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Hasta el momento se han editado obras que abarcan distintos campos del conocimiento científico-tecnológico y han constituido aportes para los diferentes sectores de la comunidad nacional e internacional.

La principal motivación de la Editorial es recoger y difundir los conocimientos relevantes en ciencia y tecnología, llevándolos a los sectores de la comunidad que los requieren.

La revista *Tecnología en Marcha* es publicada por la Editorial Tecnológica de Costa Rica, con periodicidad trimestral. Su principal temática es la difusión de resultados de investigación en áreas de Ingeniería. El contenido de la revista está dirigido a investigadores, especialistas, docentes y estudiantes universitarios de todo el mundo.

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TECNOLOGÍA en marcha

Contenidos

Presentation

On behalf of the organizing committee of **IEEE Latin American Electron Devices Conference (LAEDC) 2021** we would like to welcome you to the third edition, which has been planned and organized this year as a virtual event given the challenging circumstances, we all are facing all over the world due to the Covid-19 pandemic.

LAEDC is the Flagship conference for EDS in Region 9 and offers an enriching opportunity to learn about many of the fields related to Electron Devices and novel technologies with more than 65 technical presentations, including 3 keynote lectures, 30 invited speakers, 30 scientific papers, a free of charge MOS-AK workshop, 12 poster presentations, and 2 panel sessions in topics related to Humanitarian Technology, HAC, and Women in Engineering, WIE.

The Conference is growing with worldwide participation with presentations from 27 countries and with the full financial sponsorship of the IEEE Electron Devices Society (EDS). It is primarily geared for students as well as young researchers, with the main goal of bringing together specialists from all Electron Device related fields.

This special issue is focused on the posters related to EDS topics and humanitarian projects developed in Latin America presented at the conference.

We are confident that thanks to your active participation and tangible contributions your attendance will significantly add to the value of the conference and motivate research groups and young students in the field of Electron devices.

Sincerely,

Esteban Arias-Méndez
Posters & Projects Chair, IEEE LAEDC 2021
Instituto Tecnológico de Costa Rica
EDS Costa Rica

Mario A. Aleman
General Chair, IEEE LAEDC 2021
EDS Nicaragua

Fault diagnosis with states estimation in PV systems

Diagnóstico de fallas con estimación de estados en sistemas fotovoltaicos

Ramiro Alejandro Plazas-Rosas[1], Édinson Franco-Mejía[2], Martha Lucia Orozco-Gutiérrez[3]

Plazas-Rosas, R. A; Franco-Mejía, E; Orozco-Gutiérrez, M. L. Fault diagnosis with states estimation in pv systems. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 3-9.

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Keywords

Fault; power converter; photovoltaic; model-based; estimation; behavior.

Abstract

The photovoltaic systems are electrical, electronic, and mechanical elements. These systems also face different environmental and operating conditions susceptible to failure. In addition, photovoltaic systems can be the only source of electricity generation, and an affectation on the energy supply can harm the community. In many places, photovoltaic systems are the only source of energy because they are not part of what is known in Colombia as the National Interconnected System (SIN). Which comprises the direct connection between large generators (hydroelectric and/or thermal plants) and consumers. In fact, PV system damage would affect food refrigeration or everyday things like charging a cell phone. Therefore, it is necessary to register, monitor the operation elements of PV systems, and develop strategies that allow the diagnosis to detect faults. In this work, we propose a fault-diagnosis using the PV systems measurements that is, power converter, photovoltaic panels with also mathematical models to determine the deviation between the estimated and measured signals as voltages and currents.

Palabras clave

Falla; convertidor de potencia; fotovoltaico; basado en modelo; estimación; comportameinto.

Resumen

Los sistemas fotovoltaicos constan de elementos eléctricos, electrónicos y mecánicos. Estos sistemas, también se enfrentan diferentes condiciones ambientales y operativas susceptibles de fallar. Además, los sistemas fotovoltaicos pueden ser la única fuente de generación eléctrica, y una afectación en el suministro energético puede perjudicar a la comunidad. En muchas lugares, los sistemas fotovoltaicos son la única fuente de energía, ya que no forman parte de lo que se conoce en Colombia como el Sistema de Interconectado Nacional (SIN). Este consiste en la conexión directa entre grandes generadores (centrales hidroeléctricas y/o térmicas) y los consumidores. De hecho, un daño del sistema fotovoltaico puede afectar la refrigeración de alimentos o cosas cotidianas como cargar un teléfono celular. Por lo tanto, es necesario registrar, monitorear los elementos de operación de los sistemas fotovoltaicos y desarrollar estrategias que permitan el diagnóstico para detectar fallas. En este trabajo, proponemos un diagnóstico de fallas utilizando las medidas de los sistemas fotovoltaicos, es decir, convertidor de potencia, paneles fotovoltaicos y ademas con modelos matemáticos para determinar la desviación entre las señales estimadas y medidas como tensiones y corrientes.

Introduction

The microgrid is a new paradigm in the energy sector, which integrates parts such as renewable and/or non-renewable energy generation, energy storage, loads, power electronics, control, protection, and communications [1]. As part of the renewable generations, the PV generator consists of photovoltaic panels and a switching power converter [2]. Figure 1 show a PV array, a boost converter, and load.

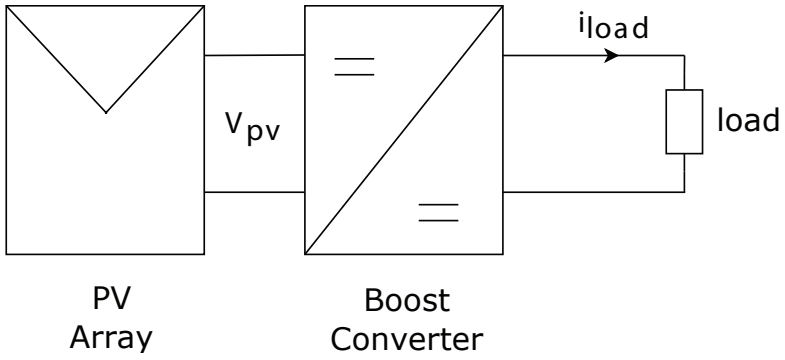

Figure 1. PV system.

The continuous operation of the power generation system is very important. Indeed, the PV systems can supply critical sectors or applications, such as food or medicine refrigeration, where power failures are not allowed. In addition to this, failures can increase operating costs due to corrective maintenance. Therefore, this paper seeks to contribute to a fault diagnosis of PV systems through state estimation. In section II general concepts of fault detection and diagnosis are shown. The model-based fault diagnosis and state estimation are presented in section III. Finally, the expected results are shown.

Fault-detection and diagnostic

Initially, a fault definition: "*An unpermitted deviation of at least one characteristic property or parameter of the system from the acceptable/usual/standard condition*" [3]-[5].

Figure 2 shows a general scheme for the fault-diagnosis, which consists of detecting, then establishing the features, and finally analyzing the symptoms detected to make the diagnosis.

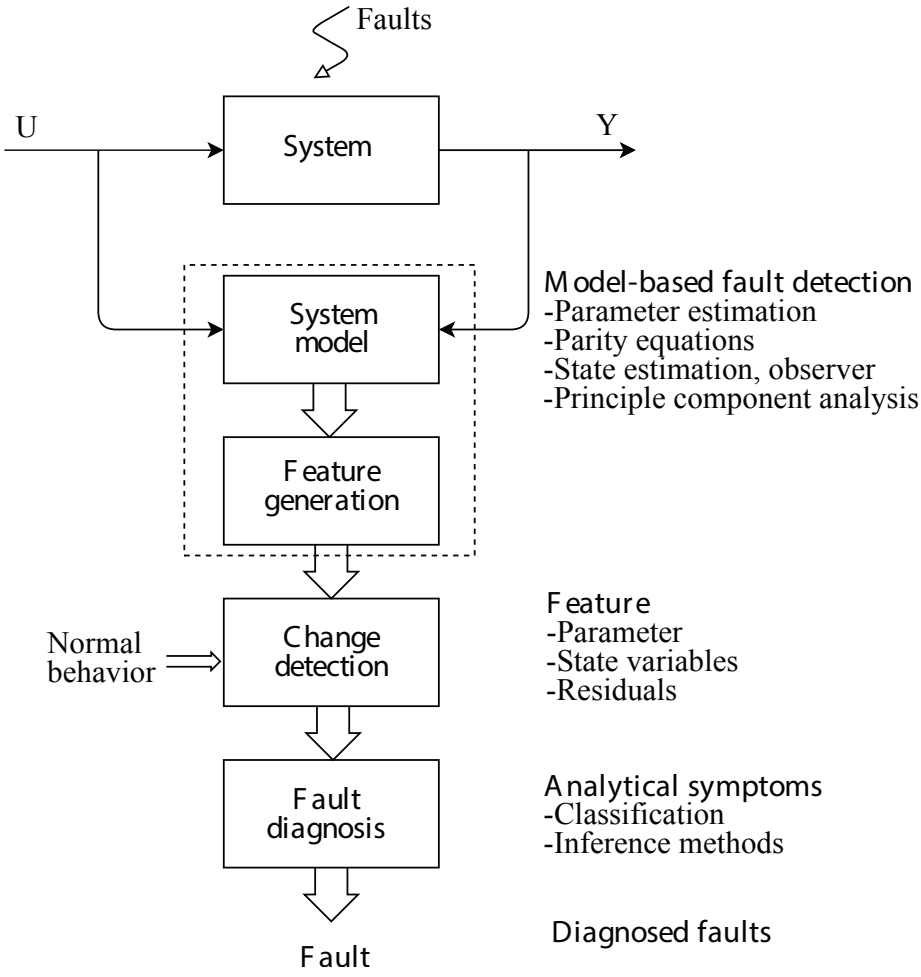

Figure 2. General scheme of process-model-based fault detection and diagnosis. Source [3].

Model-based fault diagnosis

In the approach to the model-based fault diagnosis for the PV system, initially, the boost converter is considered; the switched differential equation of boost converter is given by:

$$L\frac{di_L}{dt} = V_{pv} - Ri_L - V_C(1-u)$$
$$C\frac{dV_C}{dt} = -i_{load} + i_L(1-u) \quad (1)$$

where: L is the inductor, V_{pv} is the voltage panel, R is the inductor resistance, C is the capacitor. The states are capacitor voltage (V_C) and inductor current (i_L); u is the signal control.

Table 1 shows the values used in the simulation, where $\bar{u}$, $\overline{i_L}$ and $\overline{V_C}$ are the equilibrium points. The parameter values correspond to an experimental setup available at the Universidad del Valle.

Table 1. Parameters and equilibrium points.

Parameter	Value
R	$82mW$
L	$3.5mH$
C	$2200mF$
i_{load}	$1.8A$
V_{pv}	$30V$
u	0.5
$\overline{i_L}$	$3.6A$
$\overline{V_C}$	$59.4V$

It proposes the linear switched state estimator of the boost converter [6],[7], as:

$$\dot{\hat{x}}(t) = \begin{bmatrix} \frac{-R}{L} & -\frac{u}{L} \\ \frac{u}{L} & 0 \end{bmatrix} \hat{x}(t) + \begin{bmatrix} \frac{1}{L} & 0 \\ 0 & -\frac{u}{C} \end{bmatrix} \begin{bmatrix} \widehat{V_{pv}}(t) \\ i_{load}(t) \end{bmatrix}$$

where: $\widehat{V_{pv}}(t)$ represents estimated value of $V_{pv}(t)$.

$\hat{x}(t)$ are the estimated states vector, i.e., $\widehat{I_L}(t)$ and $\widehat{V_C}(t)$.

Simulation results are presented for the converter model and estimated states in figure 3. The green lines correspond to the estimation of current and voltage, where the estimation starts with the initial conditions as the equilibrium points. While the red and blue lines, voltage and current, respectively, correspond to the model response. It also showed a transient because the initial conditions of the model are zero. After the transitory period, it is observed that the state estimation errors decrease.

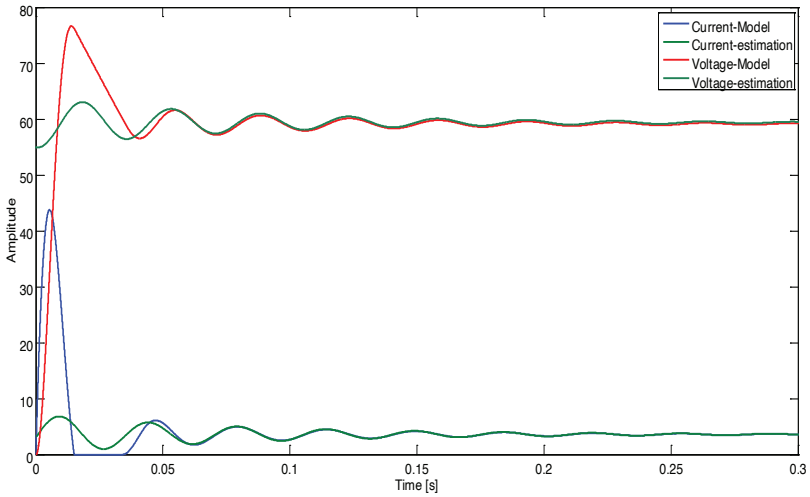

Figure 3. Model and estimation current and voltage.

Conclusions

The procedure to follow in this research is described below: Initially, perform the simulation and states estimation of the PV panels. Then, the integration of the boost converter and panel models will be carried out. Finally, the values estimated and measurements will be used for symptom-based fault diagnosis. This research seeks to faults-detection and diagnosis in PV systems through model-based techniques for sensors, switching power converter, and PV panels.

Acknowledgement

This work has been financed by "*Formación del capital humano de alto nivel para el Departamento de Boyacá-Colciencias 733-2015*" and supported by Universidad del Valle, under the project CI 21061.

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Fault diagnosis with states estimation in PV systems

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Introduction

The microgrid is a new paradigm in the energy sector, which integrates parts such as renewable and/or non-renewable energy generation, energy storage, loads, power electronics, control, protection, and communications [1]. As part of the renewable generations, the PV generator consists of photovoltaic panels and a switching power converter [2]. Figure 1 show a PV array, a boost converter, and load.

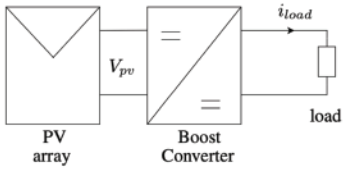

Fig.1 PV system

The continuous operation of the power generation system is very important. Indeed, the PV systems can supply critical sectors or applications, such as food or medicine refrigeration, where power failures are not allowed. In addition to this, failures can increase operating costs due to corrective maintenance. Therefore, this poster seeks to contribute to a fault diagnosis of PV systems through state estimation. In section II general concepts of fault detection and diagnosis are shown. The model-based fault diagnosis and state estimation are presented in section III. Finally, the expected results are shown.

Materials and Methods

Initially, a fault definition: "*An unpermitted deviation of at least one characteristic property or parameter of the system from the acceptable/usual/standard condition*" [3]-[5].

Figure 2 shows a general scheme for the fault-diagnosis, which consists of detecting, then establishing the features, and finally analyzing the symptoms detected to make the diagnosis.

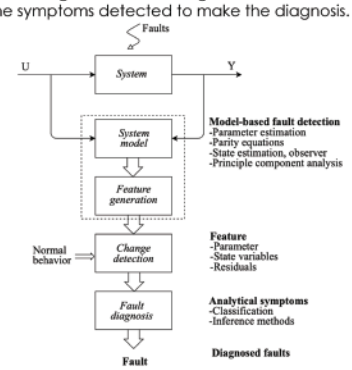

Fig.2. General scheme of process-model-based fault detection and diagnosis [3].

Results and Discussion

In the approach to the model-based fault diagnosis for the PV system, initially, the boost converter is considered; the switched differential equation of boost converter is given by:

$$L\frac{di_L}{dt} = V_{pv} - Ri_L - V_C(1-u)$$
$$C\frac{dV_C}{dt} = -i_{load} + i_L(1-u)$$

where: $L = 3.5mH$ is the inductor, $V_{pv} = 30V$ is the voltage panel, $R = 82m\Omega$ is the inductor resistance, $C = 2200\mu F$ is the capacitor. The $i_{load} = 1.8A$ is load current. The states are capacitor voltage (V_C) and inductor current (i_L) and u is the signal control. The parameter values correspond to an experimental setup available at the Universidad del Valle.

It proposes the linear switched state estimator of the boost converter [6], [7], as:

$$\dot{\hat{x}}(t) = \begin{bmatrix} \frac{-R}{L} & -\frac{u}{L} \\ \frac{u}{L} & 0 \end{bmatrix} \hat{x}(t) + \begin{bmatrix} \frac{1}{L} & 0 \\ 0 & -\frac{1}{C} \end{bmatrix} \begin{bmatrix} \widehat{V_{pv}}(t) \\ i_{load}(t) \end{bmatrix}$$

where: $\widehat{V_{pv}}(t)$ represents estimated value of $V_{pv}(t)$, $\hat{x}(t)$ is the estimated state vector, i.e., $\widehat{i_L}(t)$ and $\widehat{V_C}(t)$.

Simulation results are presented for the converter model and estimated states in Figure 3.

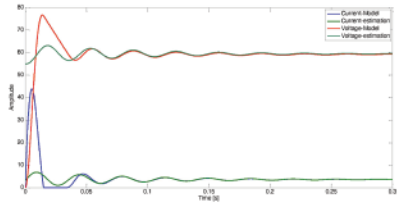

Fig. 3. Model and estimation current and voltage

Conclusions / Next Steps

The procedure to follow in this research is described below: Initially, perform the simulation and states estimation of the PV panels. Then, the integration of the boost converter and panel models will be carried out. Finally, the values estimated and measurements will be used for symptom-based fault diagnosis. This research seeks to faults-detection and diagnosis in PV systems through model-based techniques for sensors, switching power converter, and PV panels.

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Ilustration 1. Presented Poster at LAEDC 2021.

Dual gate material (Au and Pt) based double-gate MOSFET for high-speed devices

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Gowthaman, N; Srivastava, V.M. Dual gate material (Au and Pt) based double-gate MOSFET for high-speed devices. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 10-16.

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Keywords

Double-gate MOSFET; high-speed devices; high-k dielectric; microelectronics; nanotechnology; VLSI.

Abstract

Aluminium Gallium Arsenide (AlGaAs) is a semiconductor material used in the latest design of double heterostructure laser diodes. This semiconductor is mostly available in the arbitrary alloy form between Gallium Arsenide and Aluminium Arsenide. It is derived from the Tri-Methyl-Gallium (TMG/TMGa), and Arsine (AsH3), both the chemicals are pyrophoric and toxic. The resistance is less between source and drain contacts in the case of AlGaAs so that it has been proposed as a material to grow contacts on Indium Phosphide (InP) layer. The AlGaAs uses an ion implantation model for a design purpose which lowers the thermal power while the operation of the device. The parasitic capacitance has to be taken care of while designing a device using this material since the capacitance affects much in the AlGaAs based devices. The average velocity of the electrons has been observed to be increased by 14.63 % in the Au-gate (gate-1) and Pt-gate (gate-2) material-based Double-Gate (DG) MOSFET compared to the Silicon-based DG MOSFET. This paves the way for higher electron mobility, in turn, it can be used in high-frequency device manufacturing. The proposed material can be used in high-speed hybrid applications such as HEMTs and radiofrequency devices for long-haul communication.

Introduction

Gallium Aluminium Arsenide (AlGaAs), a semiconductor material that has electrical properties near the Gallium Arsenide (GaAs). The AlGaAs has a similar lattice constant to the GaAs but has a wider bandgap, making them compatible for designing high-speed devices. Usually, this material available in arbitrary alloy form, which depends on the x value, material stays between the Gallium Arsenide (GaAs) and Aluminium Arsenide (AlAs). The value of x mainly impacts the alloy's bandgap, such as $x < 0.4$ makes the direct bandgap. The GaAs have a bandgap of 1.42 eV and AlAs has a bandgap of 2.16 eV. Hence, Gallium Aluminium Arsenide can be used as a barrier in the Gallium Arsenide bulk [1]. This makes the heterostructures more reliable for high-speed applications. The application areas are semiconductor lasers and optoelectronic devices for long-distance wireless communications [2]. This device has been used to construct Quantum Well Infrared Photo (QWIP) detector because Aluminium Gallium Arsenide has higher stability in a lower power budget than GaAs.

Hill et. al. [2] had presented an enhancement-mode MOSFET which is based on III-V semiconductors with gate and insulator layer with metal and high-k-dielectric respectively with the greater mobility of electrons and improved transconductance. These mobility and device parameters are highly suitable for future design of n-channel CMOS transistors and High Electron Mobility Transistors (HEMTs) based on III-V semiconductor MOSFETs. Sen et. al. [3] had demonstrated a detailed analysis of the parameters of $Al_xGa_{1-x}As$/GaAs junction-less Double-Gate (DG) MOSFET form of sensitive biosensor application modules. Allaei et. al. [4] had proposed an extensive and analytic charge-based model for measuring the Short Channel Effects (SCEs) in Gallium Nitride based MOSFETs. Liu et. al. [5] stated Technology CAD models and their detailed analysis for AlGaAs/InGaAs; AlGaN/GaN, and Silicon-On-Insulator TeraFETs are in good agreement with the obtained current-voltage parametrs and the response to the sub Tera-Hz radiation. Hence, the DG-MOSFETs can be designed using AlGaAs material. This paper

has been organized as follows. Section II elaborates the design process and its parametric model. Section III has the result and discussion of the proposed model. Finally, Section IV concludes the work and recommends the future aspects.

Infinitesimal Design Model

Wide research has been in the long run to make MOSFETs with advanced dielectric materials with higher k – Kappa value to reduce the SCEs. The scaling down of device models has been developed with high-k dielectric materials grown on the well between the gate contacts. Previously SiO_2 layer was used as an insulator between gate material and channel [6, 7]. The usage of high k dielectric makes more insights into research in device fabrication [8, 9]. The Gold and Platinum gate material has been used to construct DG MOSFETs as shown in figure 1. The average electron velocity is higher than the previously discussed model in [5]. The material's total length has been fixed to 30 nm from the source and drain along with the entire electronic simulation [8-10]. The material behaves faster than the previous average velocity [5, 11, 12]. The drain current as in equation (1) of the proposed work has been calculated as:

$$I_d = \frac{C_0 \mu_n W}{L} (V_{int} - V_t)^2 \quad (1)$$

where L and W are the length and the width of the gate contact, respectively, V_t and V_{int} are the threshold voltage and the interference voltage at the contacts, respectively, C_0 and μ_n are the capacitance of the channel material and the mobility of the electrons under a minimized radiation field, respectively.

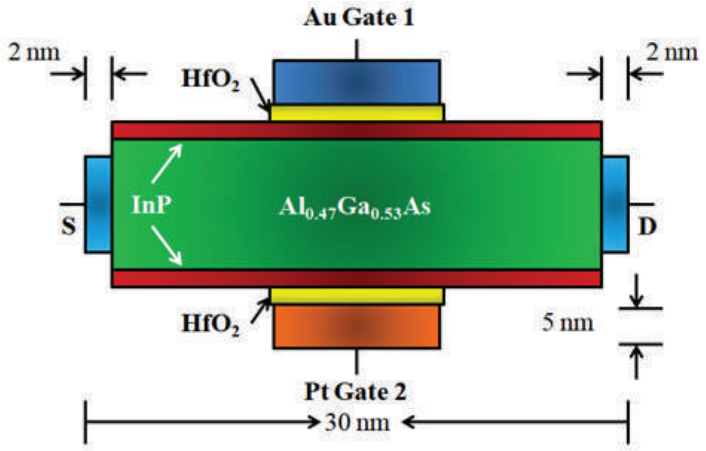

Figure 1. DG MOSFET with Gold and Platinum gate infused with Indium Phosphide as substrate.

Results and discussions

The conduction band profile of the proposed work has been analyzed. The characteristics of the material with dual Au and Pt gate material have been analyzed and comparison is given in figure 2 and figure 3. The mean velocity of electrons along the channel is shown in figure 3. The electrons' velocity has been observed that the Au and Pt behave in compliance with other configurations of materials in the DG MOSFETs design. Schygulla et. al. [8] focuses on the material properties of two III-V semiconductors, AlGaAs and GaInAs, and their usage as middle cell absorber materials in a wafer-bonded III-V/Si triple-junction solar cell.

Table 1. Simulated Analysis of Designed DG MOSFETs.

Ref.	Electrostatic Potential at Drain (V)	Transconductance (S/μm) at Vd = 0.944 V	Transconductance (S/μm) at Vd = 0.167 V
[3]	1.650	2.1141×10^{-4}	4.9643×10^{-3}
[10]	1.637	5.5284×10^{-4}	11.4801×10^{-3}
This work	1.686	18.0448×10^{-4}	11.9989×10^{-3}

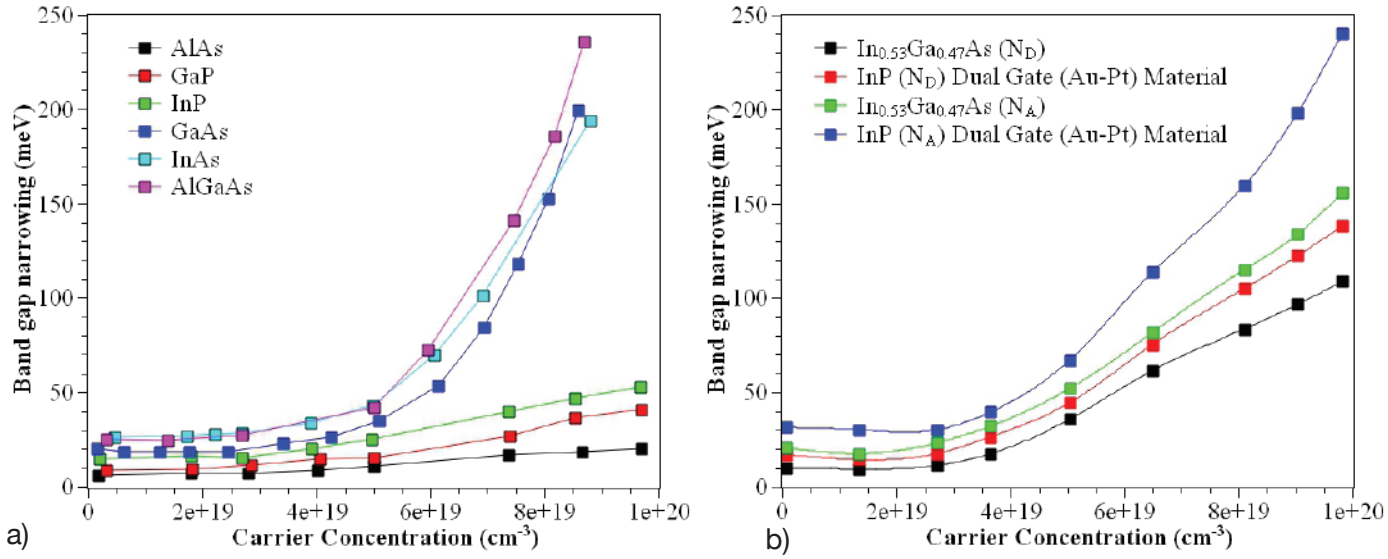

Figure 2. (a) Different Substrate Materials. (b) Dual Gate Material with conventional MOSFET model. Carrier concentration based on dual-gate (Au-Pt) material compared with previous research [1-3, 7].

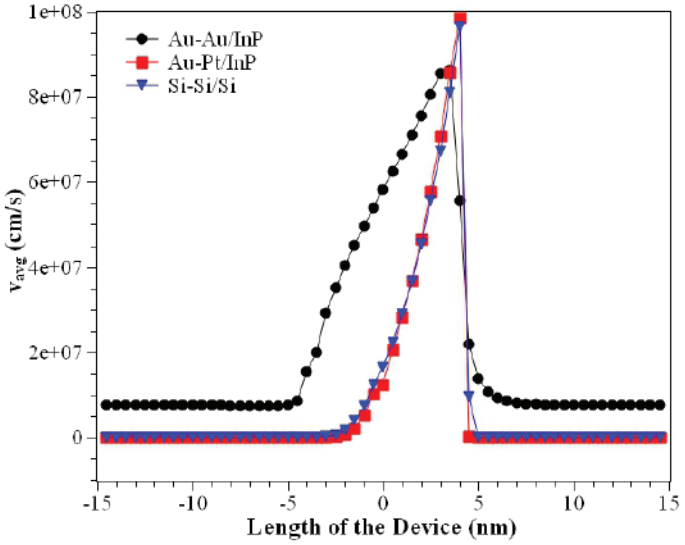

Figure 3. The mean velocity of electrons in the channel for different materials' based devices.

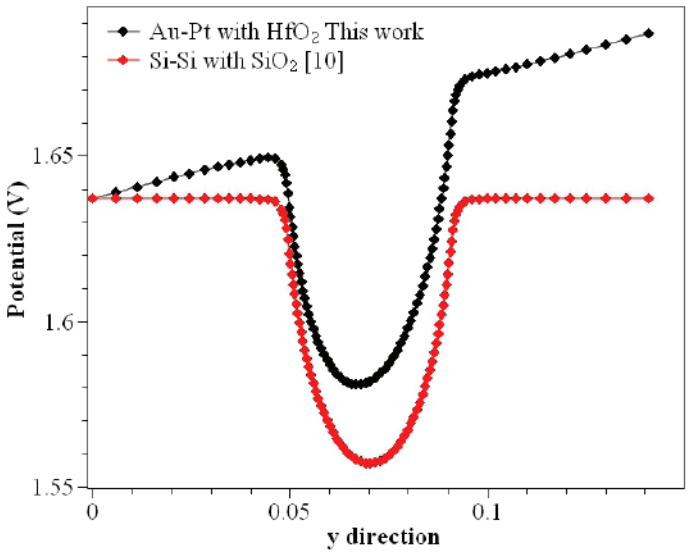

Figure 4. (a) Comparison of electrostatic potential.

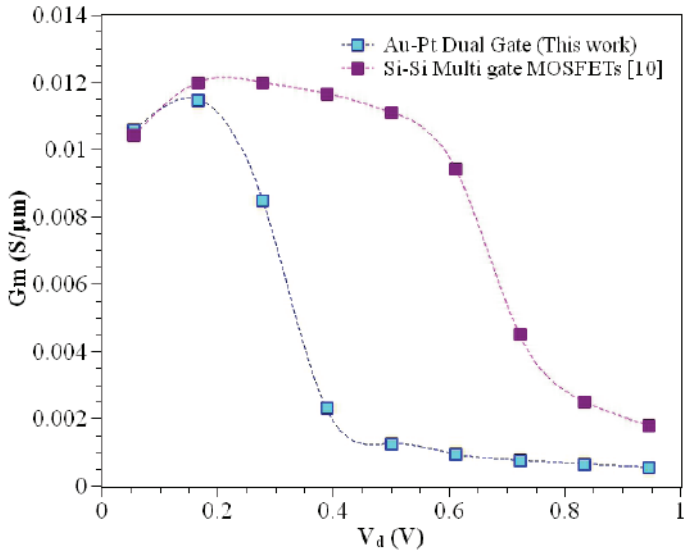

Figure 4. (b) Comparison of Transconductance values with the proposed work and [10].

The detailed analysis has been tabulated in Table I. From this, it can be concluded that the Gold and Platinum dual-gate material-based DG MOSFET provides a deeper and enhanced valley for high-speed operations. The average velocity of the electron in different materials is analyzed, and the results were compared. It describes that the electron velocity is higher in gold and platinum-based DG MOSFETs than in Si-Si based DG MOSFETs [11-13]. The comparisons of electrostatic potential and transconductance parameters have been shown in figure 4.

Conclusions and future aspects

Future nano-CMOS device structures are constructed using non-silicon materials to overcome the existing MOSFETs' basic limitations. Materials such as InGaAs and $Al_xGa_{1-x}As$ come across recent research to create faster MOSFETs with more significant scalability factor. These materials

have increased mobility of electrons. The gate had greatly influenced the channel potential. As a result of this, the Cylindrical Surrounding MOSFET model was not able to model accurately. Reducing the channel length by 40% can focus on creating the work in the CSDG paradigm.

This work mainly focuses on creating an illustration that is suitable for fully depleted CSDG MOSFETs. Furthermore, the work can be extended in developing the Cylindrical Surrounding Double-Gate (CSDG) MOSFETs with inert semiconductors materials and various other materials

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Dual Gate Material (Au and Pt) Based Double-Gate MOSFET for High-Speed Devices

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Introduction

Aluminium Gallium Arsenide (AlGaAs) is a semiconductor material used in the latest design of double heterostructure laser diodes. This semiconductor is mostly available in the arbitrary alloy form between Gallium Arsenide and Aluminium Arsenide. It is derived from the Tri-Methyl-Gallium (TMG/TMGa), and Arsine (AsH_3), both the chemicals are pyrophoric and toxic. The resistance is less between source and drain contacts in the case of AlGaAs so that it has been proposed as a material to grow contacts on Indium Phosphide (InP) layer. The AlGaAs uses an ion implantation model for a design purpose which lowers the thermal power while the operation of the device. The parasitic capacitance has to be taken care of while designing a device using this material since the capacitance affects much in the AlGaAs based devices. The average velocity of the electrons has been observed to be increased by 14.63 % in the Au-gate (gate-1) and Pt-gate (gate-2) material-based Double-Gate (DG) MOSFET compared to the Silicon-based DG MOSFET. This paves the way for higher electron mobility, in turn, it can be used in high-frequency device manufacturing. The proposed material can be used in high-speed hybrid applications such as HEMTs and radiofrequency devices for long-haul communication.

Construction & Modeling

Wide research has been in the long run to make MOSFETs with advanced dielectric materials with higher k – Kappa value to reduce the SCEs. The scaling down of device models has been developed with high-k dielectric materials grown on the well between the gate contacts. Previously SiO_2 layer was used as an insulator between gate material and channel. The usage of high k dielectric makes more insights into research in device fabrication. The Gold and Platinum gate material has been used to construct DG MOSFETs as shown in Fig. 1. The average electron velocity is higher than the previously discussed model. The material's total length has been fixed to 30 nm from the source and drain along with the entire electronic simulation. The material behaves faster than the previous average velocity. The drain current in the proposed work has been calculated as:

$$I_d = \frac{C_0 \mu_n W}{L} (V_{int} - V_t)^2$$

where L and W are the length and the width of the gate contact, respectively, V_t and V_{int} are the threshold voltage and the interference voltage at the contacts, respectively, C_0 and μ_n are the capacitance of the channel material and the mobility of the electrons under a minimized radiation field, respectively.

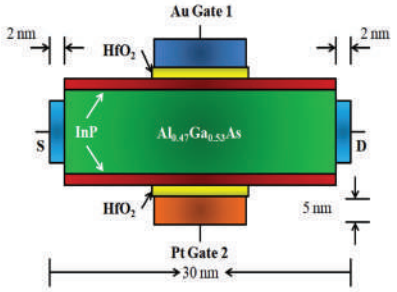

Fig. 1 DG MOSFET with Gold and Platinum gate infused with Indium Phosphide as substrate.

Results and Discussions

The conduction band profile of the proposed work has been analyzed. The characteristics of the material with dual Au and Pt gate material have been analyzed and comparison is given in Fig. 2. The mean velocity of electrons along the channel is shown in Fig. 3 (a). The electrons' velocity has been observed that the Au and Pt behaves in compliance with other configurations of materials in the DG MOSFETs design. Previous research focuses on the material properties of two III-V semiconductors, AlGaAs and GaInAsP, and their usage as middle cell absorber materials in a wafer-bonded III-V/Si triple-junction solar cell.

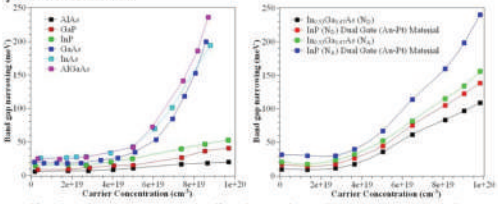

Fig. 2. Carrier concentration based on dual-gate material compared with previous research

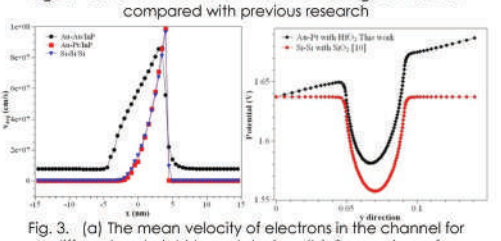

Fig. 3. (a) The mean velocity of electrons in the channel for different materials' based devices (b) Comparison of electrostatic potential

Table I Simulated Analysis of Designed DG MOSFETs

Ref.	Electrostatic Potential at Drain (V)	Transconductance (S/μm) at V_d = 0.944 V	Transconductance (S/μm) at V_d = 0.167 V
[3]	1.650	2.1141×10^{-4}	4.9643×10^{-3}
[10]	1.637	5.5284×10^{-4}	11.4801×10^{-3}
This work	1.686	18.0448×10^{-4}	11.9989×10^{-3}

Conclusions / Future Scope

Future nano-CMOS device structures are constructed using non-silicon materials to overcome the existing MOSFETs' basic limitations. Materials such as InGaAs and AlxGa1-xAs come across recent research to create faster MOSFETs with more significant scalability factor. These materials have increased mobility of electrons. The gate had greatly influenced the channel potential. As a result of this, the Cylindrical Surrounding MOSFET model was not able to model accurately. Reducing the channel length by 40% can focus on creating the work in the CSDG paradigm.

This work mainly focuses on creating an illustration that is suitable for fully depleted CSDG MOSFETs. Furthermore, the work can be extended in developing the Cylindrical Surrounding Double-Gate (CSDG) MOSFETs with inert semiconductors materials and various other materials

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Ilustration 1. Presented Poster at LAEDC 2021.

Smart Hydrant Monitoring System Prototype

Prototipo de un sistema inteligente de monitoreo de hidrante

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Saavedra-García, H. A; Mendoza-Vallecillo, E. J. Smart hydrant monitoring system prototype. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 17-22.

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Keywords

Firebase; Python; Flask; hydrants; arduino.

Abstract

In this article we will develop a system that allows the monitoring of hydrants through an Arduino microcontroller in the city of Managua. Which will consist of 3 stages. A Stage of Sensors and Actuators, Communication Stage and Server Configuration. Which can be monitored from a subdomain of the Firebase platform.

Palabras clave

Firebase; Python; Flask; hidrantes; arduino.

Resumen

En el presente artículo se desarrollara un sistema de que permita el monitoreo de los hidrantes mediantes un microcontrolador Arduino en la cuidad de Managua. El cual constara de 3 etapas. Una etapa de Sensores y Actuadores, Etapa de Comunicación y una de configuración del servidor. El cual se podra monitorear desde un subdominio de la plataforma de Firebase.

Introduction

Hydrants are useful tools in any city, since they are used mainly by firefighters to attend to the different emergencies that arise. In the case of Nicaragua, the company that is in charge of the control, installation and maintenance of the hydrants is Nicaraguan company of aqueducts and sanitary sewers (ENACAL), so it is necessary that this company have an efficient system that allows it to keep a good control of the hydrants so that the firefighters They can have them in their work and not have difficulties in this process.

In Nicaragua there were approximately 3 fires a day for the year 2017, we can also say that the places in which these fires occurred were not in operation the nearby hydrants, among the possible reasons were:

- Fire hydrants in poor condition
- Nozzles which the hose connects damaged
- There were no Nearby Hydrants in the place.

This makes it difficult to find a hydrant in operation since, due to the lack of adequate attention from the competent authorities (ENACAL), these can often be found damaged or out of operation, making emergency attention service more difficult by of firefighters, which causes them to be delayed in their work to attend to different emergencies, especially in fires, since in these cases response time is vital.

Currently ENACAL uses citizen alerts to identify the state of hydrants, this often implies that ill-intentioned people can make false notifications, therefore the authorities in charge do not take these reports seriously.

Therefore ENACAL carries out an annual schedule by a crew to check the status of the hydrants. However, these scheduling plans are no longer viable due to the response time that is needed when an emergency occurs, so that the current systems that ENACAL works with are obsolete.

This project consists of a Prototype of a Hydrant Monitoring and Location System, this through an Arduino microcontroller that will be in charge of monitoring the data from two sensors; one of pressure and another of the water flow to evaluate if the hydrant is in good working order. The location will be managed through a web page and a database that will store the data of the hydrants coordinates within the city of Managua.

Another important benefit of this project is that it seeks to identify which hydrants are in good condition and in case any hydrant is in poor condition or is not in operation; then an alert will be issued so that it can be notified about the need to repair said hydrant.

Methods

The next project will have 3 stages of development for its realization. The first stage of variable collection in which the variable can be collected in this case would be a pressure value and a binary value. In the next phase, communication between the devices and a central unit that will be in charge of sending the data to a server will be deployed. And a last stage of Web programming in which the data and the location of each one can be seen on a map. A as shown in figure 1.

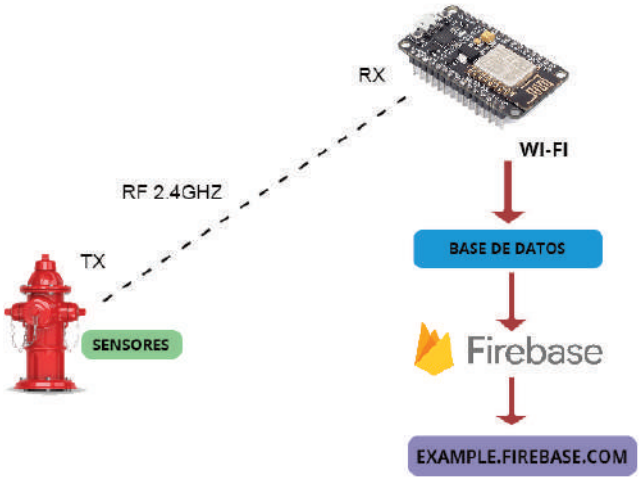

Figure 1. Hydrant Monitoring Concept Diagram.

Sensor and actuator stage

This work will deal mainly with the pressure of fluids, in Physics, a fluid is a substance that continuously deforms (flows) under the application of a tangential stress, no matter how small; specifically the water pressure; that in this case it is the force exerted by the water in the internal area of the hydrant, which must have a value of 1 Kg / cm2 following the standards used by firefighters in Nicaragua.

In addition, a magnetic contact sensor will be placed to prevent future theft of the hydrant nozzle. With this sensor, the good condition of the hydrants and the same protection will be taken into account. These variables will be read by an Arduino board which will also be programmed for this task.

Figure 2 shows the NRF24L01 transceiver module. It uses the 2.4 GHz band and can operate with transmission speeds of 250 kbps up to 2 Mbps. If it is used in open spaces and, with a lower transmission speed, its range can reach up to 100 meters. For greater distances, up to 1000 meters, there are modules provided with an external antenna instead of an antenna drawn on the same plate [5].

Figure 2. NRF24L01 transceiver module.

This module will be very useful since it will allow communication via radio frequency (RF) between the Arduino Uno and the sensors to the ESP8266 module.

Google's Firebase is a cloud platform for web and mobile application development. It is available for different platforms (iOS, Android and web), which is faster to work in development. Its essential function is to simplify the creation of both web and mobile applications and their development, ensuring that the work is faster, but without sacrificing the required quality. [2]

One of the most prominent and essential tools in Firebase is real-time databases. These are hosted in the cloud, are Non-SQL, and store the data as JSON. They allow to host and have the data and information of the application in real time, keeping them updated even if the user does not take any action.

Firebase automatically sends events to applications when data changes, storing the new data to disk. Even if there was no connection from a user, their data would be available to the rest and the changes made would be synchronized once the connection is reestablished.

Through Firebase, the system database will be designed that will handle the different data used, such as the values extracted from the sensors and the coordinates of the hydrant locations.

The programming of the web page will be done with the use of the Python language and the framework that will be Flask.

Conclusion

The project of a hydrant monitoring system will help the Fire Department to be able to solve in a more orderly and effective way before a fire call as much as in the city or the field with the location of the hydrants and first if their operation is the most appropriate. In addition to providing a good service to the population and anticipating any human or material loss.

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Smart Hydrant Monitoring System Prototype

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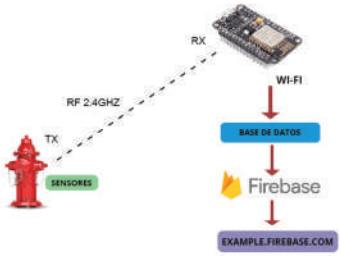
Introduction

The service of firefighters in Nicaragua is considered very important since they are the entity in charge of attending to the different emergencies that arise in the country, especially fires, so it is necessary that this service be as efficient as possible to save human lives and prevent further damage during any incident.

This project consists of a Prototype of a Hydrant Monitoring and Location System, using an Arduino microcontroller that will be in charge of monitoring the data from two sensors; one for pressure and another for water flow to evaluate if the hydrant is in good working order. The location will be managed through a web page and a database that will store the data of the coordinates of all the hydrants within the city of Managua.

Another important benefit of this project is that it will allow identifying which hydrants are in good condition and in the event that any hydrant is in poor condition or is not in operation; then an alert will be issued so that it can be notified about the need to repair said hydrant.

Materials and Methods



The next project will have 3 stages of development for its realization. The first stage of variable collection in which the variable can be collected in this case would be a pressure value and a binary value. In the next phase, communication between the devices and a central unit that will be in charge of sending the data to a server will be deployed. And a last stage of Web programming in which the data and the location of each one can be seen on a map.

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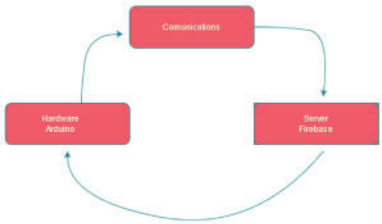

The NRF24L01 transceiver module. It uses the 2.4 GHz band and can operate with transmission speeds of 250 kbps up to 2 Mbps. If it is used in open spaces and, with a lower transmission speed, its range can reach up to 100 meters. For greater distances, up to 1000 meters, there are modules provided with an external antenna instead of an antenna drawn on the same plate

Google's Firebase is a cloud platform for web and mobile application development. It is available for different platforms (iOS, Android and web), which is faster to work in development. Its essential function is to simplify the creation of both web and mobile applications and their development, ensuring that the work is faster, but without sacrificing the required quality

Results and Discussion

Currently the project is in an initial phase and the results that we are expected to see in our system are the real-time values of each of our hydrants in operation.

Conclusions / Next Steps

The project of a hydrant monitoring system will help the Fire Department to be able to solve in a more orderly and effective way before a fire call as much as in the city or the field with the location of the hydrants and first if their operation is the most appropriate. In addition to providing a good service to the population and anticipating any human or material loss.

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Sistema de riego por goteo automatizado y sostenible en zonas rurales de Nicaragua

Automated and Sustainable Drip Irrigation System in Rural Nicaragua

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Bello-Pavón, J.F; García-Montoya, K.E; Lacayo-Arauz, K.A. Sistema de riego por goteo automatizado y sostenible en zonas rurales de Nicaragua. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 23-30.

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Palabras clave

Riego por goteo; sistema fotovoltaico; automatización; sostenibilidad; particle.

Resumen

A pesar de ser un país rico en agua, Nicaragua lucha por asegurar el acceso al agua potable para muchos de sus residentes. Además de los problemas de calidad distributivo y del agua, una prolongada sequía que afecta a todas las regiones del país ha sido un desafío para garantizar las necesidades de agua rurales. El propósito de este proyecto es crear un sistema de hardware/software fácil de usar, confiable y sostenible para automatizar el riego de tierras de cultivo en Nicaragua. El objetivo del sistema es ser lo suficientemente simple como para ser utilizado por los agricultores, pero eficaz y fiable. El sistema ayudaría a los agricultores a ahorrar recursos y mejorar la calidad de sus tierras. Un sistema de riego de agua integrado con un microcontrolador electrónico para permitir un riego por goteo eficiente y ayudar al cultivo de cultivos agrícolas durante períodos de lluvias inadecuadas, también el acceso adicional a la electricidad a través de un sistema de energía solar Una solución de riego sostenible permitirá a los miembros de la comunidad crear más oportunidades económicas y a las pequeñas empresas mantenerse mejor cerca de casa.

Keywords

Drip irrigation; photovoltaic system; automation; sustainability; particle.

Abstract

Despite being a water-rich country, Nicaragua struggles to secure clean water access for many of its residents. In addition to distributional and water quality issues, a prolonged drought affecting all regions of the country has been a challenge to ensuring rural water needs. The purpose of this project is to create a user friendly, reliable, and sustainable hardware/software system to automate farmland irrigation in Nicaragua. The goal of the system is to be simple enough to be used by farmers, yet effective and reliable. The system would help farmers save resources and improve the quality of their land. A water irrigation system embedded with an electronic micro-controller to allow efficient drip irrigation and assist growing of agricultural crops during periods of inadequate rainfall, also the extra access to electricity through a solar powered system A sustainable irrigation solution will enable community members to create more economic opportunities and small businesses to better support themselves near home.

Introducción

La seguridad del agua en las comunidades locales sigue siendo un desafío difícil a pesar de décadas de esfuerzo de los gobiernos, las organizaciones de ayuda y el liderazgo colectivo a nivel local. En Nicaragua, casi 800.000 ciudadanos, o el 13% de la población, no tienen acceso al agua potable [1]. La contaminación minera y agrícola, junto con la deforestación y la erosión del suelo de la ganadería, han afectado la calidad del agua y han provocado que muchas fuentes de agua disponibles se consideren inseguras para el consumo de agua. A pesar de la contaminación de muchas fuentes de agua dulce, todavía hay maneras de mejorar la calidad del agua en Nicaragua. Una característica común del país son los pozos excavados a mano que no se limpian ni se mantienen adecuadamente.

Actualmente los sistemas de riego se llevan a cabo manualmente sin conocer datos exactamente relevantes como la humedad y los tiempos específicos para los respectivos riegos de las plantas. A menudo, no tener en cuenta estos parámetros puede conducir a una gestación vegetal inadecuada, especialmente en las zonas rurales donde los agricultores no son conscientes o están debidamente capacitados sobre esta información. Por lo tanto, se considera que es necesario automatizar el control de riego y ser alimentado por un sistema fotovoltaico.

La alternativa de solución propuesta es el desarrollo de un sistema automatizado y sostenible de riego por goteo eficiente utilizando la tecnología de un microcontrolador con la ayuda de sensores para ayudar a la gestación de cultivos agrícolas en cualquier época del año, además de un sistema alimentado por energía solar que dará acceso adicional a la electricidad para el sistema electrónico y la iluminación en el área del proyecto. Para la ejecución, este proyecto está financiado por los Fondos de Proyecto de IEEE HAC/SIGHT.

Para el desarrollo de este proyecto se formó un grupo con miembros de la Universidad Nacional de Ingeniería (UNI) y la Universidad Centroamericana (UCA) de Nicaragua. Este documento describe el desarrollo de la solución proporcionada además de las herramientas teóricas necesarias para el desarrollo de este proyecto humanitario.

Materiales y métodos

El diseño, desarrollo y construcción del producto creativo está basado en un método de enfoque mixto, la utilización del método de enfoque mixto permitirá obtener una visión mucho más amplia del fenómeno de estudio a través de una investigación dinámica, con una información más rica y variada gracias a la posibilidad de poder realizar una correcta exploración y explotación de datos.

El método de enfoque mixto le brinda valor agregado a esta investigación al brindar la posibilidad de trabajo multimodal y multidisciplinario, permitiendo integrar información de intereses y aproximaciones metodológicas de otros campos de la ciencia y la ingeniería como puede ser el campo agrícola, permitiendo minimizar riesgos y debilidades mientras se consigue solidez en las inferencias científicas. Además, abre la posibilidad de utilizar evidencia de distintos instrumentos de recolección de datos, que pueden ser evidencia de datos numéricos, textuales, visuales, simbólicos y/o verbales.

En cuanto al tipo de investigación, este producto creativo está basado en una investigación analítica-experimental, ya que, en primera instancia se analizará la estructura, funcionamiento y comportamiento del sistema de riego por goteo, con la finalidad de entender cómo opera lógica y mecánicamente, para extraer los datos que serán de relevancia en las siguientes fases que comprenden el desarrollo del producto creativo, esto a través de la revisión de la documentación de diseño de bloques lógicos del sistema de riego.

Como primer instrumento de recolección de información una encuesta estructurada de tipo descriptivo con preguntas cerradas, esta se aplica a cada uno de los encargados del sistema de riego por goteo y personas que se relacionan directamente con los procesos de riego y cultivos de la finca, que representan una muestra no probabilística, ya que ha sido seleccionado a conveniencia para obtener los datos útiles que se requieren.

El segundo instrumento de recolección de datos que se decidió utilizar es la lista de cotejo, este instrumento será utilizado con el objetivo de comprobar la presencia o ausencia de diferentes variables que son necesarias y de suma importancia para desarrollar el producto creativo, tales como fuentes de agua, fuentes de energía, comunicaciones e infraestructura (caseta de

control). La lista de cotejo se basa en análisis de evidencias, es decir, a través de la observación, con indicadores directos, sencillos y observables, permitiendo obtener información objetiva y comprobable.

Resultados

El sistema inteligente de riego por goteo automatizará la tarea de riego en momentos establecidos a través de un sensor RTC, este será el inicio del riego y midiendo la humedad en el suelo el sistema será enviado para apagar, cuando el sensor detecte que hay suficiente humedad del suelo enviada automáticamente para cerrar las válvulas y las cintas de riego dejarán de gotear, esto ayudará a gestionar los niveles de humedad y la calidad del suelo. Por lo tanto, regaremos el suelo de acuerdo con la mejor hora del día dependiendo de la necesidad del cultivo a regar y a través de los niveles de humedad de la tierra terminará el riego. En la figura 1 se muestra un diagrama de visión general del sistema ideal.

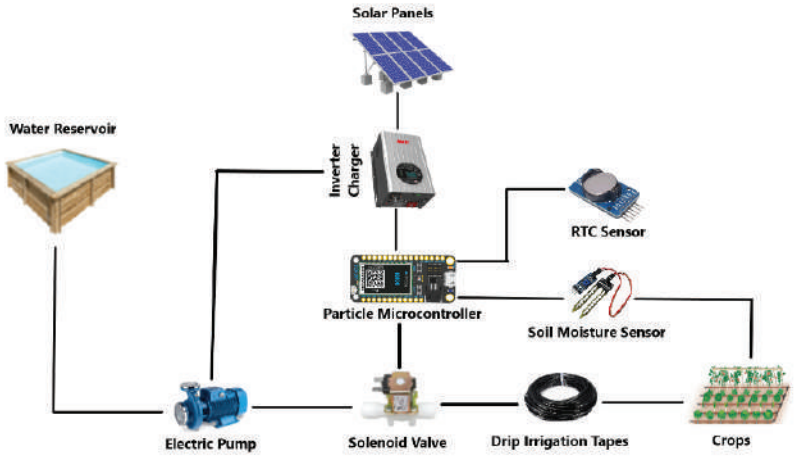

Figura 1. Diagrama general del sistema ideal.

El sistema funciona de forma autónoma después de una calibración simple que permite al usuario elegir el tipo de suelo o cultivo utilizado. El sistema regará automáticamente el suelo en momentos establecidos y leerá los niveles húmedos de un sensor de humedad colocado en el centro de la granja. Los sensores enviarán sus lecturas a un microcontrolador que controla las válvulas solenoides. Las válvulas solenoides son responsables de abrir y cerrar mangueras de riego por goteo. El microcontrolador será alimentado por el sistema fotovoltaico instalado en la caseta. El diagrama de análisis de objetivos se muestra en la figura 2.

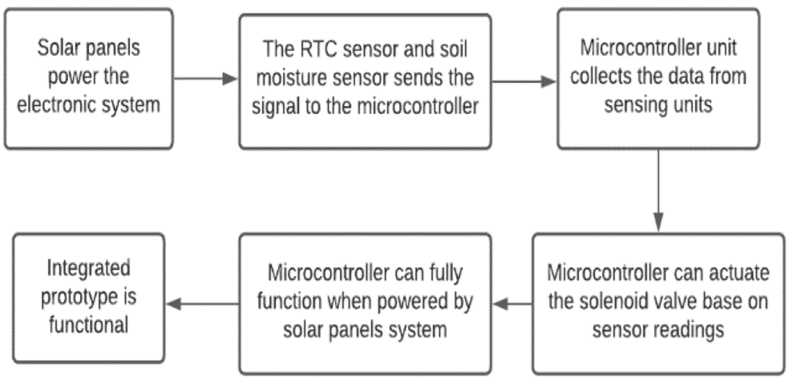

Figura 2. Diagrama de análisis de objetivos.

La construcción de 10x10 metros de un refugio comunitario (ver figura 3) que sirve como auditorio y también poder albergar electrónica y otros equipos. Este será también un punto de encuentro para los miembros de la comunidad.

Figura 3. Refugio comunitario.

Como se muestran en las figuras 4 y 5, se han realizado pruebas electrónicas automatizadas en la bomba eléctrica y en las válvulas solenoides que ya tienen sus respectivas tuberías. Se realizó un largo trabajo de programación de la placa microcontroladora Particle junto con los sensores. Pudimos verificar que el sistema es actuado por el microcontrolador basado en lecturas de sensores.

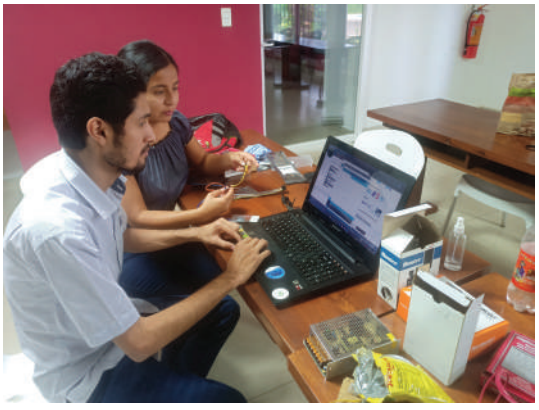

Figura 4. Programación electrónica.

Figura 5. Trabajo electrónico.

Se instalo el sistema fotovoltaico en el techo de la caseta (ver figura 6), este sistema consta de cuatro paneles solares conectados en paralelo dando un total de 76V y 18A que a la vez se conectan a dos baterías, un inversor de corriente y un controlador de carga, se comprobó que el sistema está alimentando adecuadamente a las luminarias de la caseta y a la bomba de riego (ver figura 7).

Figura 6. Instalación de sistema fotovoltaico.

Figura 7. Sistema de control de paneles solares.

En la figura 8 podemos ver que los cultivos están empezando a emerger, los cultivos están actualmente en un invernadero y luego serán trasplantados al suelo.

Figura 8. Cultivos emergiendo.

En la figura 9, podemos ver que el sistema de riego por goteo está funcionando correctamente y actualmente se está empezando a sembrar cultivos como sandías y pipián.

Figura 9. Cintas de riego por goteo.

Conclusiones

La implementación exitosa de este sistema se define como la construcción y energización de un sistema automatizado y sostenible de riego por goteo, la utilización por parte de la comunidad y el sostenimiento a lo largo de su vida esperada. Los miembros de la comunidad serán responsables de mantener el funcionamiento del sistema de riego por goteo.

El proyecto impactará en la comunidad local de 50 familias en La Paz, Carazo mediante la introducción de una fuente más confiable de electricidad y riego sostenible, la calidad de vida de los miembros de la comunidad se mejorará drásticamente. La electrificación de la producción agrícola en las comunidades rurales aumentará la calidad de vida y cubrirá las necesidades básicas de alimentos.

El refugio comunitario tiene oportunidades de educación y capacitación para la comunidad, así como otros miembros voluntarios puedan visitar esta localidad para desarrollar otros proyectos. Por último, la comunidad ya se ha comprometido y seguirá a través de todas las fases del diseño, construcción y operación.

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LAEDC2021

Automated and Sustainable Drip Irrigation System in Rural Nicaragua

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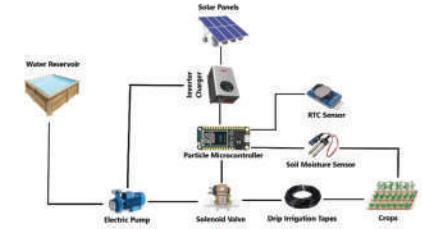
Introduction

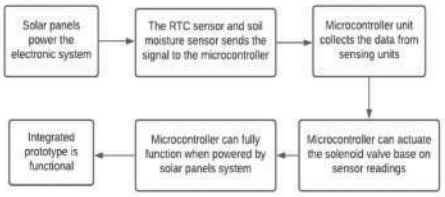
Water security for local communities remains a challenging enterprise despite decades of effort by governments, aid organizations, and collective local-level leadership. In Nicaragua, nearly 800,000 citizens, or 13 percent of the population, don't have access to safe drinking water.

Currently irrigation systems are carried out manually without knowing exactly relevant data such as humidity and specific times for the respective irrigations of the plants. The proposed solution alternative is the development of an automated and sustainable efficient drip irrigation system using the technology of a microcontroller with the help of sensors to help the gestation of agricultural crops at any time of the year in addition to a solar-powered system that will give additional access to electricity for the electronic system and lighting in the project area.

Design and Goal Analysis

The intelligent drip irrigation system will automate the irrigation task at set times through a RTC sensor, this will be the start of irrigation and by measuring moisture in the ground the system will be sent to shut down, when the sensor detects that there is enough soil moisture automatically sent to close the valves and the irrigation tapes will stop dripping , this will help manage moisture levels and soil quality. Therefore, we will irrigate the soil according to the best time of day depending on the need of the crop to be watered and through the moisture levels of the land will finish the irrigation.





The system operates autonomously after a simple calibration that allows the user to choose the type of soil or crop used. The system will automatically irrigate the soil at set times and reading the wet levels of a moisture sensor placed in the center of the farm. Sensors will send their readings to a microcontroller that controls the solenoid valves. Solenoid valves are responsible for opening and closing drip irrigation hoses.

First Results

The construction of 10x10 meters of a community shelter that serves as an auditorium and be able to house electronics and other equipment. This will also be a meeting point for community members.

Automated electronic tests have been carried out on the electric pump and solenoid valves which already have their respective pipes. We were able to verify that the system is acted by the microcontroller based on sensor readings.

In the following photo we can see that the crops are starting to emerge, the crops are currently in a greenhouse and then will be transplanted to the ground.

We can see that the drip irrigation system is working properly and is currently starting to sow crops such as watermelons and pipian.

Conclusions / Next Steps

Successful implementation of this system is defined as the successful construction and energization of an automated and sustainable drip irrigation system, utilization by the community, and sustainment over its expected life. Members from the community will be responsible for maintaining the operation of the drip irrigation system.

The project will impact to local community of 50 families in La Paz, Carazo by introducing a more reliable source of electricity and sustainable irrigation, the quality of life of the community members will be drastically improved. The electrification of agricultural production in rural communities will increase the quality of life and cover basic food needs.

The community shelter has education and training opportunities for the community, as well as other volunteer members to visit to develop other projects. Finally, the community has been engaged already and will continue to be through all phases of the design, construction, and operation.

IEEE Advancing Technology for Humanity

2021 IEEE Latin American Electron Devices Conference (LAEDC)

Electron Devices Society

Ilustración 1. Presented Poster at LAEDC 2021.

Audio module to capture, store and reproduce sound

Módulo de audio para capturar, almacenar y reproducir sonido

Jason Leitón-Jiménez[1]

Leitón-Jiménez, J. Módulo de audio para capturar, almacenar y reproducir sonido. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 31-37.

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Keywords

Digital filter, frequency , signals, signal sampling ,frequency response.

Abstract

This poster explains the design of an audio module, which is capable of capturing sound signals and storing them for later reproduction. The development platform is an embedded system (Beaglebone black), which has GPIO pins for user interaction. One of the objectives of the module is to keep production costs low, so the electronic components will be chosen taking quality criteria in operation as well as their cost. In the software component, the fdatool tool will be use to design the digital filter, getting the differences equation. It should be noted two major challenges that the development of this project has are the presence of noise in the analog signal and the sampling frequency with which the samples are taken to obtain the digital signal.

Palabras clave

Filtro digital, frecuencia, señales, muestreo, respuesta en frecuencia.

Resumen

Este póster explica el diseño de un módulo de audio, que es capaz de capturar señales de sonido y almacenarlas para su posterior reproducción. La plataforma de desarrollo es un sistema embebido (Beaglebone black), que tiene pines GPIO para la interacción del usuario. Uno de los objetivos del módulo es mantener bajos los costos de producción, por lo que los componentes electrónicos serán elegidos teniendo en cuenta tanto los criterios de calidad en operación como su costo. En el componente software, se utilizará la herramienta fdatool para diseñar el filtro digital, obteniendo la ecuación de diferencias. Cabe destacar que dos grandes retos que tiene el desarrollo de este proyecto son la presencia de ruido en la señal analógica y la frecuencia de muestreo con la que se toman las muestras para obtener la señal digital.

Introduction

LuTec is a laboratory within the Costa Rica Institute of Technology to help learn concepts related to science and technology. Its goals consider that knowledge is a critical factor for any society, and therefore, it promotes new ways to increase, acquire and transmit it [1]. One of the projects of this lab is KROTIC (Costa Rican Robotics Kit). It consists of modular robots with sensors, pins, and components for aiding children to develop their projects. The goal of the project is to motivate children in rural or low-income areas to learn about technology.

Therefore, this paper describes the design and implementation of an audio module for the robots in KROTIC. It looks to facilitate children to use recorded or downloaded sounds in their prototypes to make learning a more exciting way for them since they would be using ears in their senses.

Currently, most devices incorporate multimedia as an essential part of their functionality. One of the reasons is users' attraction when interacting with audio, and video [7]. The audio module project begins with the intention of attracting children's interest in developing their projects, thereby achieving entertained experimentation that generates new knowledge related to science and technology.

The audio module must capture analog signals (audio waves), process them to reduce noise, store them in secondary memory so that recorded sounds or some other audio type can be reproduced later or generated by other means such as songs. It also provides some mechanism for the user to interact with the system. Recordings are stored in secondary memory, in this case, in the embedded system's SD memory.

Due to legal issues, the module must also indicate to the user auditory signals when recorded (notification before starting to record) and visual signals (led on during recording).

KROTIC targets people with limited resources, so the module must be relatively low cost (\$ 15) to increase the total price of the programmable robot.

Background

In 2016, a first attempt was made to incorporate into the KROTIC project an audio module that would capture sound, store it and reproduce it to later transmit it wirelessly, however the objectives were not fully met, since the saved signal it had a very high noise component, so it was not fully intelligible. The research was done by Byron Rojas Valverde [2]. One of the conclusions of the investigation was that the hardware that was being used was very slow to fulfill the requirements, in that case the microprocessor that was used is the ATMEGA328, the great limitation was the loss of data, due to the rate of transmission of these, which implied a deteriorated signal with respect to the original and this was the reason why the sound was not heard clearly.

Most of the signals used in science and engineering are continuous, which is why they are classified as analog, some of them are voltage, electric current, light, temperature, among others. Analog-digital and digital-analog conversions allow today's computers to interact with the above signals. This research is related with processing digital signals and transforming analog signals. It should be noted that digital signals differ from analog signals in that the first ones are sampled and quantified, while the second ones are continuous [4].

When signal conversions are required from the analog domain to the digital domain and vice versa, it is inevitable to depend on the speed with which the arithmetic operations are carried out, mainly multiplication and addition, authors such as [5] mention that the quality of digital filters is directly related to the capacity of the processor, since the process generally involves the implementation of difference equations, which require many mathematical operations. The CPU frequency has an essential role due to it should be the double of the frequency of analog signal.

A typical problem that arises when the sound requires to be manipulated is the noise that the signal can take, so this effect must be counteracted with special circuits and suitable filters, in this case the filter is design in digital domain.

An audio signal processing circuit reduces noise in an incoming sound signal and is particularly useful in telephone communication systems that use one or more microphones. The audio signal processing circuit includes a pre-amplification circuit that receives the audio signal from a microphone or other transducer, an amplifier circuit that receives the pre-amplified audio signal. An output from the pre-amplifier circuit provides the processed audio signal that has an improved signal-to-noise ratio with minimal audible distortion [6]. The amplification process generates a significant increase in the magnitude of the sound signal itself, while in the noise signal the change made by is negligible [3].

Solution Description

The audio module should be capable to capture, process, and play sound, the signals are filtered in analog domain to reduce noisy and digital domain to eliminate some frequency components. It should be noted that it is necessary to eliminate the signals whose frequency exceeds 8000 Hz, since it does not correspond to the spectrum of the most common voice and sounds, so it is not interesting to store this type of audio in memory. The figure 1 shows the information flow chart that is proposed for whole processing of signals. The input requires a specific coupling circuit, since the microphone catches the audio signal with low magnitude. Digital filtering is necessary because this stage is responsible of deleting high frequencies.

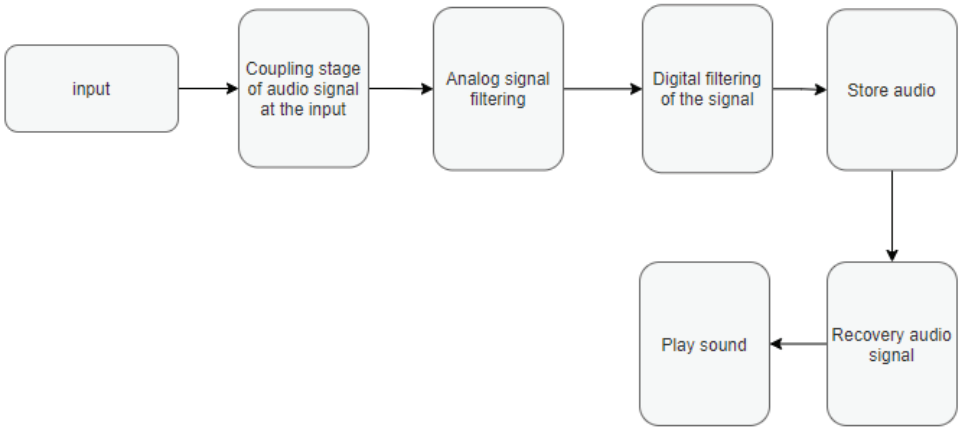

Figure 1. Information flow chart of audio signal.

The audio signal must be treated by different hardware and software modules. figure 2 shows what the process is from when the signal is captured until it is reproduced. It is observed that there is a signal acquisition stage, which corresponds to the microphone, then there is the conditioning stage, whose main function is to eliminate noise in an analog way and control the different physical signals provided by the user.

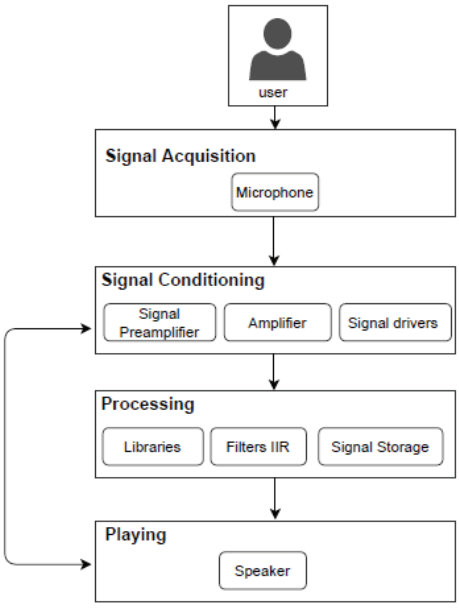

Figure 2. Processing stages.

The processing stage is where digital filtering is performed and unwanted frequencies are removed, in addition to creating the file for storage. Finally, the reproduction stage consists of providing an output system to reproduce the sounds that the user indicates by means of the buttons. This stage is directly related to the conditioning stage, since the signal coming from the embedded system needs an amplification so that it can be heard in an adequate way.

The general architecture of the solution needs some electronic components like a microphone, a coupler and amplifier circuit, an embedded system and an output system, which in this case is a speaker. Each one is related with each processing stage, e.g, output system is related with playing stage.

One of the most important processing stages is recording the signal of sound. The figure 3 shows the algorithm proposed to record and generate the audio file (.wav). The variable "Signal" corresponds to the one that comes from the record button of the circuit, then the fundamental idea is that as long as the user keeps the button pressed, the system will take samples until it is released, once it has been released it proceeds to apply filter to later generate the .wav audio file. The box call "Apply Filter" corresponds to digital filter implemented through differences equation (IIR filter).

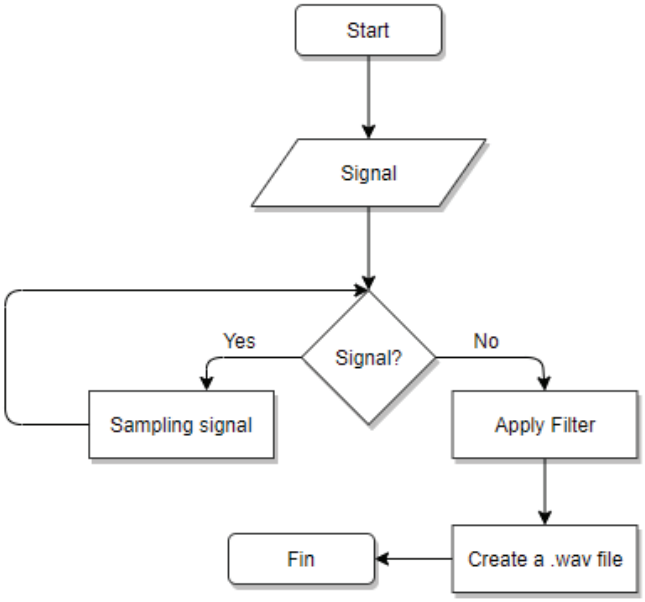

Figure 3. Proposed algorithm to store and recording audio signal.

Filtering implementation is proposed in the time domain, since less processing was needed than doing it in the frequency domain, so a function is required in the code whose objective is to apply the difference equation characteristic of the filter, whose mathematical representation is:

$$y(n) = a_0x(n) + a_1x(n-1) + a_2x(n-2) + a_3x(n-3) + a_4x(n-4) + b_1y(n-1) + b_2y(n-2) + b_3y(n-3) + b_4y(n-4)$$

From the above equation it can be deduced that the filter is of order 4, and therefore it has 5 constants a_n for input $\big(x(n)\big)$ and 4 constants b_m for data output ($y(n)$).

It should be noted that it is an IIR filter, which needs memory to store past samples, in order to calculate the corresponding output.

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LAEDC2021

Audio Module to capture, store and reproduce sound

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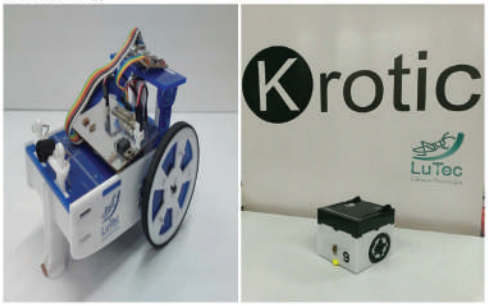
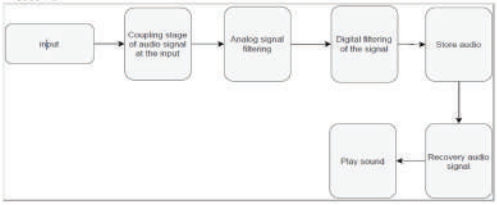
Introduction

- LuTec is a laboratory within the Costa Rica Institute of Technology to help learn concepts related to science and technology. Its goals consider that knowledge is a critical factor for any society, and therefore, it promotes new ways to increase, acquire and transmit it.
- One of the projects of this lab is KROTIC (Costa Rican Robotics Kit).
- it consists of modular robots with sensors, pins, and components for aiding children to develop their projects.
- The goal of the project is to motivate children in rural or low-income areas to learn about technology

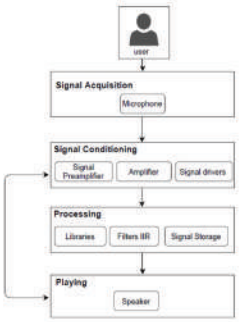


Methods

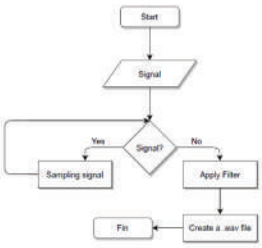
- The audio module should be capable to capture, process, and play sound, the signals are filtered in analog domain to reduce noisy and digital domain to eliminate some frequency components.
- It should be noted that it is necessary to eliminate the signals whose frequency exceeds 8000 Hz



- The audio signal must be treated by different hardware and software modules. The following Figure shows what the process is from when the signal is captured until it is reproduced.



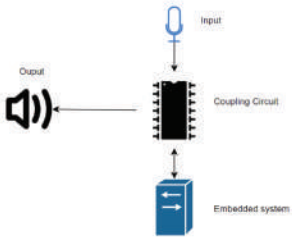
- One of the most important processing stages is recording the signal of sound. The following Figure shows the algorithm proposed to recording and generate the audio file (.wav)



- Filtering implementation is proposed in the time domain, since less processing was needed than doing it in the frequency domain

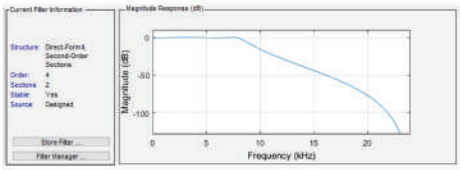
$$y(n) = a_0x(n) + a_1x(n-1) + a_2x(n-2) + a_3x(n-3) + a_4x(n-4) + b_1y(n-1) + b_2y(n-2) + b_3y(n-3) + b_4y(n-4)$$

- Architecture Diagram is shown in the following Figure.

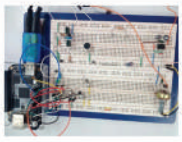


Results

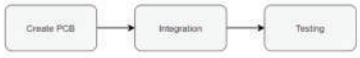
- Some results are shown in the following figures. Digital filter is stable according to the main design given by differences equation. The circuit is not ready, but it allowed to test the signals.




```
('Muestras;', array([[ 32767, -32768],
       [ 32767, -32768],
       [ 32767, -32768],
       ...,
       [  -191,    -326],
       [  -433,    -378],
       [  -334,    -463]], dtype=int16))
```



Next Steps



IEEE Advancing Technology for Humanity
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Ilustration 1. Presented Poster at LAEDC 2021.

STEM education in semi-virtual interactive environment

Educación STEM en ambiente interativo semi-virtual

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Keywords

STEM education; Costa Rica; semi-virtual environment; Covid-19; humanitarian project; STEM workshops; volunteering.

Abstract

The Covid-19 pandemic has forced us to change the way we used to handle education in our homes, through sanitary restrictions that seek to prohibit or reduce physical contact, moving from the traditional way to a virtual methodology; reason for which we must look for new solutions to adapt to this new teaching strategy. In addition, the pandemic has accelerated the arrival of the 4.0 revolution or technological revolution, where new challenges arise for society. The above reasons serve to justify and encourage that STEM education cannot stop. However, given the crisis we are experiencing and the solutions provided, the excessive use of virtual environments can affect areas such as psychological, social, etc. Through this project, a learning model implemented through volunteers is proposed, based on an interactive semi-virtual environment, where the participant can interact synchronously with a volunteering model provided by the volunteer tutor, and the learning process is supported through workshops and the use of virtual tools.

Palabras clave

Educación STEM; Costa Rica; Entorno semi-virtual; Covid-19; proyecto humanitario; talleres STEM; voluntariado.

Resumen

La pandemia del Covid-19 nos ha forzado a cambiar la manera en que solíamos manejar la educación en nuestros hogares, por medio de restricciones sanitarias que buscan prohibir o reducir el contacto físico, moviéndonos de la forma tradicional a una metodología virtual; motivo por el cual debemos buscar nuevas soluciones para adaptarnos a esta nueva estrategia de enseñanza. Además, la pandemia ha acelerado la llegada de la revolución 4.0 o revolución tecnológica, en donde surgen nuevos desafíos para la sociedad. Los motivos anteriores sirven para justificar y fomentar que la educación en áreas STEM no puede detenerse. Sin embargo, ante la crisis que vivimos y las soluciones provistas, el uso excesivo de entornos virtuales puede llegar a afectar en áreas como la psicológica, social, etc. Por medio de este proyecto se plantea un modelo de aprendizaje implementado por medio de voluntarios, basado en un ambiente semi-virtual interactivo, donde el participante pueda interactuar sincrónicamente con el tutor, y el proceso de aprendizaje sea apoyado por medio de talleres y el uso de herramientas virtuales.

Introduction

Many of the 21-century global challenges, including climate change, poverty, health, education, affordable and clean energy, economy, the care and management of the resources that impact the country and the world, are addressed for the 2030 Agenda for Sustainable Development as the 17 Sustainable Development Goals (SDGs) [1]; these challenges urge a transformation in our society, will require support and development of skills such as problem-solving in science and technology for the management of such challenges through a quality STEM Education.

From the challenges mentioned before, the prompting of STEM education stands out, since it is an area of global interest in which many governments from different countries have been involved, some of them to promote it from the early ages of their children, and others making

spaces for people to get involved. The main reason is because of the impact that these careers have on the development of the country and the possibility that they contribute to a reduction in the social gap main challenges that have been noted through the years.

Despite the aforementioned, it is known that not everyone has equal opportunities in access to knowledge in this area, and due to the pandemic, the social gap that we knew about has increased. Therefore, we propose a volunteer model where volunteers with knowledge on the subject can encourage their development from organizations such as IEEE humanitarian groups, through a program in a semi-virtual environment that strengthens education and communication, helps the mental health of students, and brings back the feeling of closeness that existed before the isolation measures imposed by the authorities.

State of the art

STEM Education

What is STEM Education, what does it mean? This is an educational trend that emerged at the beginning of the 21st century in the United States, which response to the fields and competencies most in-demand in the industry today, in addition, it is an acronym that integrates four discrete disciplines; including Science, Technology, Engineering, and Mathematics; in an interdisciplinary approach to develop collaboration skills, creativity, critical thinking, communication, problem-solving, among others. This term includes all the fields mentioned before, and according to [2], a STEM education motivates the students to increase and develop skills and applied those to an understanding approach of the usage of science, technologies, and engineering that involves problem-solving and innovation for our daily life global challenges, finally, it intends to have an impact on advanced research and development focused on innovation.

Costa Rica: Education and Work during the pandemic

With the arrival of the Covid-19 pandemic in Costa Rica, the educational system was affected and was even paused while a strategy was being generated to allow the resumption of a training cycle adapted to the measures imposed by the health agency [3]. Among the strategies used by the different entities, “Aprendo en Casa” was implemented by the Ministry of Education, which intended (through television classes and guides for students) to continue the educational progress of children and youth [4]. Another case was found in the public universities, which managed to resume classes virtually, even seeking to provide technical facilities to some students who needed it to continue [5].

Despite the efforts made, on August 28, 2020, it was reported through a press conference that around 91,000 students from schools and colleges had stopped studying through the means made available to them; which represents a dropout rate of around 8.5% of the entire enrolled student population registered at the beginning of the year [6].

Virtual environments in education

The impact of the 4.0 industrial revolution in America was influenced to a great extent by the pandemic, producing an “exponential” growth not foreseen in the implementation of virtual environments for different purposes, modifying paradigms for which we highlight the area of education, wherein most countries have had to go from a face-to-face environment to a virtual one.

Even though in this environment some many advantages and opportunities can be exploited to generate highly productive environments to compete with traditional spaces; One cannot lose sight of some negative factors such as the absence of computer equipment and the

discrimination that this can cause in education. The change requires the greater dedication of professionals to adapt their material and basic knowledge of the tools to be used. The absence of elements such as those mentioned, can cause the orientation of the technology in itself and not in the proposed learning objectives; a fact that can be considered a disadvantage compared to the traditional teaching style [7]. According to the authors of [8] in the work about the influence of the smartphone in the learning and teaching processes, it stands out how its results showed negative consequences derived from excessive use of the intelligent device, can have psychological, academic, and social repercussions, cyberbullying, abstraction of reality, a saturation of information, loss of sense of reality, among others.

Constructivism

The definition of constructivism varies according to the perspective and position, but it is usually generalized as the capacity to learn and understand reality in a personal, subjective way, related to the socio-environmental context in which each individual is formed [7]. In the educational field, according to [9], this concept is related to the result of the learner's experience and interaction with the world, a process that seeks the application of a methodology that allows the person to learn how to learn on his or her own; based on the analysis of one's own experiences and assuming representation, selection and self-direction capabilities.

Volunteering

Volunteering from the neurological view [11], depends on two things, first the motivation which can be explained as a process in which someone wants something (that they feel is attainable) and works towards that goal, to ultimately obtain satisfaction; and empathy understood as a person's ability to sympathize with someone's problems or necessities. Those two facts lead us to define volunteering as a human decision to generate satisfaction by working on someone else's cause, which is validated by the parietal lobe so that later, without falling into a bias, it is validated by the frontal lobe. Activating motivation and generating empathy for the person with the cause [12].

Some benefits of volunteering, specifically in an online system, are that volunteers can make the most out of the time they are giving to the cause, it reduces the amount of time traveling, and finally involves everyone from children to elderly, including people with disabilities or part of groups with disadvantages. (http://jhr.ssu.ac.ir/article-1-479-en.html)

In volunteering we've found the perfect environment to develop and impart courses for people of different ages and levels of knowledge, closing the social gaps created by a society where access to education is limited to people with better resources and those which are close to big cities (see figure 2).

Figure 1. STEM activity at the rural high school Gavilán Vesta in the indigenous Cabécar-Tayní community in Valle de la Estrella, Limón, Costa Rica.

Methodology

In the present project, we propose to develop exercises and workshops to be imparted in a semi-virtual environment, where the participants can learn through interactive workshop units and synchronous activities, where participants have access to the material provided. Those are implemented throughout a volunteer model, in which students can contribute and participate out of the conviction of wanting and helping others, carrying out good deeds, and sharing knowledge and experience with the youngest generations [10].

This project aims to train trainers and during that process generate the necessary tools and information that are most suitable to establish a teaching methodology that can be replicated in a large number of educational centers, including those with budget limitations and the equipment available to work on the topics required to achieve good learning and understanding of STEM topics. In these activities, the use of educational kits is proposed, for example, Snap Circuits (https://www.elenco.com/brand/snap-circuits), Arduino (https://www.arduino.cc/), Raspberry (https://www.raspberrypi.org/) and other materials that allow interactive learning “based on the constructivism pedagogy”.

Creative, interactive, and intuitive teaching-learning methodological processes can enhance the capacity of girls and boys, in sociocultural and educational contexts with a low human development index to introduce STEM and help to improve their quality of life in the future.

Figure 2. Volunteers from IEEE Student Branch at TEC Costa Rica.

The main purpose is to generate educational material after a series of dictated online workshops to be followed by participants at their own homes or schools, to determine later the best methods to be used. Part of the benefits is that in the future these materials can be available to share with others in more locations, even countries.

Looking to work with other teachers and professionals as volunteers and NGOs. The project will be implemented in different places of the country, especially in rural areas, with potentially hundreds of people (kids, young, teachers, and more), looking also to have equal gender participation.

Workshops

Workshop general content

Here an overall explanation of how each virtual workshop will be structured is given to provide the best learning experience possible for the ones attending it. Here is also explained some samples of activity and its duration, so that the extension of those is not exhausting to the attendees. The program consists of a one-week hands-on STEM methodology through workshops.

Workshop section	Description	Duration
Introduction	We introduce the participants to the STEM project and workshops that will be taught. The workshop speakers will start a brainstorm with the participants to explain the STEM concept through interactive activities to promote participation.	20 minutes
Theory explanation	Speakers introduce the formal concepts of the subject and give theoretical examples to reinforce the concepts explained and developed through the session involving the constructivist paradigm.	20 minutes

Workshop section	Description	Duration
Hands-on practice and theory reinforcement	Participants are instructed to use a specific tool to follow the example given and then encouraged to explore within the set of características and functions available so that the concepts explained before can have a better impact on them.	40 minutes
Conclusions	With the new knowledge acquired, we evaluate through an exercise the projects developed by the participants, where they will present their knowledge and how this can benefit or help in building a better society in STEM areas.	30 min

Workshops description

In the following section, we describe the workshops develop by volunteering community.

Workshop name	Description
Introduction to computer programming	The main goal of this workshop is to remove fear about computer programming from the participants, using the Python programming language. Introduce basic concepts and explain how computer programming can help to build and develop solutions, promoting the development of creativity, logic, and problem-solving.
How to build my first mobile application?	This workshop's objective is to give an overall tour of how to build a mobile application with the free visual tools available on the web. In addition, it is not intended to be specific on the instrument, but to explain the main ideas that make most of these work the way they do, so it is easier to switch from a tool to another one that works under the same concepts.
Linux as an Operating System alternative	Windows has come to be one of the main user-oriented operating systems, and so one of the most used. But what about a free alternative to it? In this workshop, some Linux history will be explained and attendees will be submerged under a new experience in a new Operating System.
Get to know college!	People have negative and different perceptions about universities, which the objective of this workshop is through university volunteers to share experiences they have had in the university with the participants, dealing points such as challenges, motivations, expectations for the future.
Hands-on inside the circuits world	Arduino and Snap Circuit is an open-source electronics prototyping platform that allows users to create interactive electronic objects. In this session, we introduce concepts, basic components, basic exercises to the participants so they can get their hands dirty in the world of electronics, without having the fear of burning an LED or getting electrocuted, and expose how you can develop modular projects that can be part of a more complex project for a complex solution.

Future work

With the advance of digitalization, the information and communication technologies have brought us benefits from different aspects in our society, but this has not been the same in all people, creating the digital gap, which has been growing with the advance of technology. And this has been a challenge for the actual society that needs to be taken into account.

Through this project, the main goal is to generate educational material and new semi-virtual environment interaction workshops to be followed by participants and encouraged by volunteers at their own homes or schools, so in the future these materials can be available to share with others in more locations, even more countries.

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Singular

STEM Education in Semi-virtual Interactive Environment

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Introduction

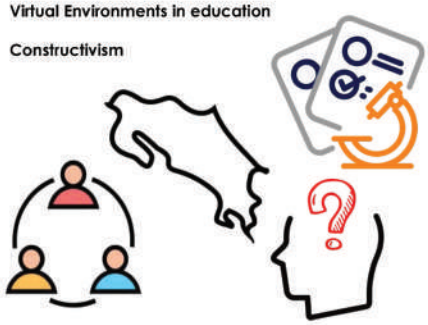
The Covid-19 pandemic is forcing us to change the way we handle education at home, due to sanitary restrictions that prohibit or reduce physical contact, carrying us from the traditional way to a virtual methodology; reason why we must look for new solutions to adapt to this new teaching strategy.

Background

- **STEM Education**

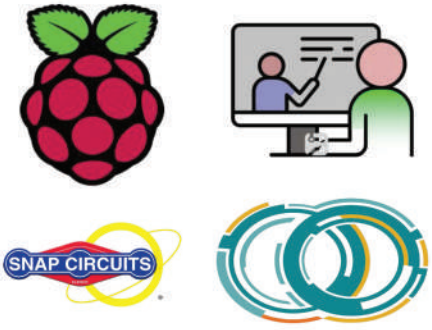
SUSTAINABLE DEVELOPMENT GOALS

- **Costa Rica Education and Work Challenges in pandemic**
- **Virtual Environments in education**
- **Constructivism**



Methods

- Develop exercises and workshops to be imparted in a semi-virtual environment where the participants can learn through synchronous and asynchronous activities.
- Implemented using a volunteer model.



Next Steps

Generate educational material for workshops to be followed by participants at their own homes or schools, so in the future these materials can be available to share with others in more locations, even countries.

IEEE Advancing Technology for Humanity

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Electron Devices Society

Ilustration 1. Presented Poster at LAEDC 2021.

Rehabilitation of an Internet network in 40 schools in Nabón, Ecuador

Rehabilitación de una red de internet en 40 escuelas en Nabón, Ecuador

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Cabrera-Tituana, R.I; Carrión-Herrera, A.K. Rehabilitation of an Internet network in 40 schools in Nabón, Ecuador. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 47-55.

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Keywords

Internet; sustainable development; maintenance engineering; Internet in rural areas; digital gap; wireless technology.

Abstract

Internet access is necessary to ensure respect for the right to education, however, worldwide about 75% of school-age children in rural areas do not have access to the Internet at home, which makes it imperative the need for actions to reduce the digital gap to improve the quality of education in rural communities in Ecuador. This article describes the rehabilitation of an Internet network of 40 schools in the Nabón community, Ecuador. An earlier initiative implemented the Internet network, but lack of maintenance left it non-functional. With the support of the Municipality of Nabón, Motorola Foundation and IEEE SIGHT, a group of volunteers from IEEE Ecuador evaluated the state of the network to identify opportunities using the existing infrastructure. The commitment to the community, as well as the development of capacities, are at the center of the intervention to guarantee the sustainable development of the project. This document reports on the design, implementation, achievements and lessons learned from the rehabilitation of the Internet network.

Palabras clave

Internet; desarrollo sostenible; ingeniería de mantenimiento; Internet en zonas rurales; brecha digital; tecnología inalámbrica.

Resumen

El acceso a Internet es necesario para asegurar el respeto del derecho a la educación, sin embargo, en todo el mundo alrededor del 75% de los niños en edad escolar de las zonas rurales no tienen acceso a Internet en el hogar, lo que hace imperativa la necesidad de acciones que permitan reducir la brecha digital para mejorar la calidad de la educación en las comunidades rurales del Ecuador. Este artículo describe la rehabilitación de una red de Internet de 40 escuelas en el cantón Nabón, Ecuador. Una iniciativa anterior implementó la red de Internet, pero la falta de mantenimiento la dejó no funcional. Con el apoyo del Municipio de Nabón, Motorola Foundation e IEEE SIGHT, un grupo de voluntarios de IEEE Ecuador evaluaron el estado de la red para identificar las oportunidades utilizando la infraestructura existente. El compromiso con la comunidad, así como el desarrollo de capacidades, están en el centro de la intervención para garantizar el desarrollo sostenible del proyecto. En este documento se informa sobre el diseño, implementación, los logros y las lecciones aprendidas de la rehabilitación de la red de Internet.

Introduction

According to ITU and UNICEF, about 75% of school-age children in rural areas do not have access to the Internet at home, compared with about 60% of school-age children in urban households [1]. In the Ecuadorian context, according to the Multipurpose ICT Survey, 54.5% of homes nationwide did not have internet access, 43.9% correspond to the urban area and 78.4% to the rural area [2].

For children and young people who do not have access to the Internet and are affected by the closure of schools due to the COVID-19 pandemic, education may be out of reach, even before the pandemic, more and more young people needed to acquire digital skills to be able to compete in the economy of the XXI century [3].

These data show the need for actions to reduce the digital gap to improve the quality of education in rural communities in Ecuador.

Although Internet network implementation projects in rural areas can provide great engineering characteristics, the solution proposed in this paper focuses on rehabilitation of an Internet network given the existing infrastructure on site and the economic limitations associated with the budget available.

Project description

The objective of this project was to rehabilitate the internet network of 40 schools in the Nabón community and train members of the local community in the proper use and maintenance of the internet network. This will reduce the digital gap and support the sustainable development of the community.

Background of the Nabón community

Nabón is a canton located southeast of the Azuay province, southern Ecuador, as shown in figure 1. Nabón has an area of 668.2 km^2, one of its geographical characteristics is the dispersion of its territory, which prevents easy access to different communities and makes communication between them difficult. Nabón has a population of 15,121 inhabitants distributed as follows: 6.9% in the urban area and 93.1% in the rural area. About 23% of the population is illiterate and the average schooling in rural areas is only 3.6 years. Nabón is considered the ninth poorest canton in the country, with 87.9% poverty and 55.7% indigence [4].

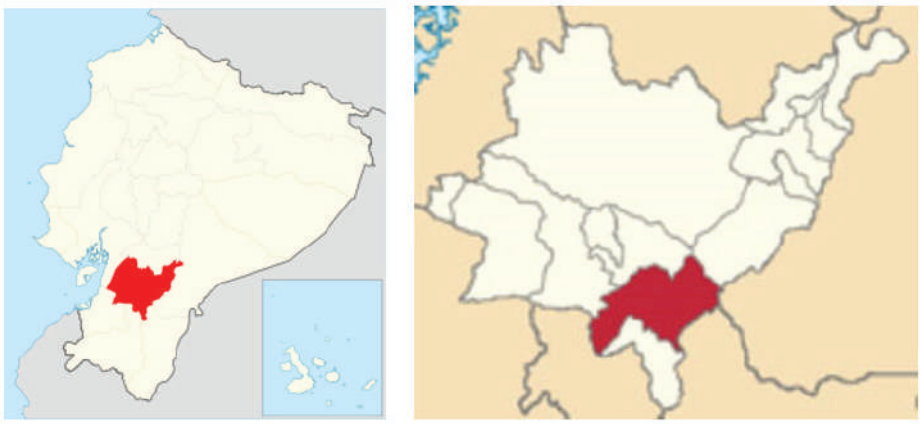

Figure 1. Geographical location of the Nabón canton. Source: [4].

Description of the past system

In 2008, the National Telecommunications Secretariat of Ecuador and the Municipality of Nabón signed a cooperation agreement for the implementation, deployment and management of an internet network for 60 educational units. In 2016, the Ministry of Telecommunications of Ecuador transferred to the Municipality of Nabón the domain in perpetuity and free of charge of all the equipment of the internet network implemented.

The Nabón internet network is based on long-range WiFi wireless technology and its topology includes four elements: service node, backbone network, access networks and terminal equipment, as shown in the block diagram of figure 2.

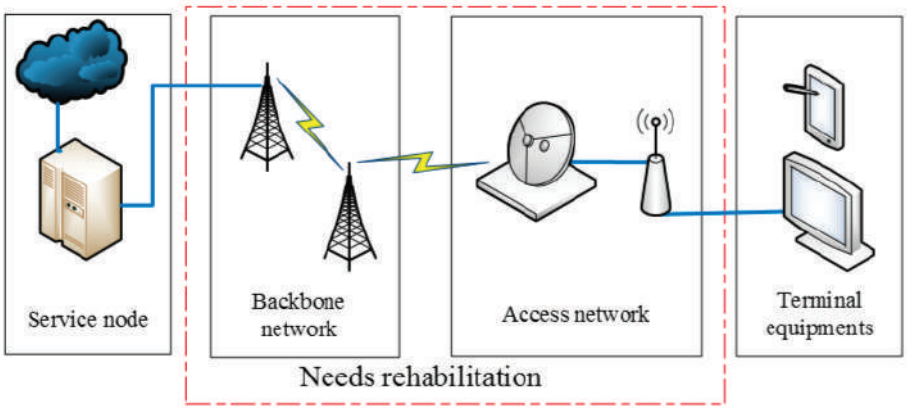

Figure. 2. Nabón network topology. Own source.

- The services node is located in the facilities of the Municipality of Nabón. The Internet service provider is CNT, which provides a bandwidth of 20 Mbps.
- The backbone network is made up of 7 radio links that should ensure an internet speed of 20 Mbps.
- The access networks in each school are made up of receiving antennas and wireless access points that should ensure an internet speed of 256 Kbps.
- The access points in each school are made up of desktop computers. The number of computers in each school varies between 1 and 8.

Motivation and objectives of the Project

This project aims to rehabilitate the Internet network of 40 schools in the Nabón canton, which will allow students and teachers to improve the quality of education. The long-term objective is that all the communities of the Nabón canton have Internet service in their schools. In addition, it could be considered in the future that the network will also be used by the community in general, in applications such as telemedicine and electronic commerce.

Cooperation and sustainable development

One of the main causes why Information and Communication Technologies projects fail has its origin in stakeholder management [5]. To minimize the potential failure of this initiative, the principle of co-creation is followed, in which the interested parties are actively involved in the implementation of the project, receiving the appropriate training, and making the community members maintain the solution by themselves.

System design

The project aims to rehabilitate the Internet network by identifying opportunities that allow to take advantage of the existing infrastructure, considering the economic, legal, geographical and environmental limitations. Therefore, the project team assesses the current situation of the Internet network.

In this evaluation it was concluded that the Internet network of Nabón does not work in 40 schools due to problems in the active equipment of 5 of the 7 radio links of the backbone network: Nabón - Arverjilla - Huasiloma - Caraylo - Bayan, as shown in the figure 3; as well as problems in the active equipment of the schools' access networks are also identified.

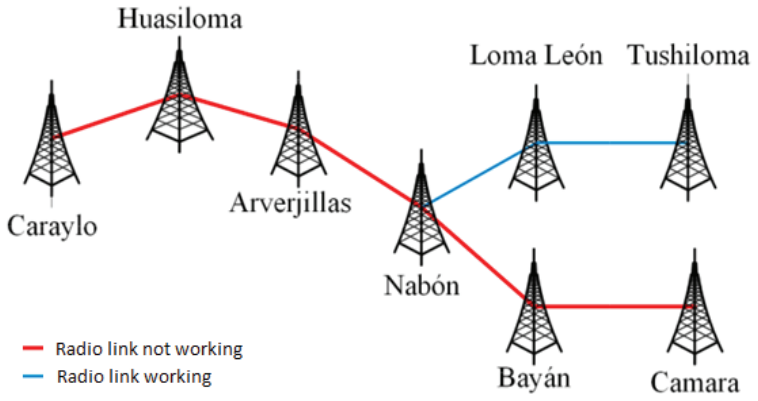

Figure. 3. Past situation of the backbone network. Own source.

Due to the unavailability of the installed equipment in the market and the fact that it is not possible to combine the radio link technologies due to incompatibility between the master and slave equipment, the complete rehabilitation of 5 radio links is necessary to put the backbone network into operation. In addition, it is necessary to carry out the rehabilitation of the 40 access networks for each of the schools.

For the calculation of radio links, parameters such as: line losses, propagation and power losses and receiver sensitivity are considered. From this, the active equipment of the network is dimensioned: point - point antennas, point - multipoint antennas and receiving antennas, for the Internet network.

To calculate the bandwidth required for the network, the capacity needed for each school is added and the result is divided for the level of sharing required. The necessary capacity for each school, according to the number of users is 10 Mbps, while the level of sharing for each link is 4 to 1. Therefore, the bandwidth required for the Internet Network in 40 schools is 100 Mbps.

Project implementation

Rehabilitation of the internet network

Based on the design of the system, the acquisition of equipment such as antennas, routers, wireless cards, network cable and other accessories is carried out; In addition, the necessary logistics are coordinated to carry out the work in 3 interventions, which included the work of volunteers from IEEE Ecuador, volunteers from Motorola Foundation and technicians from the Municipality of Nabón.

The rehabilitation of the backbone network consists of the installation of active equipment and its components in the Nabón, Arverjillas, Huasiloma, Caratlo and Bayan links. The rehabilitation also included the installation of a tower for the equipment located in Arvejillas and the preventive maintenance of the other towers.

The project team made the necessary arrangements with the Internet service provider to increase the network bandwidth from 20 Mbps to 100 Mbps, without adding the cost of the service to the Municipality of Nabón.

Figure. 4. Project team in the rehabilitation of the backbone network. Own source.

The rehabilitation of the access network consists of the change of receiving antennas, routers, network cables and other accessories for the 40 schools that are part of the Internet network and, in some cases, included the change of antenna masts and cards. wireless network of computers. The rehabilitation in each school also included the preventive maintenance of hardware and software of the terminal devices of each of the schools. Through the measurement of internet speed in each school, the adequate levels of bandwidth for each access network are verified.

Figure. 5. Volunteers installing access networks. Own source.

In order to ensure the sustainability of the network over time, four technicians from the Municipality of Nabón were trained in the management and maintenance of the Internet network, this will allow the continuous operation of the network and the solution of technical problems in less time.

Achievements and lessons learned

The participation and commitment of the community in the implementation of the project were essential for the successful completion of the rehabilitation process.

Given the restrictions due to the COVID-19 pandemic, adaptation to the new conditions in the implementation of this type of project was essential to meet the objectives of the rehabilitation of the Internet network.

The rehabilitation of the Internet network in 40 schools in the Nabón community has allowed around 2,400 students to have access to the Internet to improve their quality of education. This project had a greater impact by allowing access to virtual education to students during the COVID-19 pandemic.

Figure. 6. Beneficiaries of the project using the Internet network.

Conclusions and future work

An evaluation of the current state of the previous systems was carried out, identifying opportunities in the existing infrastructure. This evaluation showed the availability of the civil and electrical infrastructure, but also showed that the active equipment of the backbone network and the access networks had to be replaced and that training is necessary for the technical staff of the community for the management and maintenance of the network.

The Internet network for 40 schools in the Nabón community was successfully rehabilitated. Community members, mainly children, have taken advantage of the Internet to access virtual education during the COVID-19 pandemic.

This project can serve as a model that can be replicated in 8 Internet networks identified in other rural areas of Ecuador that are not operational. The project team is working on the next phase that seeks to rehabilitate the internet network in 20 schools. The authors are also working on evaluating the project's Social Return on Investment (SROI).

Acknowledgments

This work was supported by IEEE through a grant from IEEE SIGHT. This project was also partially supported by the Municipality of Nabón, the Motorola Foundation, the IEEE Young Professionals program and the Universidad Politécnica Salesiana de Cuenca. In addition, the authors thank the 35 volunteers from IEEE Ecuador and the Motorola Foundation, for their contribution during the rehabilitation of the Internet network in the Nabón community.

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LAEDC2021

Rehabilitation of an Internet network in 40 schools in the Nabón community, Ecuador.

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1. Introduction

In Ecuador, only the 22% of homes in rural areas have internet access. This show the need for actions to reduce the digital gap to improve the quality of education in rural communities.

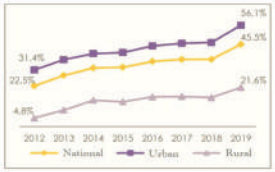

Fig. 1. Percentage of houses with internet access, by area, in Ecuador.

In 2008, the government of Ecuador and the Municipality of Nabón implemented an Internet network for 60 schools. The internet network is based on long-range wireless technology and its topology includes: service node, backbone, access networks and terminals., as shown in the Fig. 2.

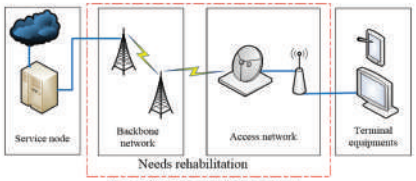

Fig. 2. Nabón network topology.

This project aims to rehabilitate the Internet network of 40 schools in the Nabón canton, which will allow students and teachers to improve the quality of education.

2. Design of the proposed network

An evaluation concluded that the network does not work in 40 schools, due to problems in 5 radio links of the backbone network: Nabón – Arverjilla – Huasiloma – Caraylo – Bayan - Camara, as shown in Fig. 3.

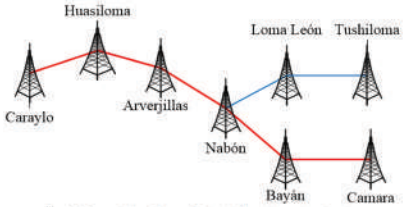

Fig. 3. Current situation of the Nabón Internet network.

For the calculation of radio links, parameters such as: line losses, propagation and power losses and receiver sensitivity are considered.

To increase the bandwidth of 0.25 Mbps to 10 Mbps for each school, management is carried out to increase the capacity of the network from 20 Mbps to 100 Mbps, without adding costs to the operation of the network.

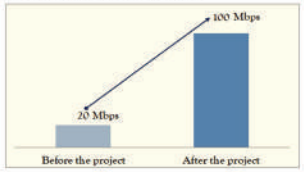

Fig. 4. Increase the bandwidth in the Nabón Network.

3. Implementation

The necessary logistics are coordinated to carry out the work in 3 interventions, which included the work of volunteers from IEEE Ecuador, volunteers from Motorola Foundation and technicians from the Municipality of Nabón.

Fig.5. Backbone and access network installation.

The rehabilitation in 40 schools in the Nabón community has allowed around 2,400 students to have access to the Internet to improve their quality of education. This project had a greater impact by allowing access to virtual education to students during the COVID-19 pandemic.

To ensure the sustainability of the network, four technicians from the Municipality of Nabón were trained in the management and maintenance of the Internet network.

Fig. 6.. Technicians from the Municipality of Nabón in the training.

4. Conclusions / Next Steps

- An evaluation showed the availability of the civil and electrical infrastructure, but also showed that the active equipment of the backbone network and the access networks had to be replaced and that training is necessary for the technical staff of the community for the management and maintenance of the network.
- The Internet network for 40 schools in the Nabón community was successfully rehabilitated. Community members, mainly children, have taken advantage of the Internet to access virtual education during the COVID-19 pandemic.

Fig. 7. Beneficiaries of the project using the Internet network

- This project can serve as a model that can be replicated in 8 Internet networks identified in other rural areas of Ecuador that are not operational. The project team is working on the next phase that seeks to rehabilitate the internet network in 20 schools. The project team are also working on evaluating the project's Social Return on Investment.

IEEE Advancing Technology for Humanity

2021 IEEE Latin American Electron Devices Conference (LAEDC)

Electron Devices Society

Ilustration 1. Presented Poster at LAEDC 2021.

Humanitarian Projects Development from Universidad del Zulia SIGHT Affinity Group

Desarrollo de Proyectos Humanitarios desde el Grupo de Afinidad SIGHT de la Universidad del Zulia

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Rodríguez, L; Hernández, J; Peres, J; Viloria, J; Sánchez, L; Urdaneta, H; González, D; Mendoza, N; Tello-Maita, J; Contreras, A; Briceño, M; Guevara, C. Humanitarian projects development from Universidad del Zulia sight affinity group. *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 56-61.

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Keywords

Humanitarian projects; Universidad del Zulia; volunteering; quality of life; distance education; educational project; COVID-19.

Abstract

This work aims to divulge the volunteering experiences within humanitarian projects development from Universidad del Zulia SIGHT affinity group in Venezuela. At first, “Una mano por tu Facultad” project carried out in 2019 is described, which had the active participation of volunteers from the RE-IEEE-LUZ student branch and the SIGHT-LUZ affinity group and resulted in the recovery of twenty-six (26) classrooms and four (4) laboratories of the Faculty of Engineering. Furthermore, a new project is underway in response to COVID-19, which is focused on a distance education system using funds approved by the Humanitarian Activities Committee (HAC) and the Special Interest Group on Humanitarian Technology (SIGHT) of the Institute of Engineers Electrical and Electronic (IEEE). This group has the objective of bringing technologies-based solutions to problems existing in local communities in the Zulia State, Venezuela.

Palabras clave

Proyectos humanitarios; Universidad del Zulia; voluntariado; calidad de vida; educación a distancia; proyecto de educación; COVID-19.

Resumen

El trabajo presentado tiene la intención de divulgar las experiencias de voluntariado en el desarrollo de proyectos humanitarios desde el grupo de afinidad SIGHT de la Universidad del Zulia (LUZ) en Venezuela. En primer lugar, se describe el proyecto “Una Mano por tu facultad” llevado a cabo en el 2019, que contó con la participación activa de los voluntarios de la rama estudiantil RE-IEEE-LUZ y del grupo de afinidad SIGHT-LUZ y resultó en la recuperación de veintiséis (26) aulas y cuatro (4) laboratorios de la Facultad de Ingeniería. Además, un nuevo proyecto se encuentra en marcha en respuesta al COVID-19, enfocado en un sistema de educación a distancia utilizando fondos aprobados por el Comité de Actividades Humanitarias (HAC) y el Grupo de interés especial sobre tecnología humanitaria (SIGHT) del Instituto de Ingenieros Eléctricos y Electrónicos (IEEE). Este grupo busca aportar soluciones basadas en tecnologías a problemas existentes en comunidades locales del Estado Zulia, Venezuela.

Introduction

The Universidad del Zulia (LUZ) is an autonomous public university funded in 1891 at Maracaibo, Venezuela. It is one of the largest and most relevant universities form this country, with more than 70.000 students and 150 academic programs [1]. Since 1999 students and professors at the Electrical Engineering School of this institution have integrated the IEEE student branch (RE-IEEE-LUZ), being a non-profit organization with the mission of bringing its members closer to the industry through the organization of extracurricular activities joining important organizations from the industrial sector [2].

The Institute of Electrical and Electronics Engineers (IEEE), is the world’s largest professional technical society dedicated to advancing technological innovation and excellence for the benefit of humanity. The student branches, chapters, and affinity groups from IEEE organize a large number of technical, non-technical, administrative and social activities, most of them free and open to the community. [3].

In 2019, the SIGHT-LUZ group was founded as an initiative of several members of the RE-IEEE-LUZ, who were already involved in community service projects paired with NGOs from the region. This proposal was also motivated by the humanitarian crisis that has taken place in recent years in Venezuela, with more than 4.5 million Venezuelans leaving the country and more than 90% of the population living with incomes that qualify as poverty [4].

Being LUZ a public institution, an important part of it depends on government funding to operate, and under current circumstances, this funding has been reduced to a historical minimum. Therefore, the members of the SIGHT-LUZ group have perceived this as an opportunity of implementing projects and programs that can contribute to the continuity of the academic activities carried out in the Electrical Engineering school, which is an essential area for the development of any country and industry.

Furthermore, the COVID-19 pandemic has affected the world in an unprecedented manner, and as such, HAC/SIGHT (Special Interest Group on Humanitarian Technology) is offering a Call for Proposals to support IEEE grassroots humanitarian technology and sustainable development projects that utilize technology to address the COVID-19. As a result, "Distance Education Program Adapted to COVID-19 for Universidad del Zulia" funding was approved, and the project is ongoing.

A helping hand for your faculty

"Una Mano por tu Facultad" was the name given to this project involving all student and professors community from the Engineering Faculty of Universidad del Zulia [5]. In 2019, this was the 4th opportunity to engage in this project with the help of different departments from the Engineering Faculty and lead by RE-IEEE-LUZ and the SIGHT-LUZ Affinity Group. It was a nonprofit initiative focused on recovering, maintaining, and rebuilding study spaces for all the students, improving quality of life and education.

It involved the development of activities in electricity, carpentry, and painting disciplines by qualified volunteers making it a special opportunity to reunite former students, professors, and young professionals during difficult times in our University. Figure 1 exemplifies some of the activities carried out by volunteers in the specific area of electricity, by the restoration and replacement of luminaries.

Figura 1. Restoration and replacement of luminaries in the Engineering Faculty of the Universidad del Zulia as part of the "Una mano por tu Facultad" project.

Distance education program adapted to COVID-19 for Universidad del Zulia

COVID-19 restrictions have worsened the already critical socio-economic situation of Venezuela. This project aims to develop a distance education program for students of electrical engineering of the Universidad del Zulia (LUZ), located in Maracaibo, Zulia State, which is one of the cities of Venezuela that has been more affected by the complex humanitarian crisis that has taken place in this country. Universidad del Zulia is one of the main universities in the state, but the current situation has impeded access to economic resources and the deterioration of its infrastructure has been evident. Therefore, the project intends to provide internet service and the appropriate electronic equipment for the implementation of an online program for the School of Electrical Engineering.

The launch of the project is possible thanks to funding opportunities offered to special project calls for proposals focused on COVID-19 [6]. This project is aligned with No Poverty, Good Health and Well-Being, and Reduced Inequalities as per United Nations Sustainable Development Goals (SDGs) [7].

The opening of virtual classrooms is currently coordinated by SIGHT group volunteer's collaboration with professors at Distance Education Services from Universidad del Zulia (SEDLUZ) where the digital content created by professors must be adapted to low-speed mobile internet connections to ensure that most of the students can have access to it so that the audio and video must be recorded and compressed.

This project will implement existing mobile apps to create and share educational content for the student community at our location. Furthermore, this Project is using open source and result in open-source resources for others to use. Once this pilot program is concluded, SIGHT volunteers from RE-IEEE-LUZ see with enthusiasm extending this project to other areas within Universidad del Zulia, across Venezuela, and even supporting collaboration with other SIGHT groups from Latin America and Caribbean IEEE Region 9.

Results and discussion

"Una Mano por tu Facultad" initiative was supported by different NGOs and private organizations providing material resources and volunteers. The project resulted in the recuperation of twenty-six (26) classrooms and four (4) laboratories in the Engineering Faculty [4].

More recently, The COVID-19 pandemic has affected the world in an unprecedented manner, and as such, HAC/SIGHT is offering a Call for Proposals to support IEEE grassroots humanitarian technology and sustainable development projects that utilize technology to address the COVID-19. As a result, #20-COV-185 project funding was approved, and the project is currently ongoing.

Conclusions and next steps

SIGHT-LUZ group work done on humanitarian projects has had important results for the Universidad del Zulia and all the students who participate in a free education in their classrooms. It is hoped that these projects can continue to be carried out with greater commitment and scope over time, to provide solutions based on technologies for the development of local communities.

In the future, it is planned to work on projects related to solar energy as a solution to electricity supply failures in the region. Likewise, work will be done on a project to provide training to migrants and people in vulnerable conditions in border areas, in conjunction with established NGOs.

Acknowledgment

RE-IEEE-LUZ and the SIGHT-LUZ group thank Chevron Corporation, Polinter, Nabors, Gerenpro, Confurca, and Turagual for sponsoring this project. Also, special thanks to BCM Ingeniería and BRIPCO Engineering & Services for gathering sponsors for this project, and always tutoring activities of RE-IEEE-LUZ.

For the new ongoing project, funding is possible thanks to HAC/SIGHT from IEEE. Special thanks to Professor Claudio Bustos de SEDLUZ for his active participation during the development of this project.

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UNIVERSIDAD DEL ZULIA

LAEDC2021

Humanitarian Projects Development from Universidad del Zulia SIGHT Affinity Group

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Introduction

The Universidad del Zulia (LUZ) is one of the largest and most relevant universities from Venezuela, with more than 70.000 students and 150 academic programs. Since 1999 students and professors of the Electrical Engineering School of this institution have integrated the IEEE student branch (RE-IEEE-LUZ).

In 2019, the SIGHT-LUZ group was founded as an initiative of several members of the RE-IEEE-LUZ.

This work describes the volunteering experiences within humanitarian projects development from SIGHT-LUZ affinity group at Maracaibo, Venezuela.

Results and Discussion

"Una Mano por tu Facultad" was supported by different NGOs and private organizations providing material resources and volunteers. The project resulted in the recuperation of **26 classrooms** and **4 laboratories** in the Engineering Faculty. RE-IEEE-LUZ and the SIGHT-LUZ group thank Chevron Corporation, Polinter, Nabors, Gerenpro, Confurca, and Turagual for sponsoring this project. Also, special thanks to BCM Ingeniería and BRIPCO Engineering & Services for gathering sponsors for this project, and always tutoring activities of RE-IEEE-LUZ.

More recently, The COVID-19 pandemic has affected the world in an unprecedented manner, and as such, HAC/SIGHT is offering a Call for Proposals to support IEEE grassroots humanitarian technology and sustainable development projects that utilize technology to address the COVID-19. As a result, **#20-COV-185** project funding was approved and the project is currently ongoing.

Materials and Methods

A helping hand for your Faculty, "*Una Mano por tu Facultad*" was the name given to this project involving all student and professors community from the Engineering Faculty of Universidad del Zulia.

It involved the development of activities in electricity, carpentry, and painting disciplines by qualified volunteers making it a special opportunity to reunite former students, professors, and young professionals during difficult times in our University.

Conclusions / Next Steps

"Distance Education Program Adapted to COVID-19 for Universidad del Zulia", in collaboration with professors at Distance Education Services from Universidad del Zulia (SEDLUZ), will implement existing mobile apps to create and share educational content for the student community at our location. Furthermore, this content will be open access and available for the public in general to use.

The new project intends to provide internet service and the appropriate electronic equipment for the implementation of an online program for the School of Electrical Engineering. Once this pilot program is concluded, SIGHT-LUZ see with enthusiasm extending this project to other areas within LUZ, all across Venezuela, and even supporting collaboration with others SIGHT groups from IEEE Region 9 Latin America and Caribbean.

IEEE Advancing Technology for Humanity

2021 IEEE Latin American Electron Devices Conference (LAEDC)

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Ilustration 1. Presented Poster at LAEDC 2021.

Comprehensive information platform of COVID-19 in Costa Rica

Plataforma de información integral del COVID-19 en Costa Rica

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Zuniga-Brenes, S.A. Comprehensive information platform of COVID-19 in Costa Rica . *Tecnología en Marcha*. Vol. 34, especial. Noviembre LAEDC 2021. Pág 62-72.

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Keywords

COVID-19; Costa Rica; development project; information and development; investigation project; avoid the infodemic.

Abstract

The availability of information locally and in an accessible way on active cases of COVID-19 is essential for the control of a pandemic because the population can be protected with greater accuracy and sensitivity. The Comprehensive Information Platform of COVID-19 in Costa Rica was created and was available during the first wave of COVID-19 and had a great impact on Costa Rican society and communities since approximately one million people received information from the Platform between July and December 2020.

Its construction specifically aimed at the different epidemiological moments of the country and the most relevant aspects of the Costa Rican agenda in the economic, social, and medical sector, made the platform fulfill the objective for which it was created since its instantaneous versatility made it adapt to the various moments of the pandemic in the country.

For the construction of this non-profit humanitarian project, we had the support of donations from Costa Rican civil society.

Palabras clave

COVID-19; Costa Rica; proyecto de desarrollo; información y desarrollo; proyecto de investigación; evitar la infodemia

Resumen

La disponibilidad de información a nivel local y de manera accesible de los casos activos del COVID-19 es esencial para el control de una pandemia debido a que la población puede protegerse con mayor exactitud y sensibilidad. La Plataforma de Información Integral del COVID-19 en Costa Rica fue creada y estuvo disponible durante la primera ola de COVID-19 y tuvo un gran impacto en la sociedad y las comunidades costarricenses ya que aproximadamente un millón de personas recibieron información de la Plataforma entre julio y diciembre del 2020.

Su construcción específicamente destinada a los diferentes momentos epidemiológicos del país y a los aspectos más relevantes de la agenda costarricense en el sector económico, social y médico, hizo que la plataforma cumpliera con el objetivo para el cual fue creada ya que su versatilidad instantánea hizo que se amoldara a los diversos momentos de la pandemia en el país.

Para la construcción de este proyecto humanitario sin fines de lucro, se contó con el apoyo de donaciones de la sociedad civil costarricense.

Introduction

The first detected case of COVID-19 in Costa Rica was on March 6th of 2020 [1]. The Pandemic declaration by the Health World Organization was 5 days after [2] and then was declared the National Emergency of the Centro-American country [3].

In the process of changing the national agenda into an “agenda for COVID-19”, Costa Rica had several issues; one of them was the communication with the citizens and local governors [4].

The information of the active cases of COVID-19 in Costa Rica was published daily by the Health Ministry on their official Facebook page (on an image sometimes with indistinguishable information) at a regional level (but not district).

Figure 1. Example of a Facebook post by the Health Ministry with the country and regional (not district) epidemiological data. [5]

The district information was available on another website for download. If the people wanted to observe the active cases in their district, they would need to download a file (an excel) with thousands of rows (all the data of the country with a 7-day history). This process made the information inaccessible for the citizens since you may need a computer with a Microsoft Office license and several abilities with excel to visualize the data properly [6] [7].

a)

b)

CUADRO No.7-2
Número de casos acumulados, recuperados, fallecidos y activos por COVID-19[1]
Por provincia,cantón y distrito
22 de julio,2020

Provincia	Cantón	Distrito	ACUMULADOS Casos*	RECUPERADOS Casos*	FALLECIDOS Casos*	ACTIVOS Casos*
San José			6809	1282	42	5485
	Acosta		41	19	0	22
		Cangrejal	2	1	0	1
		Guaitil	3	2	0	1
		Palmichal	10	2	0	8
		Sabanillas	1	0	0	1
		San Ignacio	24	13	0	11
		Sin información de distrito	1	1	0	0
	Alajuelita		790	101	2	687
		Alajuelita	126	30	1	95
		Concepción	169	28	0	141
		San Antonio	33	2	0	31
		San Felipe	371	28	1	342
		San Josecito	85	11	0	74
		Sin información de distrito	6	2	0	4
	Aserrí		154	73	0	81
		Aserrí	104	51	0	53
		Legua	0	0	0	0
		Monterrey	2	0	0	2
		Salitrillos	19	7	0	12

Figure 2. Access of the excel file with all the epidemiological data. (a) Download bottom of the Excel file . (b) Excel with hundreds of rows and thousands of data [6].

That lack of progress in the usage of technology tools regarding accessibility for the citizens and even decision-makers made the cornerstone of the Comprehensive Information Platform of COVID-19 in Costa Rica. The Regional data could include de epidemiological information of multiple towns. The district data is a more local (single town) information.

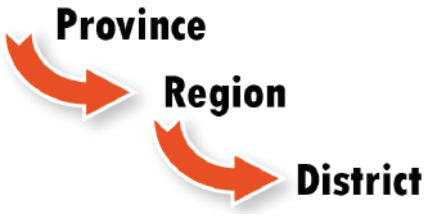

Figure 3. Territorial organization of Costa Rica.

The main objective of the Platform was the accessibility of the epidemiological district data of the pandemic all over Costa Rica since the empowering of the communities with correct information is one of the main methods of weakening the spread of COVID-19 [8, p. 6].

Methodology

The Platform was developed with an app engine called "Appsheet" which uses Google services and hosting. This decision made the Platform robust and secure since it had several security steps for sign in and it had support 24/7 in case a bug happened.

The Platform development began in May 2020 and was a process of analysis and constant change since those are the characteristics of this COVID-19 Pandemic. At that moment, the Platform had to:

- Change immediately in certain circumstances.
- Be secure.
- Be accessible.
- Display with high-quality standards and without errors all the epidemiological information of COVID-19 in Costa Rica at a district level.
- Display any other information that may help the efforts weakening the spread of COVID-19.

At the beginning of June, the Platform was done. The process of programming and development was fast because of the increasing number of active cases and the need for information of the population. All the data on the Platform was trusty since the only source was the data of the Ministry of Health of Costa Rica and the systems were connected in real-time.

The platform had a verification system that corrected any kind of mistakes made by the Ministry, specifically in the "new cases". Sometimes, there were days on which the accumulated number of cases (AC) of day 2 were inferior from the data of day 1 and that is impossible. These mistakes in the data could have been related to administrative mistakes. If "AC" represents the "Accumulative Cases" and "NC" represents the New Cases:

$$NC = AC\ day\ 2 - AC\ day\ 1 \geq 0 \quad (1)$$

1. If [1] is True, the data had no mistakes. The premise was: "Tomorrow must have zero or more accumulate cases than today."

2. If for some reason, the data had a mistake; (1) is False and the result was a negative number.

$$AC\ day\ 2 - AC\ day\ 1 \leq -\ \# \quad (2)$$

As a correction, The Platform changed the number below zero (-#). So, the result in this case was that the New Cases (NC) was changed and equal to zero and the Accumulate Cases (AC) was updated to the AC day 2 info.

$$AC\ day\ 2 - AC\ day\ 1 = 0 \quad (3)$$

$$AC\ day\ 2 = \text{"Accumulate Cases (AC)'} \quad (4)$$

These changes are optimal and a must since those mistakes could have an impact on the popularity and thrust of the Platform.

There were irregularities with the management of the information and data registration of the Pandemic by the authorities [9], but this paper is not going deep inside that.

For security reasons, the Platform did not collect any kind of data from the users.

Release of the platform

The Platform was accessible since the users were able to access it from a web page and a mobile app available for iOS and Android users.

In the beginning, the people knew about the creation of the Platform thanks to communities and local committees that shared the content of the Platform. There was not a marketing budget.

After several meetings with the Institute of Technology of Costa Rica, Department of Communication and Marketing, the Platform was massively disclosed to the public.

Days after, the Platform was announced on several impressed and digital media and almost every popular TV Broadcast Network in the country [10] [11] [12]. As a result, the users of the Platform increased abruptly.

a) b)

Figures 4. Media interviews with major TV Broadcast in Costa Rica. 4a) Interview with Noticias Repretel. 4b) Interview with Sinart 13.

Results

The Platform gave COVID-19 epidemiological information directly and indirectly approximately to 1 million citizens from July 15 th to December 31st.

The Platform was completely accessible and that is the main reason why in a small period, had the potential to impact so many people.

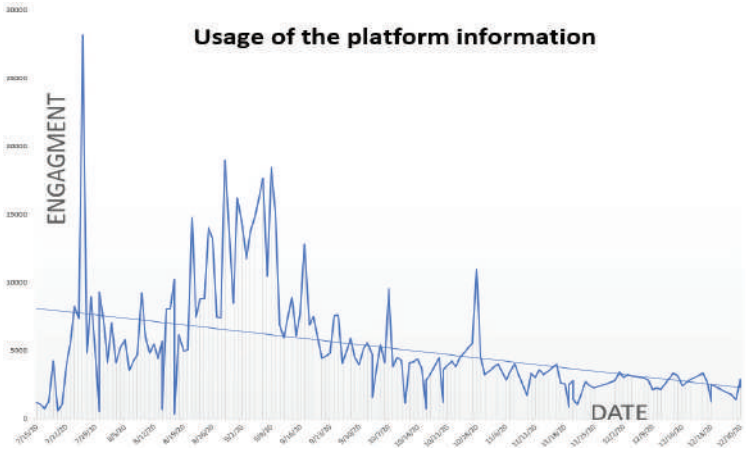

Figure 5. Usage of the Platform information. In y axis, is the Engagement represented by the number of the users of the Platform and the total impressions of the Facebook page. In x axis is the date from July 15 th to December 31st.

Also, some effects could higher up those statistics. For example, local Facebook pages used the information of the Platform and transformed those into infographic files (those numbers are contemplated in the approximation of the 1 million people), but then, those infographic flyers were sent via Whatsapp (these numbers were not possible to measure). In other words, there was a whole social network (WhatsApp) that was used by the people to divulge information given by the Platform. These statistics were impossible to collect and are unmeasurable.

Another positive aspect is that the Platform was an “All in one “; as the name said. The people were able to consult a variety of information. Since the COVID-19 pandemic had negative effects on every social activity, those changes created big issues in the economic and mental health of the people. The Platform included mental health advice, a national program of virtual education called “Aprendo en Casa” [13], information and “what to do”, if someone had COVID-19 symptoms, frequently questions regarding the pandemic, motivation videos, automobile and regional restrictions on commerce, as well as other sections of importance. The Platform did well, and no kind of problems were reported in the more than 219 000 minutes (5 months) that the Platform was active.

Platform View

Figures 6. Detail of the epidemiological data by district. This data was updated daily.

Figure 7 . Economic section with all the commerce restrictions.

Figure 8 . Menu for the program “Aprendo en Casa”. In this section, students could watch videos from the Ministry of Education regarding their level at school and high school.

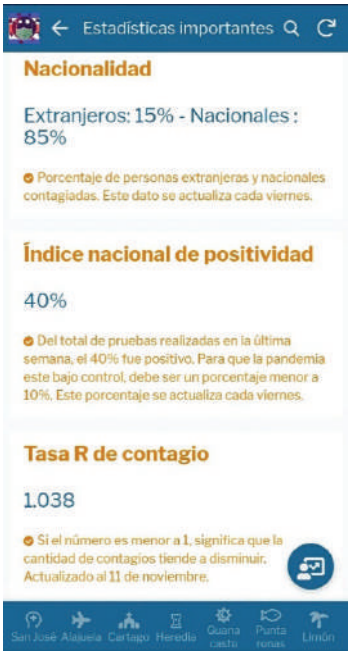

Figure 9 . Epidemiological technical information such as the Positivity National Rate and the R Rate (Reproduction number).

Figure 10 . Hospital occupancy.

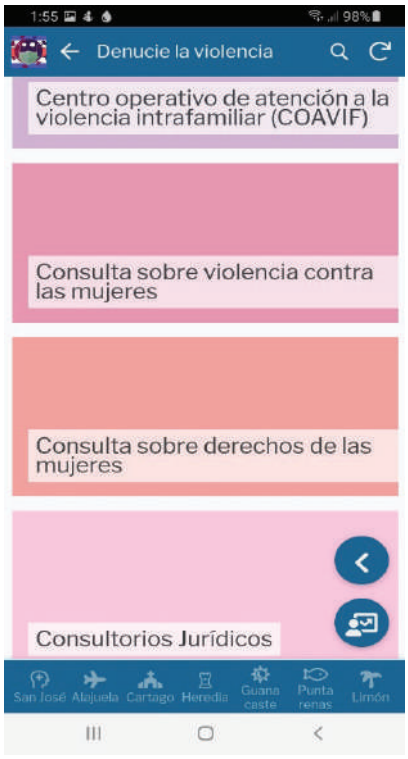

Figure 11 . Menu with social approach and information regarding violence in the family.

The platform was comprehensive since the Pandemic affected all levels of society. The last 6 figures reflects some of the final product that the platform gave to thousands of people. Also, there were other sections such as the vehicular restrictions, motivational videos, FAQ regarding the pandemic, airport, and immigration policies section.

The official logo of the Platform was an animated COVID-19 virus with a mask.

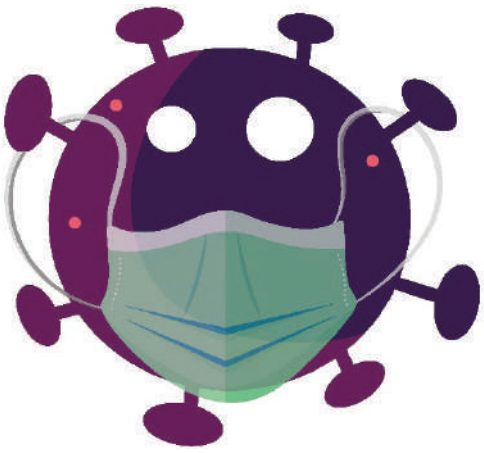

Figure 12 . Official logo of the Comprehensive Information Platform of COVID-19 in Costa Rica.

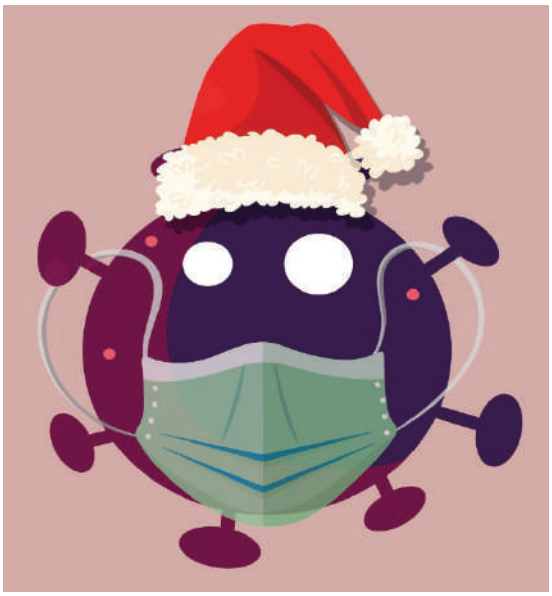

Figure 13 . Official Christmas logo of the Comprehensive Information Platform of COVID-19 in Costa Rica.

Conclusion

The main objective of the Platform was completed since approximately more than 1 million people had essential epidemiological information of the pandemic in Costa Rica thanks to the Comprehensive Information Platform of COVID-19 from July 15 th to December 31st.

It is impossible to determine if the Platform had a role in weakening the spread of COVID-19 in the country, but the fact is that approximately 20% of the population of Costa Rica had essential COVID-19 information thanks to this non-profit project.

Acknowledgment

To the anonymus people that donate to the project, My family, Esteban Arias Méndez, Iván Vargas Blanco, Irina Grajales Navarrete, close friends that supported the project in different ways.

This project is dedicated to all the families who lost a loved one to the COVID-19 pandemic.

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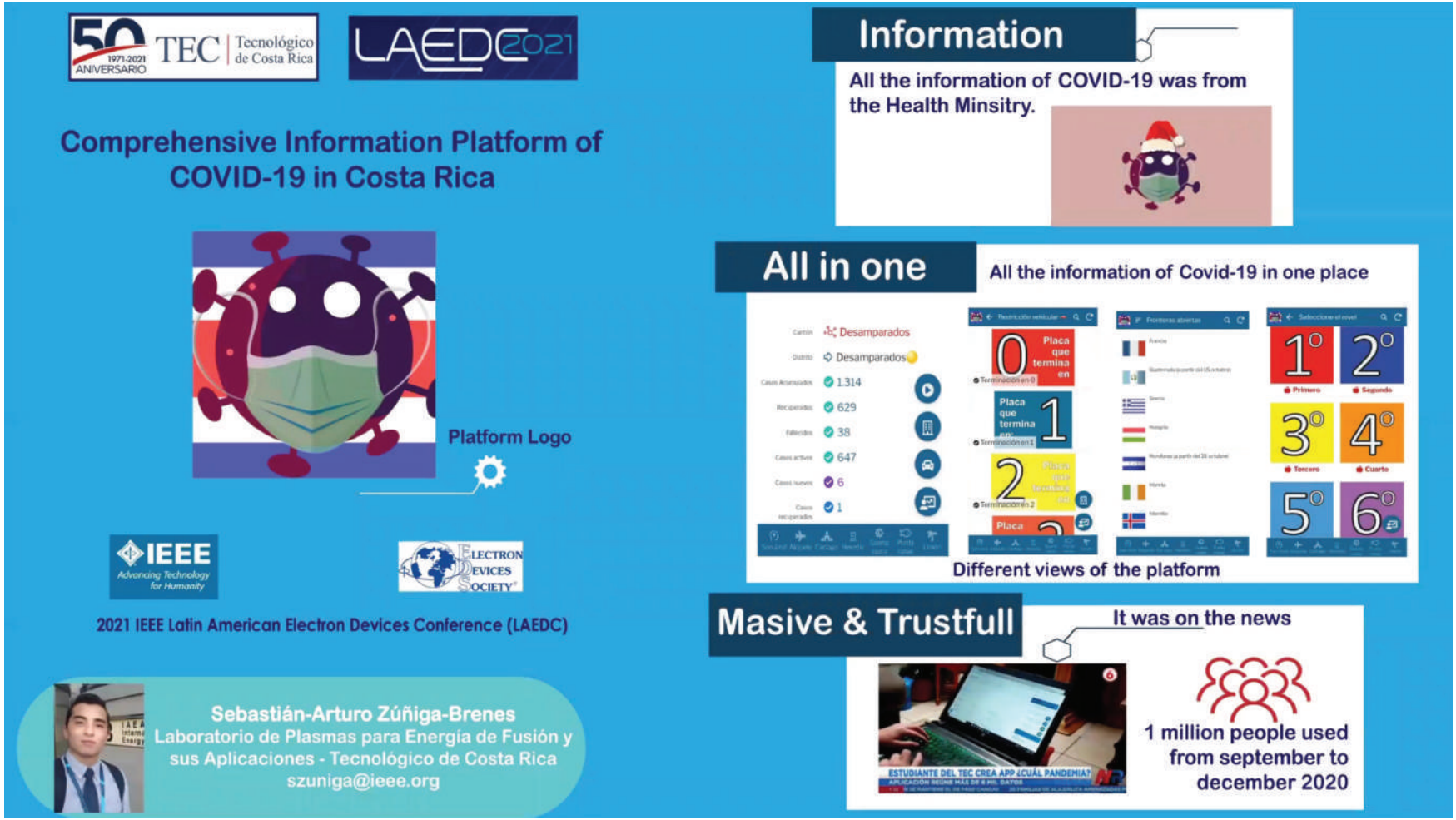

Ilustration 1. Presented Poster at LAEDC 2021.