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An Experimental Research with 3D Objects for the Internet of Things

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Abstract

This study presents the results of experimental research with the use of 3D resources. Unlike the creation and printing of physical objects, that can serve as an interface for 3D devices. The creation of solutions for the internet of things requires, besides the knowledge of programming, electronics, internet, and computing, also requires the creation of parts, which are often complex, for coupling and manipulation of devices to the internet of things. Personal experience during computer classes was the main motivation for the development of this work, demonstrating how to create solutions that can meet the different projects that involve the internet of things. In addition to presenting the results of a comparison between some tools evaluated during the research. The results were collected during the creation of the objects in 3D systems, besides presenting the results in pieces that were printed with this technology, these results demonstrated the possibility of creating viable solutions, and that can serve as a model for new projects, facilitating the development of solutions to the internet of things.

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1. Introduction

Due to the growth in the development of solutions for the internet of things. This project had the greatest motivation, the need to create objects that can serve as an interface for devices created for the internet of things, such as sensors, screens, couplings, among other needs involved during the projects to meet the transmission or receipt of data collected during the research. As a general objective, a discussion about the main tools existing between 2017 and 2018 should be presented. These tools are very used for the creation of 3D objects as if they were tools used by architects or engineers; these tools allow to define the size, colors, width, depth, as well as the connection for screws and openings for the passage of connecting devices.

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As a specific goal, a 3D project must be created to attend a particular study using the internet of things, the tools 3DBuilder, 123 Design, Google SketchUp should be analyzed. In this way, the reader will be able to understand its applications and implications in the creation of the solution after the creation of the project, the physical impression of the object must be performed to demonstrate its coupling with the Nextion and NodeMCU TFT devices. The results, although used in a specific project, could be adapted among other different types of projects, allowing them to be expanded to the different demands, as well as being the basis for future studies on the internet of things. This project besides being necessary a basic knowledge of computation also offers a cost considered low, because for the creation of the objects there are no costs, but for the printing, which can be done by renting or requesting an impression on demand.

As expected results, quantitative and qualitative data should be presented for the validation of the research, as well as the discussion about the different technologies used during the project. To exemplify the process, from the basic and basic needs for the construction of solutions for meet the type of project, allowing adaptation to more sophisticated projects which meet higher demands.

2. Research Methods

During the development of this project, the following research methods were used:

Basic research: to understand the main components involved, analyzing scientific materials, manuals among other commercial documents, about the products that can serve as a basis for the creation of the solution, mainly because it is modern technology. It is necessary a study on the literature that involves the universe about the products.

Experimental research: it should be presented other experiments that served as the basis for this project, enabling the creation of the solution. In this way were analyzed other projects that deal with the internet of things, in which specific solutions were presented for a certain real need, in this way validation of the studies through this experience. Presentation of current computational tools that are normally used for the creation of 3D objects should be presented some 3D printers, the type of material used for printing such as filaments. The development tools used in this study are: Microsoft 3DBuilder, AutodeskDesign 123Design, and Google SketchUp, these tools are known and easy to use, often used in different types of projects.

After the experiments are carried out, a real object must be developed, which must be tested and coupled to the project for the internet of things, this should use a NodeMCU 12e, which replaces an Arduino, it is greater capacity, speed, and data communication with WiFi networks. In addition to the use of a Nextion 2.5 "TFT touchscreen, which was used to configure the devices, besides presenting the data on the screen, serving as an interface between the user and the device.

The bibliographical references for the use of the methods and approach of the project were based on the works developed and presented by Marconi and Lakatos (2017). Being this a reference in the studies for the development of projects of academic research, demonstrating the structure of a project, its phases, and forms of organization and structure, as well as the main topics that involve scientific research. Repetier software was used to print objects; this program allows the conversion of files that were developed in the 3D tools like 3DBuilder to the print format in STL file. With Repetier it is possible to control the creation of the object. During the printing of layer levels as well as orientation and arrangement of the object in the 3D printer.

The bibliographic research was carried out on the internet subject of things presented by: Cui [5], Drucker [6], Li et. al. [8], Ma et. al. [9], Mukhopadhyay & Suryadevara [11], Osemwegie et. al. [12], Stankovic [16], Whitmore and Agarwal [19], Wortmann & Flüchter [20], Zanella [21]. On the NodeMCU 12e device, the following authors were studied: Bento [1][2][3][4], Kamel et. al. [7], Siva [13], Škraba et. al. [14], Škraba [15]. On the 3D printing features, involving 3D Builder software, the following works were studied: Micallef [11], Turbovich et al. [17], Wang et al. [18].

3. Results and Analysis

For the use of the materials, several devices for the construction of 3D objects were studied, the studies were developed in the Brazilian national market, which has imported equipment divided into pieces, which are usually assembled and sold as a complete product. The various types of equipment that are of international origin. After the study, we selected low cost, quality equipment that could satisfactorily meet the requirements. Based on these requirements, the Stella 3D printer was selected because it is easy to acquire, as well as low cost, as detailed in following.

Figure 1. *Stella 3D printer, selected for the printing of objects.*

The Stella printer was selected for its simplicity and low cost. The final cost of the device was around 900.00 dollars, is available in different colors, some specifications are selected during the purchase of the printer, such as the type of nozzle injector, as well as their heating capacity, these requirements serve to improve the quality of the parts.

To use the printer you need to set up the Repetier software which is free. It is used to configure the print quality as well as some specific characteristics of the Stella printer, such as speed, layers between the position of objects during printing.

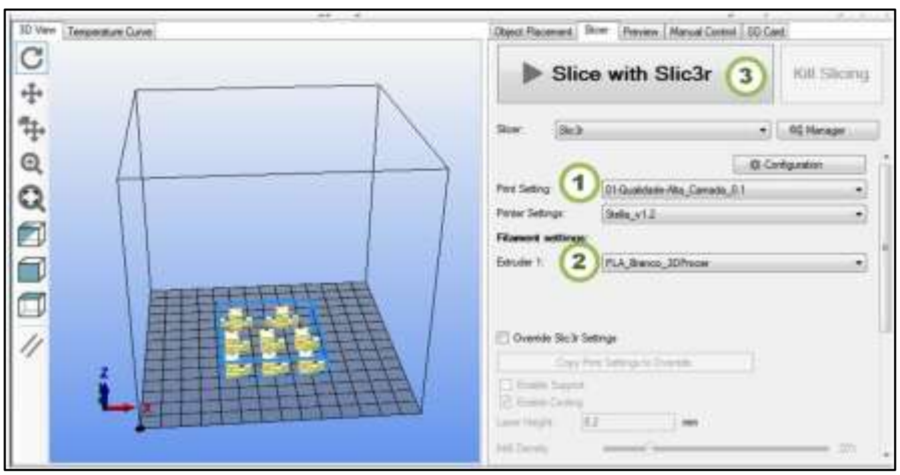

Figure 2. *Slitting screen with Repetier software for printing on Stella 3D*

When printing with Repetier software, it is necessary to configure the type of printer. The slicing off the part, i.e., the layers that should be required, considering the quality of the object, the layers may interfere with the final result, it is also configured the type of filament, in this case, the PLA was the material used, because it is less aggressive in the environment, it is not toxic to the human being, in case other material like the PET, are considered for objects like vases between other pieces in which it should not have direct contact with users.

Following the definition of the printer and the software for slicing, different systems were studied for the construction of 3D objects, such as Autodesk Design, Google SketchUp, and these are more complex resources, requiring a more in-depth technical knowledge. In this way, after analyzing Microsoft's 3D Builder software, which is already installed in the Windows 10 operating system, it was selected for its simplicity and objectivity in the construction of 3D objects.

Figure 3. *Microsoft 3D Builder Application Home Screen.*

In the initial screen, it is possible to select some models for example of creation. Besides allowing the opening of previously developed projects. There are several templates to be used, the basic features of construction are the expansions, rotations, duplication, these basic features allow you to build a myriad of objects as well as your organization.

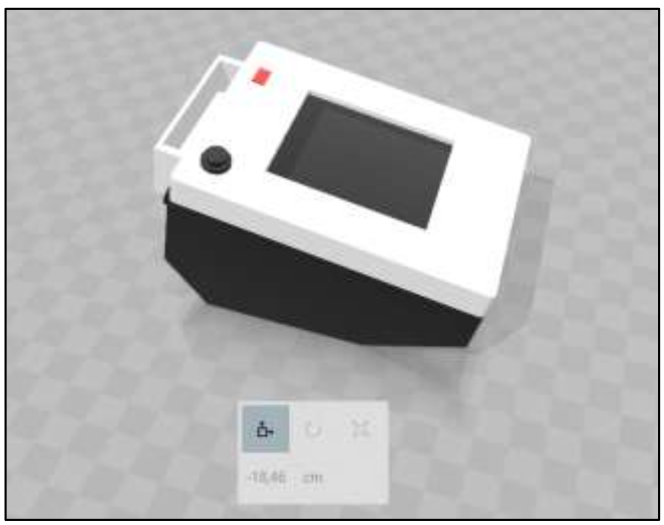
Figure 4. *Final result of the 3D object created in 3D Builder software*

As a final result, we have the 3D object created in 3D Builder software, using the basic features of the tool, and the bottom part of the object was used the box model for electronic devices presented by the company Patola, model PB-204/3. With the Patola model, the bottom was removed, and the device was turned upside down, the top part being the support for the Nextion TFT display, serving as a lock and for control and configuration of the NodeMCU 12e device in conjunction with Shield for expansion of connections and resources.

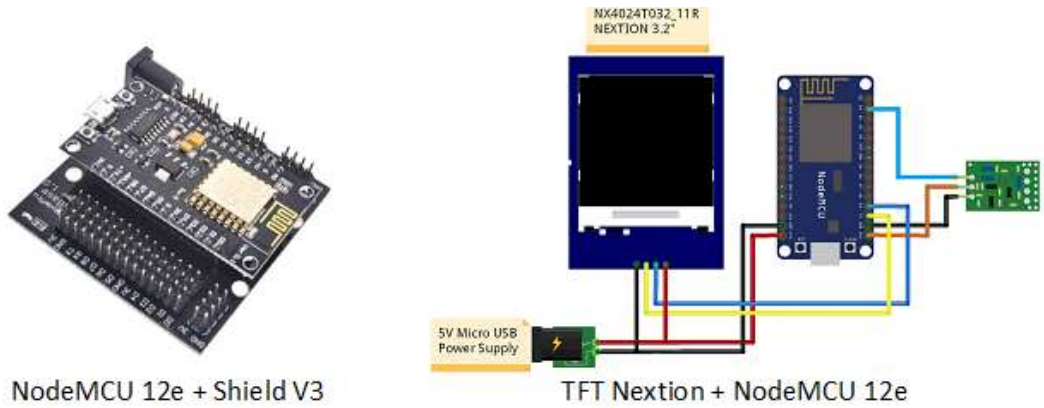

Figure 5 *Nextion TFT connection scheme with NodeMCU 12e*

The printed objects and their proper coupling must then be presented with the Nextion 2.5 "TFT devices and NodeMCU, already properly fixed and in operation.

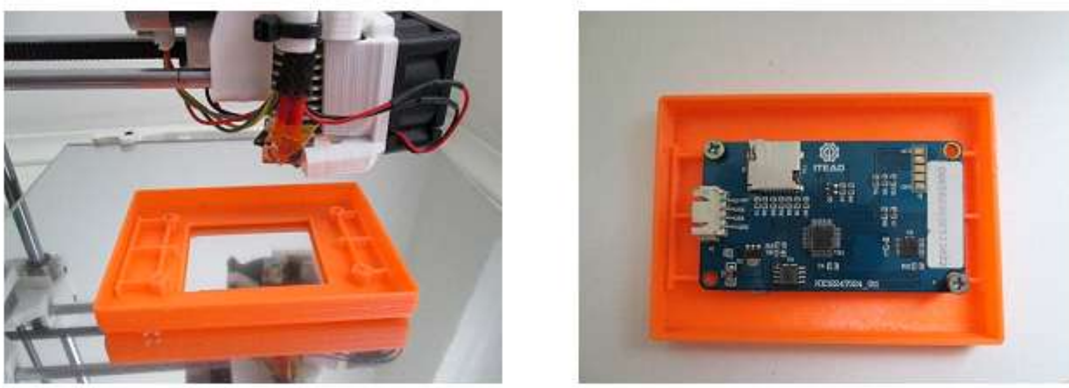

Figure 6 *TF Nextion printing and coupling process*

The printing process took about 1 hour; the 3D object was removed from the print tray, then the Nextion device fastened with screws on the 3D object, the construction of this object allowed the connection of the devices, as well as the realization specific tests to validate its operation. Despite being a simple model, the object meets the needs for coupling devices such as touch monitors, among other types that serve as the interface, for configuration, alteration, and presentation of data, collected during the use of sensors, or even for the presentation of images, and other features.

Figure 7 *TF Nextion TFT device fixed to 3D object*

With the object properly printed and the Nextion TFT device coupled, it was possible to carry out the connection and connection test on the electrical part, thus demonstrating the operation of the already fixed device and with the appropriate programming, codes loaded.

Figure 8 *TF 3D object printed and coupled with the Nextion TFT, connected in the Patola PB-204/3 box*

After all the tests with the coupled devices were carried out, the set was fixed in the Patola model PB-204/3 box. Also the power buttons were set, among other more specific features, to meet the different types of projects, considering small or large models.

Considering the results, it was possible to develop a model that can meet different types of projects, according to the type of Tex Nextion display of size of 2.5 inches. This type of display beside being the cheapest, meets different types of needs, using the basic features, such as allowing the configuration of sensors and recording and changing the date and time. These results allowed us to validate the use of the presented resources. Besides providing a model for more sophisticated projects, the creation of 3D objects, enabled prototyping and testing with the NodeMCU and Nextion devices, offering a broad view of how it could be coupling in different environments and configurations, to meet demands on various needs.

4. Conclusion

With the results of these studies, was to present in a practical way the use of 3D resources, to build solutions for the internet of things, serving as the basis for future projects, which can use this type of technology, due to the large number of tools available in the market, the focus of this study was to present a simple and feasible solution for project completion.

Despite the high cost of 3D printers in the Brazilian market, it was possible to identify its efficiency in the construction of objects that can have a medium scale. In this way, the production can be realized to meet small market demand, besides demonstrating as a reality even more current, about the materialization of objects using 3D resources.

The low cost involved in this project also demonstrates the ability to serve a small project, which requires only one or a few devices, typically used during classes, or for demonstrating solutions to the internet of things. The internet of things is a reality that only grows the enthusiasm of its followers, by facilitating the automation and communication between different devices. The costs involved in the creation of 3D objects are none because different computer systems allow the user to use their creativity to create different solutions. It is necessary an early study understand the main features of this step, which are still very similar to each other, will allow the user to evolve in their projects.

The highest cost involved the purchase of the 3D printer, which involved the value of $ 600.00, in addition to the filaments PLA, the material used to create the objects, which cost $ 60.00. The time of creation of the pieces varied between 1 and 2 hours, is extremely fast, compared with the complexity of the structure of each object constructed, the results demonstrated quality. It was hoped that the results of this study could contribute to the development and application in larger projects. Its complexity could contribute to the creation of new solutions that could serve the projects for the internet of things, among other types of projects used for demonstration, or even for a production, capable of solving some of the problems of society.

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