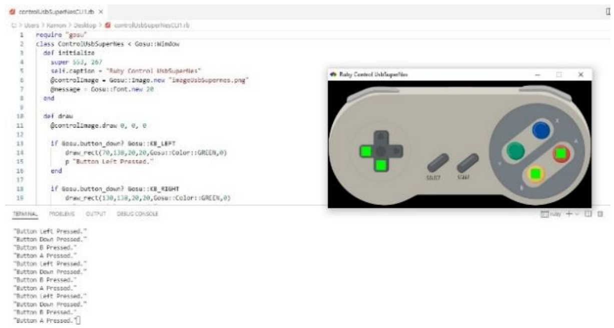

Figure 2

In the third GUI prototype, the printing of buttons on the console is eliminated to place it in the center of the control illustrated on the screen and leaving the display of the buttons of the second prototype which are simulated by the keyboard.

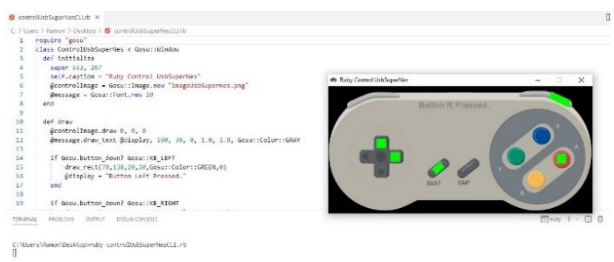

Figure 3

In the final development of the GUI, it has the same elements of the previous visual prototypes, only the keyboard simulation method is changed to SNesUSB command control and code has also been added so that it can run on different operating systems.

Figure 4

Results

Figure 5

Figure 6

The results shall be by section of the article.

Appendix: Code prototype one

```
require "gosu"
class ControlUsbSuperNes < Gosu::Window
  def initialize
    super 553, 267
    @controlImage = Gosu::Image.new
"imageUsbSupernes.png"
  end

  def draw
    @controlImage.draw 0, 0, 0

    p 'Button Left Pressed.' if
Gosu.button_down? Gosu::KB_LEFT

    p 'Button Right Pressed.' if
Gosu.button_down? Gosu::KB_RIGHT

    p 'Button Up Pressed.' if
Gosu.button_down? Gosu::KB_UP

    p 'Button Down Pressed.' if
Gosu.button_down? Gosu::KB_DOWN

    p 'Button B Pressed.' if
Gosu.button_down? Gosu::KB_B

    p 'Button A Pressed.' if
Gosu.button_down? Gosu::KB_A

    p 'Button Y Pressed.' if
Gosu.button_down? Gosu::KB_Y

    p 'Button X Pressed.' if
Gosu.button_down? Gosu::KB_X

    p 'Button Select Pressed.' if
Gosu.button_down? Gosu::KB_SPACE

    p 'Button Start Pressed.' if
Gosu.button_down? Gosu::KB_RETURN

    p 'Button L Pressed.' if
Gosu.button_down? Gosu::KB_L

    p 'Button R Pressed.' if
Gosu.button_down? Gosu::KB_R

  end
end

ControlUsbSuperNes.new.show
```

Code prototype two

```
require "gosu"
class ControlUsbSuperNes < Gosu::Window
  def initialize
    super 553, 267
    self.caption = "Ruby Control
UsbSuperNes"
    @controlImage = Gosu::Image.new
"imageUsbSupernes.png"
    @message = Gosu::Font.new 20
  end

  def draw
    @controlImage.draw 0, 0, 0

    if Gosu.button_down? Gosu::KB_LEFT
        draw_rect(70,138,20,20,Gosu::Col
or::GREEN,0)
        p "Button Left Pressed."
    end

    if Gosu.button_down?
Gosu::KB_RIGHT
        draw_rect(130,138,20,20,Gosu::Co
lor::GREEN,0)
        p "Button Right Pressed."
    end

    if Gosu.button_down? Gosu::KB_UP
        draw_rect(100.7,110,20,20,Gosu::
Color::GREEN,0)
        p "Button Up Pressed."
    end

    if Gosu.button_down? Gosu::KB_DOWN
        draw_rect(100.7,167,20,20,Gosu::
Color::GREEN,0)
        p "Button Down Pressed."
    end

    if Gosu.button_down? Gosu::KB_B
        draw_rect(425,185,20,20,Gosu::Co
lor::GREEN,0)
        p "Button B Pressed."
    end

    if Gosu.button_down? Gosu::KB_A
        draw_rect(478,142,20,20,Gosu::Co
lor::GREEN,0)
        p "Button A Pressed."
    end

    if Gosu.button_down? Gosu::KB_Y
        draw_rect(383,137,20,20,Gosu::Co
lor::GREEN,0)
        p "Button Y Pressed."
    end

    if Gosu.button_down? Gosu::KB_X
        draw_rect(437.5,94,20,20,Gosu::C
olor::GREEN,0)
        p "Button X Pressed."
```

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```
    end

    if Gosu.button_down? Gosu::KB_SPACE
        rotate(50,230,170)
{draw_rect(224,159.5,15,23,Gosu::Color::
GREEN,0)}
        p "Button Select Pressed."
    end

    if Gosu.button_down? Gosu::KB_RETURN
        rotate(50,236,296)
{draw_rect(170,159.5,15,23,Gosu::Color::
GREEN,0)}
        p "Button Start Pressed."
    end

    if Gosu.button_down? Gosu::KB_L
        rotate(65,100,100)
{draw_rect(15,80,15,45,Gosu::Color::GREE
N,0)}
        p "Button L Pressed."
    end

    if Gosu.button_down? Gosu::KB_R
        rotate(295,100,100)
{draw_rect(321,396,15,45,Gosu::Color::GR
EEN,0)}
        p "Button R Pressed."
    end

  end
end

ControlUsbSuperNes.new.show
```

Code prototype tree

```
require "gosu"
class ControlUsbSuperNes < Gosu::Window
  def initialize
    super 553, 267
    self.caption = "Ruby Control
UsbSuperNes"
    @controlImage = Gosu::Image.new
"imageUsbSupernes.png"
    @message = Gosu::Font.new 20
  end

  def draw
    @controlImage.draw 0, 0, 0
    @message.draw_text @display, 190,
30, 0, 1.0, 1.0, Gosu::Color::GRAY

    if Gosu.button_down?
Gosu::KB_LEFT
        draw_rect(70,138,20,20,Gosu::Col
or::GREEN,0)
        @display = "Button Left
Pressed."
    end

    if Gosu.button_down?
Gosu::KB_RIGHT
        draw_rect(130,138,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button Right
Pressed."
    end

    if Gosu.button_down? Gosu::KB_UP
        draw_rect(100.7,110,20,20,Gosu::
Color::GREEN,0)
        @display = "Button Up Pressed."
    end

    if Gosu.button_down? Gosu::KB_DOWN
        draw_rect(100.7,167,20,20,Gosu::
Color::GREEN,0)
        @display = "Button Down
Pressed."
    end

    if Gosu.button_down? Gosu::KB_B
        draw_rect(425,185,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button B Pressed."
    end

    if Gosu.button_down? Gosu::KB_A
        draw_rect(478,142,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button A Pressed."
    end

    if Gosu.button_down? Gosu::KB_Y
        draw_rect(383,137,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button Y Pressed."
    end

    if Gosu.button_down? Gosu::KB_X
        draw_rect(437.5,94,20,20,Gosu::C
olor::GREEN,0)
        @display = "Button X Pressed."
    end

    if Gosu.button_down? Gosu::KB_SPACE
        rotate(50,230,170)
{draw_rect(224,159.5,15,23,Gosu::Color::
GREEN,0)}
        @display = "Button Select
Pressed."
    end

    if Gosu.button_down? Gosu::KB_RETURN
        rotate(50,236,296)
{draw_rect(170,159.5,15,23,Gosu::Color::
GREEN,0)}
        @display = "Button Start
Pressed."
    end

    if Gosu.button_down? Gosu::KB_L
        rotate(65,100,100)
{draw_rect(15,80,15,45,Gosu::Color::GREE
N,0)}
        @display = "Button L Pressed."
```

```
    end

    if Gosu.button_down? Gosu::KB_R
        rotate(295,100,100)
{draw_rect(321,396,15,45,Gosu::Color::GR
EEN,0)}
        @display = "Button R Pressed."
    end

  end
end

ControlUsbSuperNes.new.show
```

USBSNES Ruby Final Code

```
require "gosu"
class ControlUsbSuperNes < Gosu::Window
  def initialize
    super 553, 267
    self.caption = "Ruby Control UsbSupe
rNes"
    @controlImage = Gosu::Image.new "ima
geUsbSupernes.png"
    @message = Gosu::Font.new 20

    if RUBY_PLATFORM =~ /win32/ || RUBY_
PLATFORM =~ /x64-mingw32/
        lsusb_results = `wmic path CIM_L
ogicalDevice where "Description like '%j
uego%'"`
        if lsusb_results.include?("juego
") || lsusb_results.include?("gamepad")
            @display = "Windows - Gamepa
d On"
        else
            @display = "Windows - No Gam
epad"
        end
    elsif RUBY_PLATFORM =~ /linux/
        lsusb_results = `lsusb`
        if lsusb_results.downcase.includ
e? "gamepad"
            @display = "Linux - Gamepad 
On"
        else
            @display = "Linux - No Gamep
ad"
        end
    elsif RUBY_PLATFORM =~ /darwin/
        lsusb_results = `system_profiler
 SPUSBDataType`
        if lsusb_results.downcase.includ
e? "gamepad"
            @display = "MacOS X - Gamepa
d On"
        else
            @display = "MacOS X - No Gam
epad"
        end
    elsif RUBY_PLATFORM =~ /freebsd/
        lsusb_results = `lsusb`
        if lsusb_results.downcase.includ
e? "gamepad"
            @display = "FreeBSD - Gamepa
d On"
        else
            @display = "FreeBSD - No Gam
epad"
        end
    else
        #@display = "Unknown operating s
ystem - No gamepad detected"
    end

  end

  def draw
    @controlImage.draw 0, 0, 0
    @message.draw_text @display, 190, 30
, 0, 1.0, 1.0, Gosu::Color::GRAY

    if button_down? Gosu::GP_LEFT
        draw_rect(70,138,20,20,Gosu::Col
or::GREEN,0)
        @display = "Button Left Pressed.
"
    end

    if button_down? Gosu::GP_RIGHT
        draw_rect(130,138,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button Rigth Pressed
."
    end

    if button_down? Gosu::GP_UP
        draw_rect(100.7,110,20,20,Gosu::
Color::GREEN,0)
        @display = "Button Up Pressed."
    end

    if button_down? Gosu::GP_DOWN
        draw_rect(100.7,167,20,20,Gosu::
Color::GREEN,0)
        @display = "Button Down Pressed.
"
    end

    if button_down? Gosu::GP_BUTTON_0
        draw_rect(425,185,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button B Pressed."
    end

    if button_down? Gosu::GP_BUTTON_1
        draw_rect(478,142,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button A Pressed."
    end

    if button_down? Gosu::GP_BUTTON_2
        draw_rect(383,137,20,20,Gosu::Co
lor::GREEN,0)
        @display = "Button Y Pressed."
    end
```

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```
    if button_down? Gosu::GP_BUTTON_3
        draw_rect(437.5,94,20,20,Gosu::C
olor::GREEN,0)
        @display = "Button X Pressed."
    end

    if button_down? Gosu::GP_BUTTON_4
        rotate(50,230,170) {draw_rect(22
4,159.5,15,23,Gosu::Color::GREEN,0)}
        @display = "Button Select Presse
d."
    end

    if button_down? Gosu::GP_BUTTON_6
        rotate(50,236,296) {draw_rect(17
0,159.5,15,23,Gosu::Color::GREEN,0)}
        @display = "Button Start Pressed
."
    end

    if button_down? Gosu::GP_BUTTON_9
        rotate(65,100,100) {draw_rect(15
,80,15,45,Gosu::Color::GREEN,0)}
        @display = "Button L Pressed."
    end

    if button_down? Gosu::GP_BUTTON_7
        rotate(295,100,100) {draw_rect(3
21,396,15,45,Gosu::Color::GREEN,0)}
        @display = "Button R Pressed."
    end

  end
end

ControlUsbSuperNes.new.show
```

Results and conclusions

A GUI application was developed using the Ruby programming language with the GOSU library, in this application we simulate a control on the screen that when pressed on the remote is also reflected on the screen, indicating by means of green boxes which button is pressed and also indicating in the central part of the screen with text which was the button pressed, prior to the final result there were three prototypes which were giving way to the final result since in the first prototype it only showed the button simulated by the console. keyboard, in the second it illustrated the buttons on the screen and showed them on the console, and the third and last prototype added text in the central part of the screen indicating which button was pressed and reaching the end with an SNes command control USB.

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Block programming to develop interactive activities in the analysis of passive filters using an RC circuit for distance classes

Programación a bloques para desarrollar actividades interactivas en el análisis de filtros pasivos usando un circuito RC para las clases a distancia

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Abstract

Block programming was developed for interactive activities in the analysis of a passive low pass filter using a RC circuit for distance classes. On a breadboard, was integrated an Arduino development board, a potentiometer and a visual indicator (a light emitting diode LED). The development of the programming was carried out using the software LabVIEW to generate an interactive front panel that allows us to manipulate and visualize the calculations, the graphic expressions and at the same time vary at least one passive element. A graphical interface was obtained that allows iterations and immediate calculations for the missing parameters to see the behavior of the filter and also generates a display for the mathematical expression and its Bode plot, the resistance allows us vary the values and make a sweep to locate the angular frequency and activate the light emitting diode connected on the development board. In the programming a web camera was implemented to visualize the circuit in real time at the moment of manipulating a graphical interface.

Filter, Bode, Programming

Resumen

Se desarrolló la programación a bloques para actividades interactivas en el análisis de un filtro pasivo pasa bajas usando un circuito RC para las clases a distancia, En una placa de prueba (protoboard), se integró una tarjeta de desarrollo Arduino, un potenciómetro y un indicador visual (un diodo emisor de luz LED). El desarrollo de la programación se realizó usando el software LabVIEW para generar un panel frontal interactivo que permite manipular y visualizar los cálculos, las expresiones gráficas y al mismo tiempo variar al menos un elemento pasivo. Se obtuvo una interfaz gráfica que permite hacer iteraciones y calcular de forma inmediata los parámetros faltantes para ver el comportamiento del filtro y además se genera un visualizador para la expresión matemática y su diagrama de Bode, la resistencia nos permite variar los valores y hacer un barrido para localizar la frecuencia angular y activar el diodo emisor de luz conectado en la tarjeta de desarrollo. En la programación se implementó una cámara web para visualizar el circuito en tiempo real al momento de manipular la interfaz gráfica.

Filtros, Bode, Programación

Citation: GONZÁLEZ-GALINDO, Edgar Alfredo, CARRILLO-MORENO, Aldo Omar, DOMÍNGUEZ-ROMERO, Francisco Javier and PÉREZ-GARCÍA, Jorge. Block programming to develop interactive activities in the analysis of passive filters using an RC circuit for distance classes. Journal of Computational Systems and ICTs. 2022. 8-21:19-28.

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† Researcher contributing as first Author.

Introdution

Nowadays we can complement teaching and learning with simulators and with some programming programs that allow the way of transmitting the teaching to be more interactive and that the students can call their attention and many of these programs are available some for free due to the agreements of the universities with the companies and others allow you to have access for 30 days. While it is true that before the problem of the global confinement situation arose due to severe acute respiratory syndrome (SARS CoV2), and the disease it causes is called COVID-19(Hoffmann,2019). Nowadays, the way of learning and teaching is carried out by means of information and communication technologies (ICT), learning and knowledge technologies (LKT) and technologies of empowerment and participation (TEP) that are allies of teaching strategies and promoters of active learning processes.

On the other hand, it is essential that their incorporation is mediated by pedagogical reflections, which implies, in turn, a set of decisions in relation to the teaching proposal, while the TAC is the set of reflections and decisions about teaching with the collaboration of digital tools and/or supports, i.e., learning and knowledge technologies. This necessary transition positions these resources as such, tools at the service of teaching and learning, stripped of ends in themselves. In this sense, ICTs imply a change in the position of the teacher and, therefore, in that of the student. It is a matter of working in a scenario where decisions are pedagogical. But it is not enough to master technology, content and didactics; it is necessary to strengthen the work with others. To provide information and communicate to develop skills to select our sources, analyze information, build new knowledge and promote participation. Hence, he calls technologies of empowerment and participation (TEP) those that promote active interventions through the use of ICT (Vidal, 2022).

In the Faculty of Higher Studies Aragon in the area of Physical Mathematical Sciences and Engineering in one of its careers of electrical and electronic engineering, the training of students has been complemented with the use of simulators in the basic subjects and in the specialization subjects, some simulators that have been used in the career of electrical and electronic engineering are: Proteus, Eagle, OrCAD & PSpice, multiSIM, LabVIEW, Mathematics, Matlab(DGTIC, 2019), Mathcad, Language C, Python, Visual Basic, and some simulators or software to develop schematic circuits, programming and simulation online are: Easyeda, DCACLab, MasterPLC, PC SIMU, PartSim, Falstad,Simulator.io, Schematics, Circuit Sims, DcAcLab, EveryCircuit, DoCircuits, PartSim, 123D Circuits, TinaCloud, Spicy Schematics, Gecko simulations, Fritzing, Simduino, TinkerCad, Yenka. In this time where a distance communication has been implemented having present that one way is visual, oral, and written using the tools provided by The University to be communicated with students at a distance.

A. Passive Filter

The filters play an important role today in electronics, they have different applications within the area of health has become very important for the effects in which the COVID19 has driven the development of this type of electronic instruments to amplify the sound of the heart and breathing for diagnostic purposes using a stethoscope using band-pass filters (Birrenkott, 2021). In communications and image processing, as well as in instrumentation and automatic control. These can be classified into analog, digital and hybrid (switched-capacitor, which contains both analog and digital elements) filters. A filter is a two-port device capable of transmitting a limited frequency band. They can be passive or active (Huircán, 2012). Passive filters are built based on resistors, coils and capacitors, Figure 1 shows the Bode diagram in magnitude of a low pass filter if it presents the condition when $0 < \omega c$ allows to pass the signal frequencies and as long as it does not exceed the amplitude of the input signal is maintained but when it crosses the angular frequency or frequency in Hertz begins to suppress and attenuate the amplitude of all higher signals and that region is called rejection frequency.

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When we obtain dB=20log10[H(s)] we can obtain dBrms if we divide by the √2 and we obtain the point of intersection of the -3dB according to Figure 1.

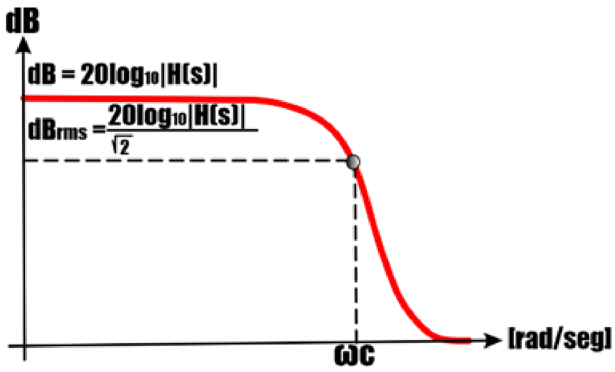

Figure 1 Magnitude Bode plot of a low-pass filter

Considering the system shown in Figure 2, an RC filter in low-pass configuration, the differential equation that governs its behavior can be determined by applying Kirchhoff's laws as well as the voltage drops produced in the resistors and capacitors (fundamental elements of any electronic circuit).

The Laplace transform has several applications. One of the most important is that it allows to solve differential equations in a simple way. Basically, it is a function that transforms a function of a variable t to a variable s (Guelbenzu, 2011). If the Laplace transform is applied to the differential equation that governs the input to output ratio, the filter is characterized by the transfer function of Equation 10. However, the analysis of the schematic circuit yields the equation that satisfies to obtain the Bode diagram in Figure 2 shows the first order passive low-pass filter that only lets through the signals that limits the angular frequency.

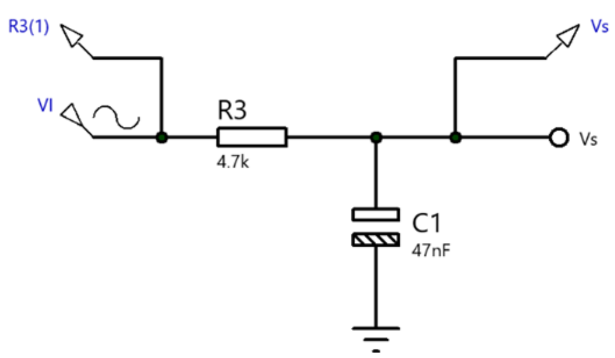

Figure 2 Circuit with passive elements that make up a first order low pass filter, for this case

If we analyze the following circuit Kirchhoff's Voltage Law (KVL Kirchhoff's Voltage Law) we have two equations in the first mesh we have the following:

$$-V_i(s) + V_R + V_c = 0 \quad (1)$$

For the second mesh we have

$$V_s(s) = V_c = \frac{1}{sC} I_c \quad (2)$$

Substituting the variables in Equation 1 in each of the passive elements we have

$$-V_i(s) + RI_R + \frac{1}{sC} I_c = 0 \quad (3)$$

From Equation 3 we assume that the current I_c=I_R=I sby substituting it into Equation 3 and factoring the I we have the following expression:

$$-V_i(s) + I\left(R + \frac{1}{sC}\right) = 0 \quad (4)$$

If I_c=I in Equation 2 to obtain the current at the output of the circuit, the following is obtained:

$$I = sCV_s(s) \quad (5)$$

Substituting 5 in 4 we have

$$-V_i(s) + sCV_s(s)\left(R + \frac{1}{sC}\right) = 0 \quad (6)$$

Doing some algebraic operations, Equation 6 can be represented as follows

$$V_s(s)(sCR + 1) = V_i(s) \quad (7)$$

Now we can express the ratio of the output voltage with respect to the input voltage and finally we have the expression of the transfer function that will allow us to assign values to obtain the angular frequency ω_c n units of radians/second and we can obtain the frequency in units of Hz if we clear it from the cut-off angular frequency ω_c=2πf_c. The transfer function, H(s), of a system or circuit is the ratio of the output, Vs(s), to the input, Vi(s), in the s-domain (frequency domain). The transfer function is very useful for characterizing the behavior, stability and responses of the circuit, The transfer function is a rational function of s, and the denominator of the transfer function is the characteristic equation of the system. The roots of this characteristic equation can be used to determine the stability of the system.

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The roots of the characteristic equation of the denominator are called poles. The roots of the numerator of the transfer function are called zeros. The poles are used to identify the frequencies at which the system will grow without stalling or becoming unstable (Schubert,2018). The transfer function is defined as:

$$H(s) = \frac{V_S(s)}{V_i(s)} = \frac{1}{1+sRC} \quad (8)$$

Another way of expressing the transfer function is as follows

$$H(s) = \frac{V_S(s)}{V_i(s)} = \frac{1}{\left(\frac{1}{RC}+s\right)} \quad (9)$$

If we relate Equation 9 to Equation 10 the angular frequency can be obtained.

$$H(s) = \frac{V_S(s)}{V_i(s)} = \frac{1}{(\omega_c+s)} \quad (10)$$

Then the cut-off frequency is obtained from the following relation

$$\omega_c = \frac{1}{RC}\left[\frac{rad}{ses}\right] \quad (11)$$

To obtain the frequency in units of Hz, we only have to substitute ω_c=2πf_c in Equation 11 and we have the following expression:

$$f_c = \frac{1}{2\pi RC}\ [Hz] \quad (11)$$

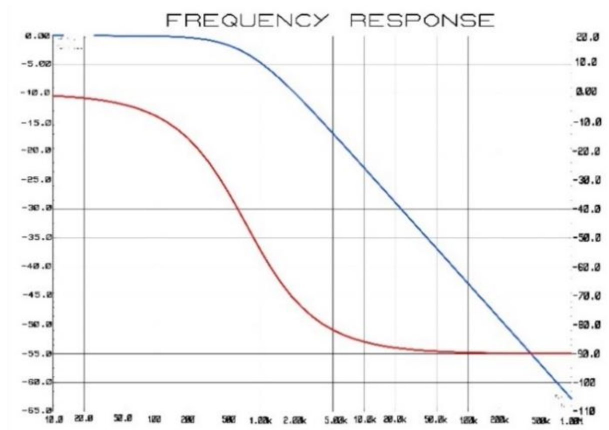
Substituting the values of Equation 10, Equation 11and Equation 12 to obtain the value of angular frequency ω_c and the frequency in Hz and the transfer function.

$$\omega_c = \frac{1}{(4.7 \times 10^3)\,(47 \times 10^{-9})} = 0.00021277\left[\frac{rad}{ses}\right]$$

$$f_c = \frac{1}{2\pi(4.7 \times 10^3)\,(47 \times 10^{-9})} = 748.01\ [Hz]$$

$$H(s) = \frac{V_s}{V_i} = \frac{1}{\left[\frac{1}{(4.7 \times 10^3)\,(47 \times 10^{-9})} + s\right]}$$

$$H(s) = \frac{1}{[0.00021277 + s]}$$



Graphic 1 Magnitude and phase plot of the Bode diagram corresponding to a first order passive low-pass filter and it can be seen that at -3 dB it cuts at 45° with the data of the passive elements of 4.7×10^3 Ω y 47×10^ (-9) F

B. Hendrik Wade Bode

American engineer, researcher, inventor, author and scientist of Dutch descent, Hendrik Wade Bode (December 1905-June 1982) was born in Madison, Wisconsin. His father was a professor of education and a faculty member at the University of Illinois at Urbana-Champaign, he received his bachelor's degree in 1924, at the age of 19, and his master's degree in 1926, both in the field of mathematics, completed his doctorate in physics in 1935 at Columbia University, He is a pioneer of modern control theory and electronic telecommunications, revolutionized both the content and methodology of his chosen fields of research. In 1938 he made important contributions to the convergence of mathematics, information theory, telecommunications, control theory and electronic design, and was hired by Bell Laboratories in New York City, where he began his career as a designer of electronic filters and equalizers. In 1938 he made important contributions to the theory of control systems and mathematical tools for stability analysis of linear systems. He developed the asymptotic phase-magnitude diagram that bears his name, the Bode diagram, which clearly showed the frequency response of systems. Innovative methods for investigating system stability using the frequency domain. gain and phase margin concepts derived from his now famous diagrams.

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The method is based on the observation that a logarithmic representation of magnitude (in dB) is additive in the elementary factor contributions of poles and zeros in the transfer function, and the observation that the instability of a feedback system is generated by positive feedback (i.e., a phase difference of 180 degrees or more at some critical frequencies), an estimate, which is obtained by comparing the magnitude plot with the corresponding phase plot. Although the method has good engineering properties and is very useful for the initial design of a (linear time invariant) system (such as an amplifier), it suffers from a lack of generality (Bode diagrams can only be derived fairly accurately for simple systems), allows quick and easy evaluation, and provides a sometimes surprisingly accurate estimate of stability. Bode had a good working relationship with Harry Nyquist, who was able to derive an accurate criterion for the stability of a system based on its frequency response. But perhaps he made his most important contributions at the beginning of World War II, with the development of a fully automatic anti-rocket defense system. It was a sophisticated example of Artificial Intelligence. The system successfully defended London from V-1 flying bombs during World War II. After the war, Bode along with his wartime rival, Werner von Braun, developer of the V-1 flying bomb and later the father of the U.S. space program, served as members of the National Advisory Committee for Aeronautics (NACA), the predecessor of NASA During the Cold War, he contributed to the design and control of missiles and anti-ballistic missiles. When he retired in October 1967, he held a total of 25 patents in various areas of electrical and communications engineering, including signal amplifiers and ordnance control systems. Shortly after retirement, Bode was elected to the prestigious position of Gordon McKay Professor of Systems Engineering at Harvard University. During his tenure there, he conducted research on military decision-making algorithms and optimization techniques based on stochastic processes, which today play an essential role in modern control and estimation theory (Mitra, 2021).

The year 1960 is considered as the beginning of the modern era for nonlinear control. This is the same time when the first congress of the International Federation of Automatic Control (IFAC) was held in Moscow, which brought the theory of mechanics and Nyquist-Bode's feedback theory closer together to create the current control theory (Iqbal,2017).

Bode also studied the asymptotic representation of frequency response (Nuñez, 2021). The Bode magnitude diagram plots the modulus of the transfer function (gain) in decibels as a function of frequency (or angular frequency) in logarithmic scale. It is often used in signal processing to show the frequency response of a linear and time invariant system (Sanchez, 2022). We can find nowadays several applications with RC and RL filters in areas ranging from electronics to mechanical engineering, but also as a modeling approach for these same areas. The unit of measurement known as decibel, or dB, is often adopted to characterize the properties of liters. Its name means one tenth of a belio, which is itself a tribute to Alexander Graham Bell. Basically, the decibel is used to express the logarithmic ratio or gain between two quantities of power (DA, 2021). Filters have been applied in different areas such as biology by developing functionalized molecular layer neuro-electronic interfaces for electronic components and biological objects plays a crucial role for the success of bioelectronic devices (Wolf, 2021).

C. Data acquisition

DAQ data acquisition is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure or sound. A DAQ system consists of sensors, DAQ measurement hardware, and a PC with programmable software. For more than 30 years, NI PC-based DAQ devices have set the standard for accuracy and performance. Measurement accuracy is arguably one of the most important considerations when designing any data acquisition application (NI, 2021). There are various data acquisition boards which are inaccessible and expensive in the market to develop research projects, that is why development boards have been used which have enabled to carry out academic works for teaching-learning and research in various areas, these boards are economical so that students, academics and researchers can be within their reach, but also particular cards have been developed as an example, we can observe the work of Skulski, Ruben and BenZvi in the creation of a device, called Femto DAQ for the acquisition and processing of signals by SiPM for the HAWC ('High-Altitude Water Cherenkov') Observatory (Duarte, 2019).

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Another example of applications where a development board has been implemented is in the measurement of parameters that are necessary to evaluate the performance of solar panels, ambient temperature and sunlight intensity can also affect the performance and efficiency of the panels to know certain parameters are implemented sensors an Arduino connected to the PLX-DAQ can be a solution to obtain measurement data and acquire output data from the solar panel performance(Supriyono, 2022). Many academic and research projects are being carried out with a software Parallax Data Acquisition Tool (PLX-DAQ) linked to Microsoft Excel to acquire up to 26 channels of data from any microcontroller Parallax provides easy spreadsheet analysis of data collected in the field, laboratory analysis of sensors and real-time monitoring of equipment (Parallax, 2022).

Implementing a form of virtual and interactive teaching-learning is much better because the teacher has the freedom of teaching that allows them to develop and use available tools without depending on a platform that allows them to access or use programming languages, although it is true that it was a challenge to use new distance learning platforms using programs that some academics did not know, if we implement already known tools together with what was learned during the confinement and if we add that the academic uses programming language tools and pay the subscription to a server, it becomes more chaotic as mentioned by Ortega (2022), nowadays the implementation of a virtual laboratory is an important factor in the understanding of analogue system simulations in online education and helps to achieve the teaching objective for which it was implemented. The integration of a website developed in the languages of HTML, CSS and PHP, according to the author it is observed that 90% of the respondents believe that the implementation of the virtual laboratory is useful for learning analogue systems, 85% state that the interface of the laboratory website is user-friendly and intuitive, and 80% consider that the operation of the virtual laboratory with the execution of the simulators is efficient (p. 79, 81).

Sometimes the surveys do not allow to observe a real result, the students must visualise in real time the simulation, the physical connection, the acquisition of data and the measurements of the physical variables in that way it is motivating for the student to observe the behaviour of the experimental arrangement that is being tested in that instant and at a distance, as are the electronic instruments that are developed in the case of the career of electronic electrical engineering. There are didactic programmes that are excellent for implementation in subjects where only the theoretical part is taught, so that students can understand some concepts or definitions that allow them to develop the reasoning that leads to problem solving, but in some careers the theoretical-practical complement becomes fundamental as students use creativity and innovation in the development of technologies in the area of Physical Sciences - Mathematics and Engineering. There are some points of view as Sotomayor (2022) mentions that one of the possible weak points that I find in my innovation is its fundamentally practical character, since it is too big a break in relation to the way philosophy is commonly taught. Based on this, I consider it necessary to observe rigorously how it is given in practice, since it is possible that on many occasions the activities deviate from the central theme and to a certain extent the teaching of properly philosophical content is lost (p. 72).

In this work, a block programming software called LabVIEW was used to generate an interactive graphical interface using an Arduino development board and a webcam to visualise in real time the manipulation of a passive element and generate iterations to calculate the parameters and generate the Bode diagram, during the online class modality to complement the theoretical-practical knowledge in teaching-learning, in the Electrical and Electronic Engineering Degree.

Objectives

A block programming will be developed for interactive activities doing passive filter analysis using an RC circuit, applied to distance learning classes with a development board that allows the generation of the Bode diagram and visualisation of the mathematical model.

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Hypothesis

The challenges and challenges in recent years for university academics of the Electrical and Electronic Engineering course at the Faculty of Higher Education Aragon at the National Autonomous University of Mexico, to transmit the knowledge of teaching-learning during this health contingency of SARS CoV2 severe acute respiratory syndrome. If interactive programming is developed that can capture the attention of the students at the end of the theoretical analysis, then they will be able to understand how the passive filters behave with the RC circuit, and the option to vary at least one passive element using a development board, to generate a sweep and modify the cut-off frequency in the Bode diagram is displayed on a front panel.

Methodology and development

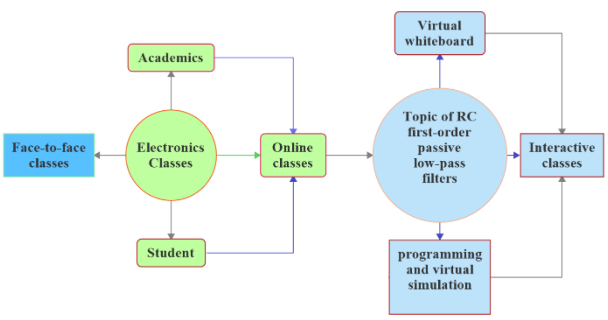

Figure 3 Procedure to generate interactive classes using the tools to generate teaching-learning for the students of the Electronic Electrical Engineering course at FES Aragón

Figure 4 shows how to enable the webcam, for this you need to be in the work area of the block diagram, and the following path is required to locate it Vision and Motion and then select Vision Express and select Vision Acquisition, and in the image output option all you do is select an indicator that will allow me to see in real time the image generated by the webcam in the front panel area and this arrangement is placed within a While Loop.

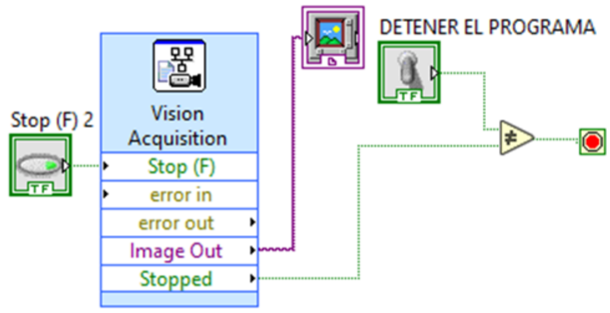

Figure 4 Wiring diagram to enable the camera to make a classroom interactive so that students can see how the theory is physically displayed and see how the electronic components can be manipulated

To generate the Bode diagram in magnitude and phase, it is necessary to obtain an arrangement that allows to introduce the coefficients that are going to generate the polynomial of n order, both in the numerator and in the denominator that conforms the transfer function, to generate these connections, as shown in Figure 5, before introducing these values of the coefficients, an arrangement must be generated, These blocks are found in the option of the block diagram area in Control and simulation in the option Model construction and we select the blocks to generate the programming, so that this arrangement can show the graphical interpretation, you must go to the frequency response folder and select the CD Body block. Vi

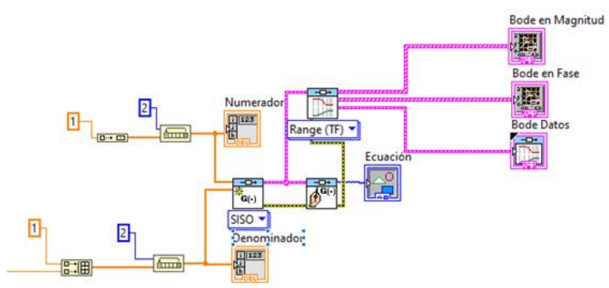

Figure 5 Connection diagram to generate the Bode in magnitude and phase of the low-pass filter and express it graphically on the front panel

In the formula diagram it is possible to introduce the mathematical equations to calculate the angular frequency of cut-off and its respective frequency in units of Hz. It can be helped with a coefficient with the name of the variable A that multiplies the part of the denominator of the polynomial function to introduce it in the arrangement to generate the transfer function and using the blocks of condition operations the value will be placed to generate the sweep and locate the angular frequency that is being sought, as can be seen in Figure 6.

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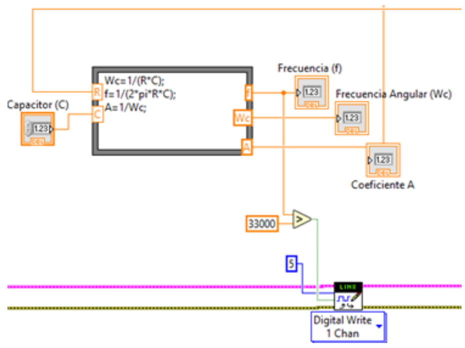

Figure 6 Wiring diagram for the calculations of Hz frequency and angular frequency and transfer function coefficient

The simulation of the variation in the increase of the resistance value was done using the mathematical operation blocks to multiply the data logarithmically as shown in Figure 7, these will be obtained from the development board by introducing a variable resistor in the pin of the analogue port A0 where a variable resistor will be connected.

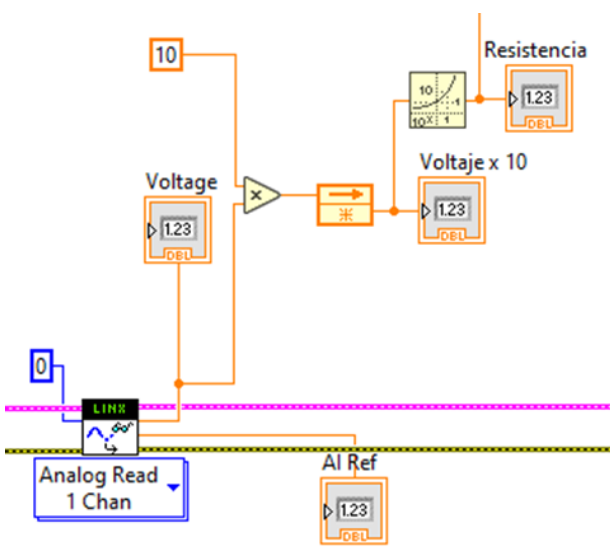

Figure 7 Wiring diagram to obtain the change of the resistor value to sweep the angular frequency to the left or right side, by setting the capacitor value constant

To interact with the Arduino development board within the block programming in LabVIEW is used the tool called Digilent LINX is the successor of LabVIEW Interface for Arduino. Both packages are from the same software author who recommends migrating to LINX. LINX is designed to be a more generic hardware abstraction layer for embedded devices, rather than being designed for a single specific microcontroller platform (NI Engineer, 2021).

It is required to download to integrate it to the tool of the block diagram that allows to configure the programming, as well as the Firmware and the development board works as an interface or as a data acquisition board as shown in Figure 8, to generate the arrangement is important that when selecting the Open option is required to generate a control that allows to select the port where it is linked to the development board in case of omitting this option when running the program will not be sent the instructions required by the user will send the card for operation.

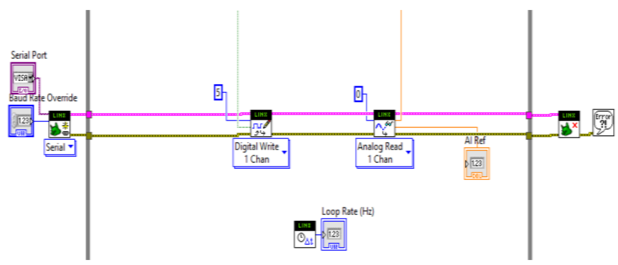

Figure 8 Connection diagram for using the Arduino development board using LINX to operate as a data acquisition board, enabling digital port 5 and analogue input A0, setting the USB port selector and the baud rate for digital transmission of the communication

Results

The importance for the student to observe both the calculations and the mathematical model, the graphical interpretation of an electronic circuit and to see a schematic circuit of a first order passive low pass filter RC. By programming all the variables in the block diagram and displaying on the front panel as shown in Figure 9, the transfer function is recorded on this panel, The values entered for the passive element, in this case the capacitor, are proposed and the value of the resistance will be entered externally with the potentiometer to be able to sweep the frequency and activate a light emitting diode which will indicate that the previously programmed cut-off angular frequency has been located and it will be seen how the bode diagram varies in magnitude and phase and the data when the signal is introduced into the analogue port of the Arduino development board.

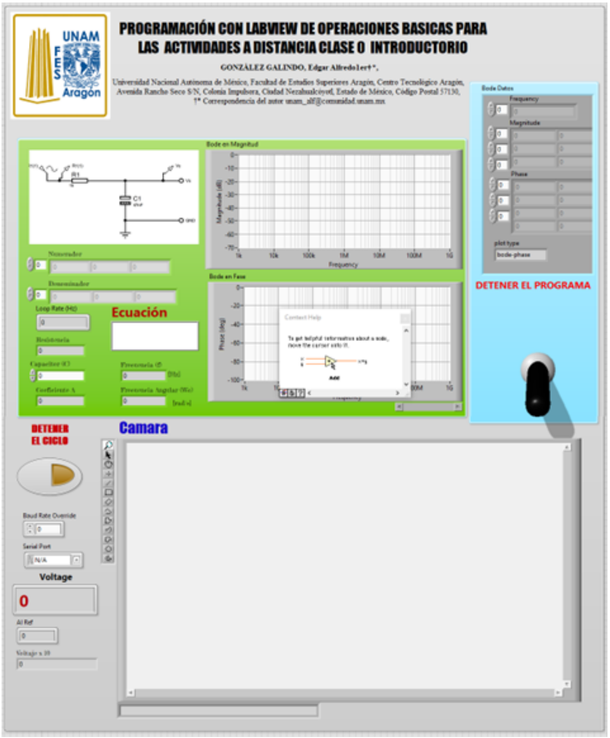

Figure 9 Front panel to develop interactive teaching and learning where we can show the mathematical analysis and graphic expression, as well as the display for the connection of the electronic circuit through a webcam

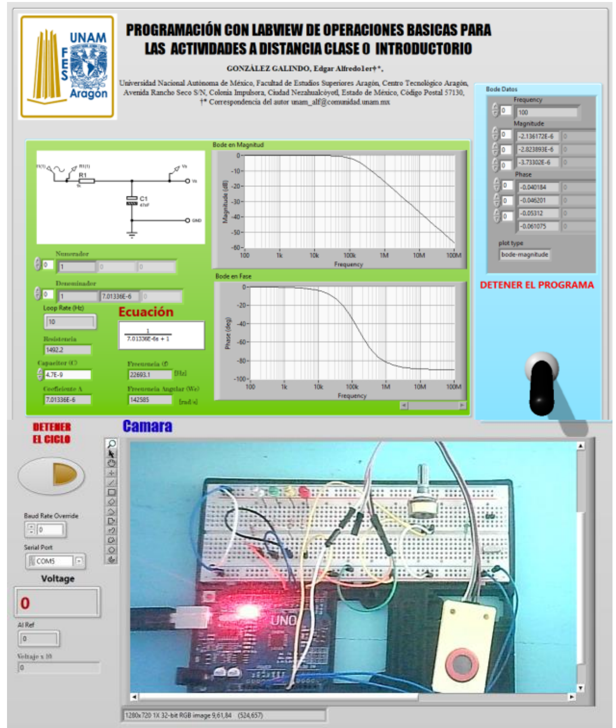

Figure 10 Final development front panel for visualisation for interactive knowledge sharing for online teaching-learning of the Electrical and Electronic Engineering course at the Facultad de Estudios Superiores Aragón

On the front panel of Figure 10 when running the program, the value of the capacitor is introduced using the scientific notation expression and the resistance is a data that is entered externally as seen when the webcam is activated. On the test board (protoboard) is placed a variable resistor (potentiometer) and on one side are also placed an array of light emitting diodes (LED'S) will indicate at the exact moment that has been obtained the angular frequency of cut-off of this particular filter, In this way the students not only observe a schematic circuit figure but also see how it interacts and how more information can be obtained when it is simulated through virtual programming. This way of complementing teaching-learning motivates students to develop their imagination and creativity applied to electronic circuits.

Implement an interactive way of teaching to show the knowledge in a visual way and that through a card of economic development and easy access for all students, allows to develop block programming once, to manipulate and calculate through iterations and locate the angular frequency or frequency in Hz making a sweep and get the data and to express it graphically so that students can alter the data and obtain an infinite number of values of a passive element that can be purchased commercially, This type of programming is more interactive and the student can easily change the data and enter it from his monitor as if he had an electronic instrument to generate and calculate passive filters.

Conclusions

90% of the students who took the class in a virtual and dynamic way managed to understand the subject in a theoretical-practical way. This way of carrying out the teaching-learning the student can develop in real time the activity both virtual and physical. We were able to develop block programming and link it with the Arduino development board to send and receive instructions by configuring the analogue-digital input.

A webcam was programmed so that the students can see the interaction between the front panel and the Arduino development board in real time. The mathematical expression and the graphic expression of the Bode diagram of the RC passive low-pass filter and the calculations developed through block programming to generate a sweep and locate the previously programmed frequency and visualise it with a light-emitting diode were obtained.

Acknowledgements

The authors would like to thank the Coordination of the Technological Centre of the Facultad de Estudios Superiores Aragón and the Electrical and Electronic Engineering Department of the Universidad Nacional Autónoma de México, for the facilities in the use of tools provided through agreements with different software companies.

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Microcontroller lab with remote connectivity and control of virtual instruments

Laboratorio de microcontroladores con conectividad remota y control de instrumentos virtuales

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Abstract

This article shows a learning alternative for undergraduate engineering students, who due to force majeure do not attend their practices or projects in a face-to-face manner in the subject of microcontrollers. This guarantees a hybrid teaching-learning process, where students can interact remotely with control boards located in laboratories and workshops. To achieve this task, the syllabus of this subject was consulted, a series of practices were selected and with them the use of graphical interfaces for visualization and control of virtual instruments was developed, which through a USB-Serial RS232 adapter communicates with the transmission (Tx) and reception of data (Rx) ports of the PIC18f4550 microcontroller, thus allowing control actions on output actuators. Finally, the remote connection is made, through the NodeMCU development board based on the ESP8266 chip and a mobile application developed in Blynk, allowing the student to learn in a more didactic way. The implementation of this type of alternative is intended to ensure quality education at the higher level, in situations where students do not have the availability to attend the facilities of their academic institution.

Virtual control, Remote connectivity, Microcontrollers, RS232, NodeMcu Esp 8266, Blynk

Resumen

Este artículo muestra una alternativa de aprendizaje para los estudiantes de ingeniería de pregrado, que por fuerza mayor no asisten a sus prácticas o proyectos de manera presencial en la asignatura de microcontroladores. De esta manera se garantiza un proceso de enseñanza-aprendizaje híbrido, donde los estudiantes pueden interactuar de manera remota con tableros de control ubicados en laboratorios y talleres. Para lograr este cometido, se consultó el temario de esta asignatura, se seleccionaron una serie de prácticas y con ellas se desarrolló el uso de interfaces gráficas para la visualización y control de instrumentos virtuales, que a través de un adaptador USB-Serial RS232 se comunica con los puertos de transmisión (Tx) y recepción de datos (Rx) del microcontrolador PIC18f4550, permitiendo así acciones de control sobre los actuadores de salida. Por último, se realiza la conexión remota, a través de la placa de desarrollo NodeMCU basada en el chip ESP8266 y una aplicación móvil desarrollada en Blynk, permitiendo al alumno un aprendizaje más didáctico. Con la implementación de este tipo de alternativas se pretende garantizar una educación de calidad en el nivel superior, en situaciones en las que los estudiantes no tienen la disponibilidad de asistir a las instalaciones de su institución académica.

Control virtual, conectividad remota, Microcontroladores, RS232, NodeMcu Esp 8266, Blynk

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Introdution

The evolution of technology has allowed many advances in different fields of science. One advance that has had a great impact on the lives of human beings is undoubtedly the "Internet of Things". Often in automated processes, remote operation is required, so the use of graphical control and visualization interfaces connected to the cloud, provide a fast and efficient solution to this problem [1-3]. This type of system is not only required in the industrial field. For example, a simple home automation system [4], gives us absolute control remotely, with this we can control electronic devices and monitor the place constantly. The control and monitoring system can be improved depending on the needs of users, resulting in a more robust system, incorporating control cards such as RaspBerry Pi Pico [6]. A more revolutionary application would be the implementation of home health systems [7,8], where family members of sick, elderly, or disabled people can have some independence in their daily activities. Although the incorporation of the internet of things in the home environment is of great importance, we can observe various sectors in which its implementation significantly helps society. As can be seen in the implementation of non-invasive devices in students to measure factors that affect their academic performance [9], the remote control of a robotic arm through Labview and Solidworks platforms with a constructivist approach to learning [10], the structural monitoring of buildings, through the Arduino Mega board and the Labview graphical interface, controlled remotely through a mobile application in Data Dashboard [11]. This article shows the incorporation of a graphical control and visualization interface in Virtual Instruments so that engineering students can develop laboratory practices of the microcontroller subject remotely, employing the Team Viewer platform. This learning alternative does not seek to replace traditional learning, where students are physically present in laboratories and workshops to develop practices and projects, since a direct experience with the physical elements and face-to-face interaction with team members always provide the learner with the maximum experience and significant quality learning, however, it can be implemented in cases where students do not have the opportunity to present themselves.

The resolution of this problem has a great impact since in the face of extreme situations such as the COVID-19 pandemic that hit the world this 2020 (WHO), it is of vital importance to seek solutions in the educational field, to avoid the backwardness of students in the medium and long term. This article is structured in 4 sections, the first one being the introduction. Section 2 shows the materials and methods used to solve the problem. Section 3 shows the results obtained and the discussion. The last section presents the conclusions of the work. Additionally, the references used throughout the paper are shown.

Objective

Implement a remote microcontroller laboratory using virtual instruments.

Methodology

The implementation of a remote microcontroller laboratory is very useful in the teaching-learning process since many applications are currently possible thanks to the programming of these electronic devices. Virtual instruments in the LabView platform, on the other hand, offer us the creation of graphical interfaces, where the user can visualize and control physical actuators. Linking the virtual objects created in this platform through the RS232 communication protocol and controlling the process from a mobile application developed in Blynk, it is possible to carry out practices and projects of great impact.

Graphical interfaces with virtual instruments

LabView of National Instruments gives us the facility to program employing blocks and has 2 environments. The first one is the front panel, where virtual objects can be placed (indicators, text messages, push buttons, bars, etc.) Figure 1. The second one allows us to program these objects, to establish control algorithms, depending on the desired application, as shown in Figure 2.

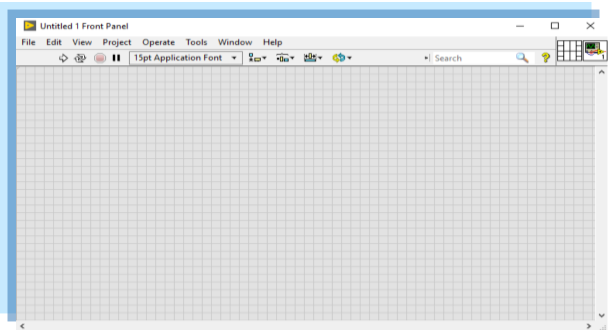

Figure 1 Front panel for displaying virtual

Instruments

LabView interfaces can be created only by simply dragging the components from the libraries where they are located. The complexity of the front panel design depends on the resources available to the programmer, so there are several ways to achieve the same result.

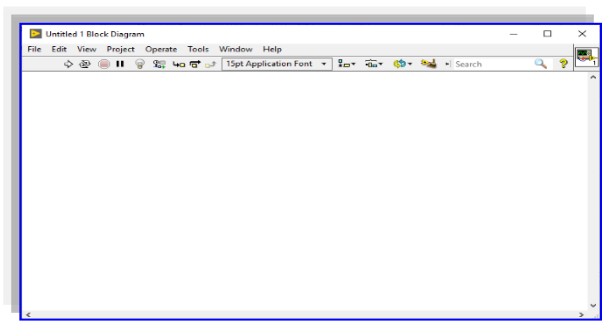

Figure 2. Programming environment

The following is the graphical interface of the on-off control of a direct current motor Figure 3. There are 2 push buttons (one for starting and one for stopping the motor), an indicator that lights up when the start button is pressed, and a display labeled "STATUS" that defines the status of the motor (if it is on it shows the message "MOTOR ON", if it is off it shows the message "MOTOR OFF") and finally an animation made with several images overlaid and programmed in such a way that they show a movement effect when the start button is pressed.

Figure 4 (a and b) shows the block diagram that allows the on-off control of the direct current motor. It can be seen that the variables of the front panel and the block diagram must match the name, s that LabView can associate them correctly and not generate errors when compiling.

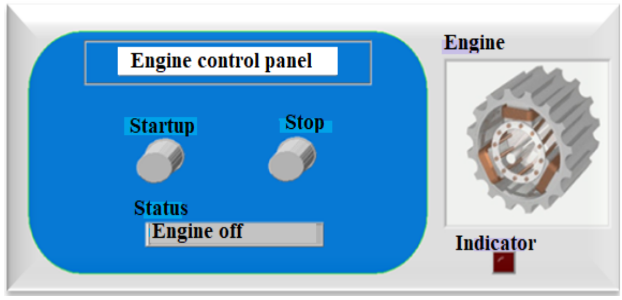

Figure 3 The graphical interface of the on-off control of a direct current motor

Figure 4 Block diagram of the on-off control of a DC motor (a) first part, b) second part

Serial Communication

The communication between LabView and the control board described in section 2.2 is done through the transmission and reception of serial data. The transmission is asynchronously done in 1-byte packets, as shown in Figure 6. We can see that the communication protocol starts with a Start bit, which goes from a high to a low voltage logic signal. Then the data transmission is performed at a certain frequency or speed (Baud Rate), after the transmission of the data packet there may be a parity bit, which is used for error detection in the process of sending and receiving, and finally the communication is closed with a stop bit. The process is repeated continuously as long as there is data on the communication bus.

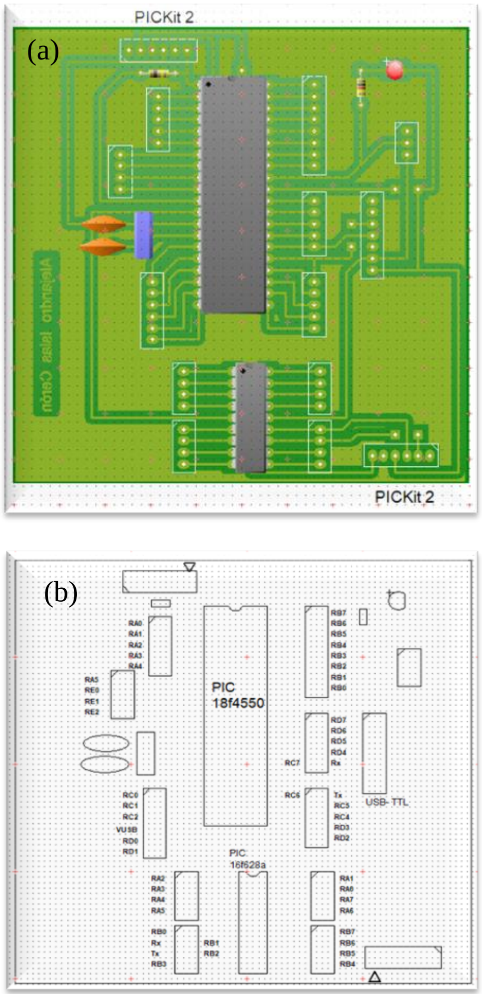

Figure 5 (a) Printed circuit board layout.(b) Printed circuit board pin layout

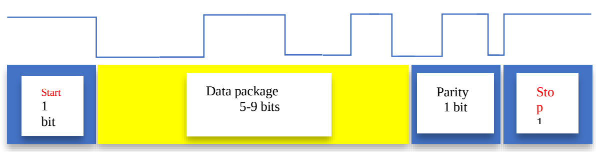

Figure 6 Data sending and receiving protocol

The physical connection is achieved through a USB - TTL device as shown in Figure 7 (a), which allows data transmission and reception through two Dupont cables connected to the Tx and RX terminals. Figure 6 (b) shows the typical cross configuration between the USB - TTL adapter and microcontrollers. It is important to note that for the serial communication to be successful, GND must be bonded on both sides of the connection between devices.

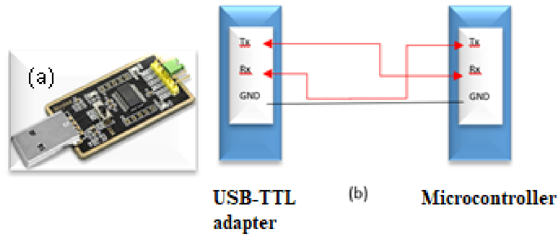

Figure 7 (a) USB to TTL adapter, (b) Physical connection between devices linked by serial communication

Configuration of serial communication in Labview

To communicate the control board with the LabView graphical interface, virtual serial communication objects are used, located in the following path. Instrument I/O, Serial, as shown in Figure 8. Once the virtual instruments are located, locate the "VISA Configure Serial Port". Drag it to the work environment and proceed to configure it based on the parameters of section 2.3. Figure 9 shows in more detail how the block is configured.

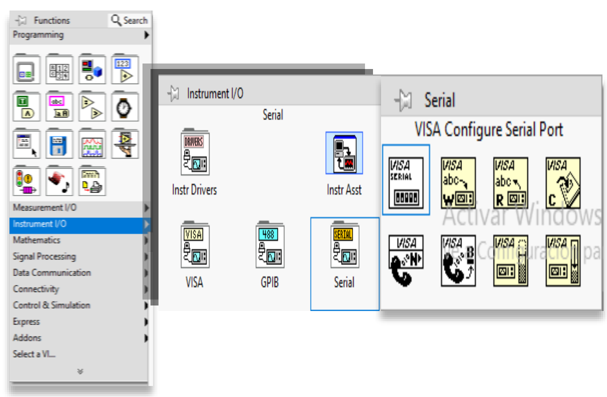

Figure 8 Location of virtual serial communication objects in LabView

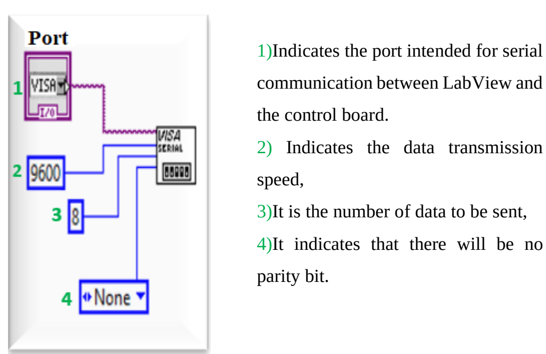

Figure 9 Serial port configuration

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Remote control by means of the NodeMCUdevelopment board based on the ESP8266 chip and the mobile application developed in Blynk

For remote control of the electronic devices, the NodeMCU development board based on the open source ESP8266 SoC and a mobile application developed in Blynk were used. The pinout of the ESP8266 NodeMCU board is shown below (Figure 10).

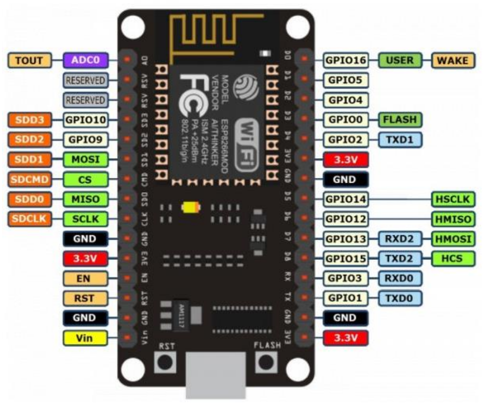

Figure 10 Pinout of the NodeMCU development board based on the ESP8266 chip

It can be seen in the Pinout that the board has basic tools similar to those of Arduino, which allows us to develop practices and projects simply. It contains GPIO pins (general purpose Input/Output) which allow us to control digital input and output signals, it also has analog pins, serial communication (Tx, Rx), I2C, and SPI communication. The board has an integrated microcontroller with 32-bit architecture and a Wi-Fi antenna that allows connection to the Internet.

This last feature allows us to develop projects focused on the Internet of Things (IoT), programming from the Arduino IDE, as was done in this project.

It is important to emphasize that the boards focused on IOT work regularly at logic voltages of 3.3 V, so if you want to develop projects where there is an integrated that serves as an intermediary with different voltage levels in their inputs and outputs, you must use a CD-CD converter. For example, a bidirectional voltage converter, to perform the conversion of logic levels between the Pic 18F4550 (5V) and the NodeMCU board (3.3V).

Blynk is an IOT platform that allows connecting devices to the cloud and provides a graphical interface for visualization and control, where the user can create their remote-control boards, through virtual instruments defined by the application (Widgets). Each widget can be configured as a controller or as a graphical element. In controller mode, a physical GPIO pin is assigned to the Widget, so when sending any logical voltage signal, it is directly reflected on the pin of the board. In graphic mode, we can activate, deactivate, write and delete values to the virtual instruments from the IDE programming, so we can observe LEDs turning on and off, level bars, increasing or decreasing, etc.

Results

By integrating the LabView graphical interfaces with the serial communication protocol, a correct data flow could be observed. For this analysis, a simple circuit was used, consisting of a switch and the serial communication terminal as shown in Figure 11 (a). Opening the block diagram, it was possible to observe in Figure 11 (b) the programming of the virtual instruments.

Figure 11 (a) The graphical control interface of a simple circuit in Labview, (b) Block diagram of a simple circuit in Labview.

At the moment of connecting our control card employing the USB-TTL adapter, a COM was automatically generated, which allowed the communication with Labview. In the case of the example, when we connected it, we could see in Figure 11 (a) the COM1. To corroborate that the communication was successful, the "Highlight Execution" function was used to visualize the data flow throughout the simulation. Figure 11 (b) shows that the communication between Labview and the control board was successful, since, from the port configuration to the closing block, the serial communication was preserved. This was easily corroborated by the labels marked "OK" along the error detection lines.

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We also note in the circuit that there is a block for writing character data that depends on the state of the switch. The data that was added to the serial bus was 'c' and 'd'. From the mobile application created in Blynk, it was possible to control the position of the switch and thus the voltage output of pin D2. The front panel of the application, as well as the programming in the Arduino IDE of the ESP8266 NodeMCU board, are shown in Figures 12 and 13 respectively.

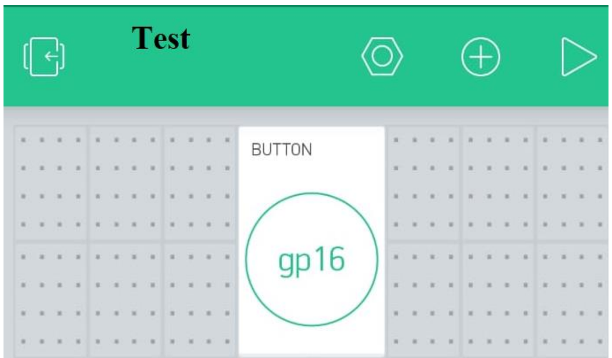

Figure 12 Control interface developed in Blynk

```
#define BLYNK_PRINT Serial


#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "1ZbR0pMD1jdmiQA17xFord9bcA7cq42m";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "INFINITUM639D_2.4";
char pass[] = "k65R59eD3s";

void setup()
{
  // Debug console
  Serial.begin(9600);
  pinMode(16,OUTPUT);
  Blynk.begin(auth, ssid, pass);
}

void loop()
{
  Blynk.run();
}
```

Figure 13 Shows the resulting code, which allowed the control of the widget labeled "BUTTON" created in Blynk.

The resulting microcontroller program using Necto Studio is shown below.

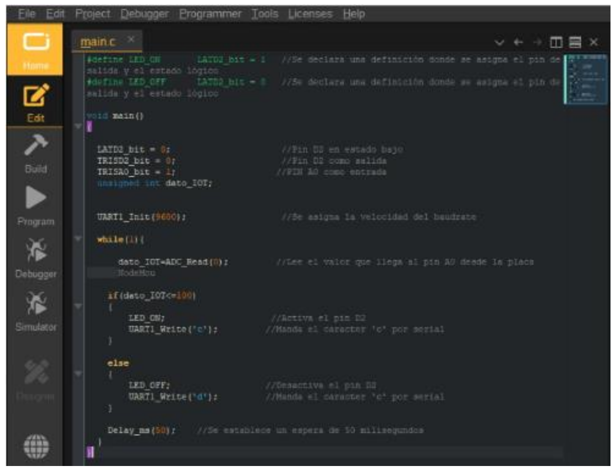

Figure 14 Program in Necto Studio of a simple circuit

Once the mobile application was linked to the NodeMCU board, the data was sent to the PIC18F4550, considering the transformation of voltage logic levels. In this example, the analog channel input of the microcontroller was used to receive GPIO 16, so when a signal greater than 100 was received on channel A0, the LED connected to pin D2 was activated and a 'c' was sent by serial. Otherwise, the LED was turned off and a 'd' was sent serially.

The electrical connection diagram using Fritzing is as shown in Figure 15.

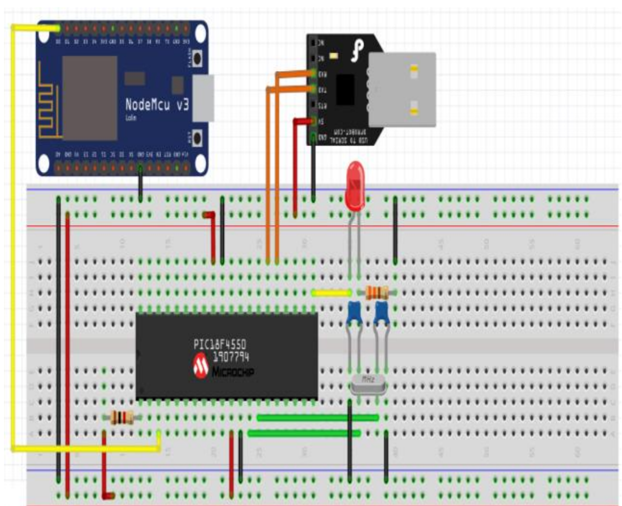

Figure 15 Electrical diagram using Fritzing

The programs in Necto Studio and the Arduino IDE were compiled without errors and allowed reading and writing of the data sent to Labview and received from the mobile application.

On some devices, it was observed that the control board did not show any response, but this problem was solved by installing the CP2102 driver.

It is also important to add that to avoid any error in Labview, the NI-VISA and NI Serial libraries must be downloaded, otherwise, the proper connection will not be achieved.

Conclusions

The implementation of applications focused on the Internet of Things (IoT), allows students to perform practices and projects remotely, strengthening the teaching-learning process. To achieve interaction with the physical elements of the laboratory, we need a control card connected to our computer. Labview facilitates the creation of graphical control and visualization interfaces. To link the virtual objects created on the Labview front panel with physical pins on the control board, communication protocols are used. Using a USB - TTL adapter, data can be easily transmitted serially from Labview to the control board. It is important to know the logic voltage level that the integrated units admit in their inputs and outputs to avoid damaging them and to communicate correctly with other elements that work at different logic levels. For the successful communication of the Pic18F4550 and the NodeMCU board, a bidirectional converter (5-3.3V) or the use of analog channels for reading was used.

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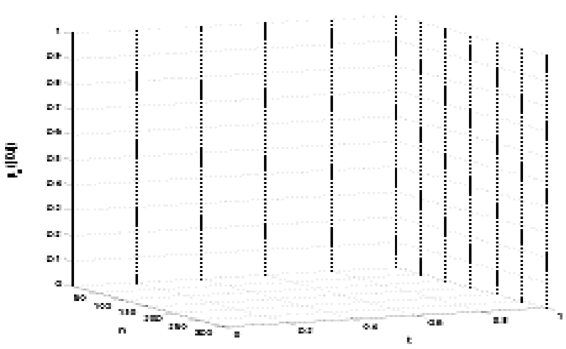

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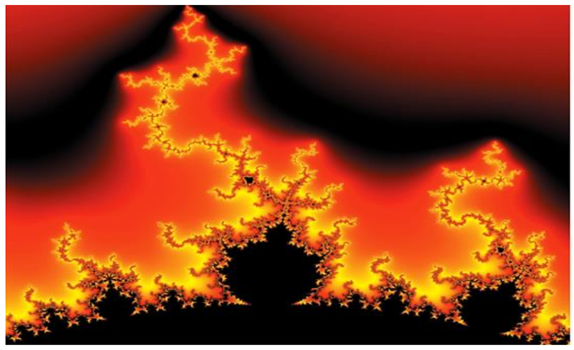

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