Chapter 173

Development of an automated greenhouse for plants

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ABSTRACT
This project proposes the development of a didactic plant (greenhouse) for monitoring and automating the variables of temperature, humidity, and luminosity through the Arduino, aiming at the development of a plant in a protected environment and on a reduced scale. As a project methodology, an automated prototype for greenhouses based on the Arduino platform was implemented, which receives information from the sensors and compares it with the pre-selected parameters, making it always follow the established measures for the good development of the crop in question. It is concluded that the simulations produced are fundamental to verify the response mode of the didactic plant in different conditions, chosen materials, and worked parameters, as well as allowing to guide the research group, regarding the ideal conditions for the development of the plant. Studies of this nature enable the development of domestic greenhouses combined with automation techniques, in addition to making plant production accessible and efficient in small-scale protected environments.

Keywords: Greenhouse, Arduino, Automated greenhouse, Sensors.

1 INTRODUCTION

Protected environments allow for increased efficiency in production, about the main factors that influence the development of these plants: are the controlled use of water, inputs, fertilizers, and luminosity (Azevedo Junior, 2016). In countries with high climate variation, such as Brazil, the cultivation of plants in greenhouses is widely used because it allows an increase in agricultural productivity since the variables that most influence the development of plants can be monitored and controlled, therefore, work in the area automation of resources such as automatic irrigation, ventilation systems, lighting, and room temperature control are gaining prominence.

Considering the specificities for the development of each plant, this project proposes the development of a greenhouse where variables such as humidity, temperature, and luminosity can be monitored and controlled to automate resources, thus enabling a better development of the crop plant in question. This work also aims to build a didactic plant in which automation and control techniques can be applied, allowing students of the Industrial Automation course to learn in practice the theoretical concepts seen during the course.

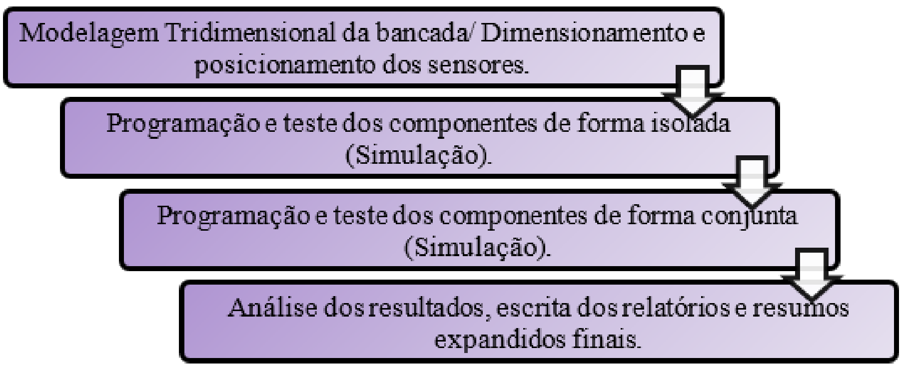
2 METHODOLOGY

This project lasted between August 2019 and August 2020, being extended for another three months due to the Coronavirus pandemic, ending in November 2020. best greenhouse to be mounted, the most suitable sensors, and the methodologies used. This step was also fundamental for the study of the theory involved in the development of the project.

The entire methodology was reformulated due to the new scenario in which we were inserted. Pre-pandemic, studies of the works were carried out, and the choice of sensors to be used, choice of the plant (beans), and some preliminary versions of the plant (prototypes) were made, however, due to the pandemic, the entire project was finalized virtual and as planning for the execution in future works. The new methodology adopted is outlined in Figure 1.

The Tinkercad platform was used for code simulation. The humidity sensor chosen was the Arduino hygrometer, widely used in electronic projects and home automation. The soil moisture sensor consists of 2 parts: a probe that comes into contact with the soil and a small module containing an LM393 comparator chip (datasheet) (Thomsen, 2016), which will read the data coming from the sensor and send it to them to the microcontroller, in our case an Arduino Uno. The luminosity sensor chosen was the LDR (Light Dependent Resistor) luminosity sensor, widely used in public lighting areas (Datasheet - Light Dependent Resistor - LDR, 2008).

Figure 1 - Updated flowchart on the methodology used in the research.



Subtitle: Three-dimensional modeling of the bench / Dimensioning and positioning of sensors
Programming and testing of components in isolation (Simulation)
Programming and testing of components together (Simulation)
Analysis of results, writing of reports, and final expanded summaries

To simulate the sensors (luminosity, humidity, and temperature) a potentiometer would be used and ranges of values would be used for each situation. For humidity, the values were divided into low, medium, and high humidity ranges. When the potentiometer was within the Low (< 340) range, the red color of the RGB led would light, medium (value > 339 & value < 688) the blue led would light and high (value > 687), the green led would light. A priori, the same ranges were used for luminosity and temperature, only for testing, as luminosity would be monitored for temperature control.

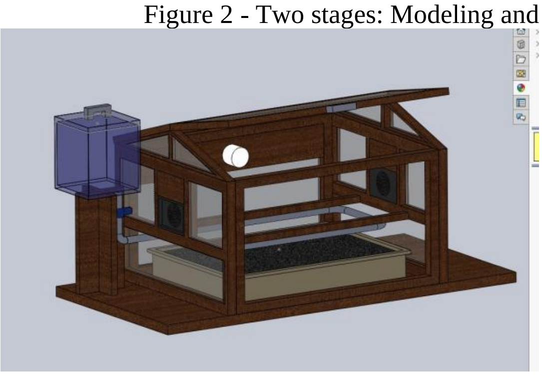
In possession of the temperature and humidity values, it was possible to send a command to turn the pump on/off, if necessary (dry soil/humid soil), or to turn the lamp on/off, to control the ambient temperature. The temperature sensor chosen, for convenience and for perfectly fitting the conditions, was the LM35 (analog output voltage, temperature range from 0º to 100ºC, accuracy of ±0.5ºC and linear output voltage of 10 mV/ºC), thus being ideal for the project (Instruments, 1999).

The LED lamp and two coolers (ventilation and exhaust) were chosen for temperature control. It is intended to irrigate through the opening and closing of a valve so that the water descends by inertia from a suspended tank and wets the entire surface of the greenhouse. The final test was to put all these elements together and finish with LED and display, as we are dealing with a simulated environment.

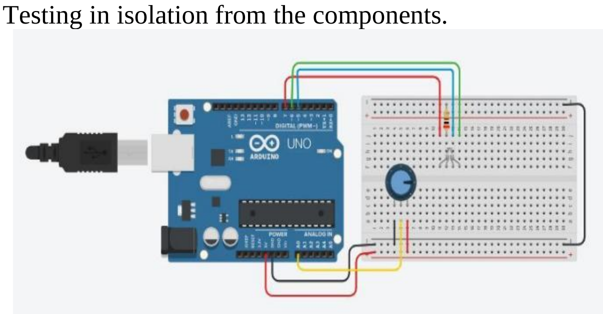
3 RESULTS AND DISCUSSION

Figure 2 shows the result of the simulations made of the first two stages of the flowchart (Figure 1). Part (a) shows all the modeling of the final version of the greenhouse, in which all the positioning of the sensors can be observed. It is possible to notice the suspended tank that will supply the irrigation of the greenhouse controlled by a valve, which will be activated whenever the land is dry. In Figure 3a, it is possible to observe the distribution of the hose with holes spaced throughout the greenhouse, allowing uniform and economical irrigation.

Figure 2 - Two stages: Modeling and Testing in isolation from the components.



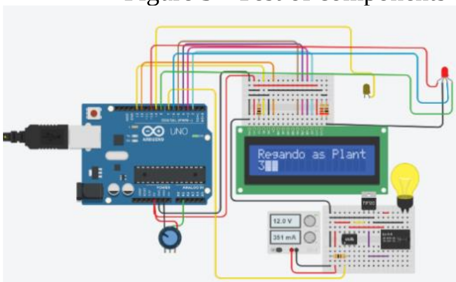
a) Modeling and positioning of sensors



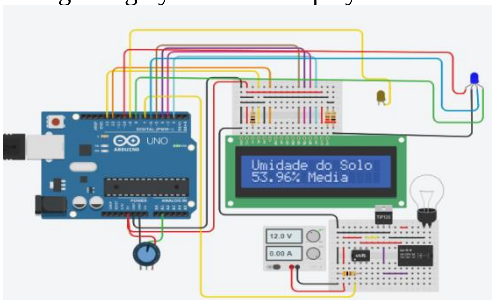
b) Test of brightness, humidity, and temperature sensors

Figure 3 shows the result of testing the components together in the simulation environment. The colors of the LEDs were used to signal each result, which can be seen in more detail in Figure 3.

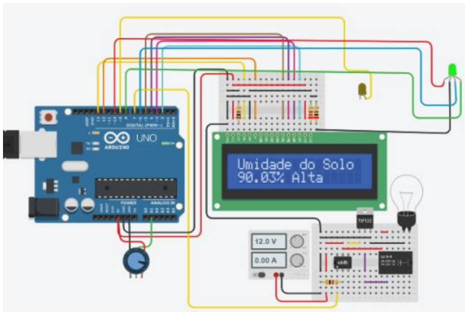
Figure 3 - Test of components together and signaling by LED and display



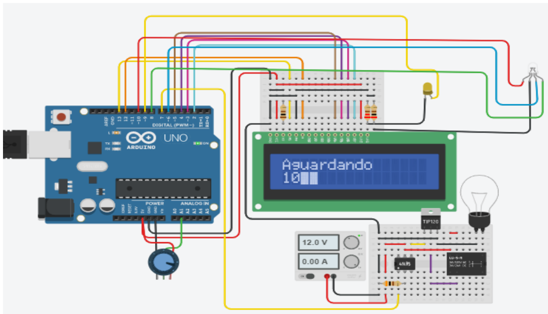
a) Red LED on: Indicating low humidity, lamp indicating valve open/close command or lamp on/off



b) The blue LED on: indicating medium humidity



c) Green LED: indicating high humidity.



d) Yellow led signaling to wait for new reading

4 FINAL CONSIDERATIONS

The simulated way to continue the project was the best option found within the current pandemic scenario in which we are inserted. The sensors capture information from the environment and are therefore replaced in the simulation environment by the potentiometer, in which the users themselves can enter the data. Simulation is the best way to represent the real environment, and the platform used (Tinkercad), within its possibilities, proved to be a good tool. The final code made will only need to be adapted for opening/closing the valve, and turning the coolers on/off, among others. It is intended to put into practice all the tests developed in the simulation environment and develop the greenhouse, as it was designed in the modeling to test the planting of a vegetable, such as beans, and analyze its development inside and outside the greenhouse.

In this way, it is concluded that the present work allowed the students to practice programming in Arduino, familiarization with sensors and assembly of structures, in addition to an insight into the practice of research, a reality still distant in the course, as well as adding means for the development of possible future work that may encourage other students of the subsequent course in Industrial Automation to participate in projects that may contribute to the teaching-learning process aimed at applying the knowledge acquired in theoretical classes.

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