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RESEARCH ARTICLE

POWER SUPPLY FOR GREENHOUSE WITH CLEAN ENERGY FOR PLANTING VEGETABLES (ALLIUM FISTULOSUM)

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Abstract

This work demonstrates the development of an automated greenhouse system with clean energy. However, these systems are expensive and not suitable for small farmers, so, in view of this, a low-cost automatic greenhouse system was developed, using an Arduino microcontroller, showing the benefits of carrying out cultivation using automated greenhouses. and how they help farmers to optimize the use of energy and water in their agricultural practices. The results obtained are very optimistic, as predicted.

Introduction:-

Thanks to the exponential technological advancement presented at the end of the 20th century to the present day, man has designed and built countless types of machines and systems that help in various activities, from the simplest to the most complex, such as, for example, the steam engine, computers, programmable logic controllers (PLC), among other inventions. In this context, one of the areas that underwent the most changes and improvements was agricultural activities, due to their enormous relevance in the market and in the population's diet (GUEDES, 2017).

Due to the advent of Globalization and Industry 4.0, the insertion of technology in agronomy has grown exponentially, thanks also to the high levels of practicality and efficiency that it provides to the means of production (EMBRAPA, 2017). The accelerated population growth that the world has experienced in recent years is evident, which has led to an increase in uncertainty in the agricultural production capacity to guarantee the supply of food and other goods for the primary industry. Food insecurity is a concern growing. (CAVALCANTE et al., 2018). In this context of concern in guaranteeing the quantity and quality of food, there are problems such as soil degradation, water scarcity, inefficient use of agrochemicals and other social, economic and environmental barriers due to the misuse of existing resources (LOPES; CONTINI, 2019).

The introduction of technology in the agrarian environment made it possible to reduce water consumption, an important practice for the preservation of the environment. In addition, it provides a decrease in the use of fertilizers and pesticides, which are responsible for causing the degradation of soil quality, the pollution of water sources and the atmosphere and increased resistance to pests.

In the agribusiness sector, the use of new technologies has helped the country to reach production records (NEVES, 2015). However, the cost of this equipment is considerably high, meaning that small and medium-sized farmers are unable to purchase it. According to the difficulties mentioned above, we will give importance to the waste of water, which is a topic of great relevance nowadays. Furthermore, it is necessary to emphasize the high consumption of non-renewable energy for the use of these technologies. In this way, we note that the environmental issue covers

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several axes of society, including education, therefore, we understand it as our responsibility to intervene in the current scenario of food production.

Based on an awareness of cooperation between the area of information technology and agriculture, this work proposes to optimize irrigation techniques and the use of renewable energies in the planting of chives (Allium fistulosum) through an automated greenhouse prototype, making use of the platform arduino.

Theoretical Reference

For the development of this project, concepts were taken into account that must necessarily be addressed for a better understanding of the objective and the elaboration process of the same, such as:

Greenhouse

According to Moreira, agricultural greenhouses are structures used to retain the sun's heat by trapping it inside, protect plants against possible external threats and keep the internal temperature controlled according to the entry of solar radiation.

According to Moreira, the main function of agricultural greenhouses is to protect the plants and maintain the best conditions for the perfect development of the crop. It is made of transparent materials such as glass or plastic that allow the passage of solar radiation that heats the greenhouse floor and emits infrared radiation. The greenhouse air is heated by infrared radiation forming convection currents.

Irrigation

According to Brandão and Calgaro (2016), irrigation is a technique used to meet the water needs of crops in a planted area due to factors such as unavailability of water, poor distribution of rainfall or to maximize the production of a given plant, allowing that there are plantations even in environments that do not have the basic requirements for this activity. In the market, still according to Brandão and Calgaro (2016), several irrigation systems are available that offer efficient agricultural production technology to producers who, by using techniques such as balanced management of fertilization and cultural practices, provide plants with a conducive environment for them to grow. develop their full production potential. However, determining the ideal type of system for each type of crop depends on a technical-economic analysis based on factors such as soil type, topography, climate, culture, equipment cost, energy supply and labor.

Surface Irrigation

According to TESTEZLAF (2017), in this method, water is applied directly to the soil surface and, due to the effect of gravity, it moves and infiltrates the soil.

Figure 1:- Surface Irrigation.

Source: Inovagri, 2021.

Table 1:- Main advantages and disadvantages of Surface Irrigation.

Main advantages	Main Disadvantages
There is no need for high-tech equipment as the system works well with simple equipment.	In areas with steep slopes, it is necessary to systematize or regularize the terrain, making it more laborious.
Allows for a lower unit cost and good operational simplicity	There is a great need for good planning, as the system has a low water distribution efficiency during application.
Unlike localized systems, it allows the use of water with solids in suspension.	Its dimensioning is complex, as it requires field tests and permanent evaluations.

Source: Authors 2022.

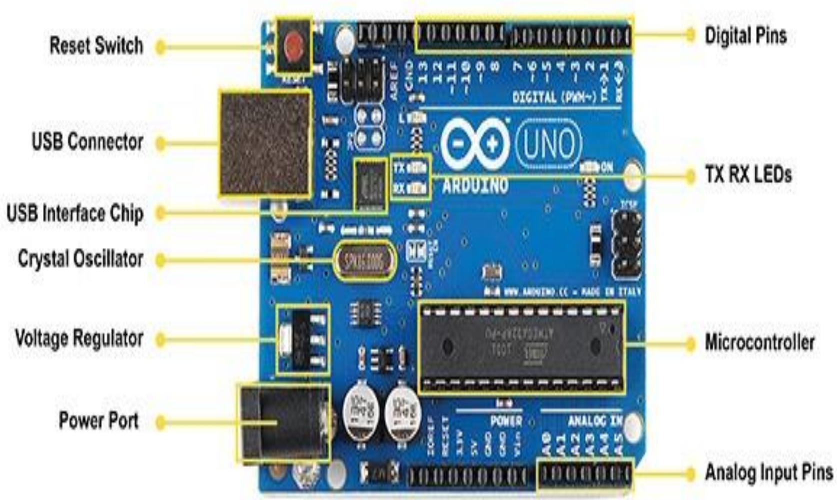
Arduino Platform

According to Rodrigues (2012), Arduino is a physical or embedded computing platform, capable of interacting with the environment through hardware and software, which can be programmed to process data between its system and external components interconnected to it.

According to Thomsen (2014), Arduino technology was created by Massimo Banzi and David Cuartielles in 2005, in Italy, Arduino can be applied to the development of different types of projects, from the simplest to the most complex. Its versatility allows the connection of LEDs, dot matrix displays (displays), buttons, switches, motors, sensors, GPS receivers, Ethernet modules or any other device that emits data or can be controlled, just connect it to a computer or network.

The Arduino development environment (IDE) is a free software based on the C and Java programming language that allows the elaboration of instructions (codes) that will determine the actions that the Arduino should perform. Both Arduino hardware and software are open source, which allows its use freely by anyone and for any well-defined purpose. As for its architecture, Souza (2015) states that the Arduino platform has six parts – digital input and output pins, analog input and output pins, USB connector and serial/USB converter, power supply, power pins and CPU, as shown in the figure (figure 2).

Figure 2:- Architecture of the Arduino UNO board.



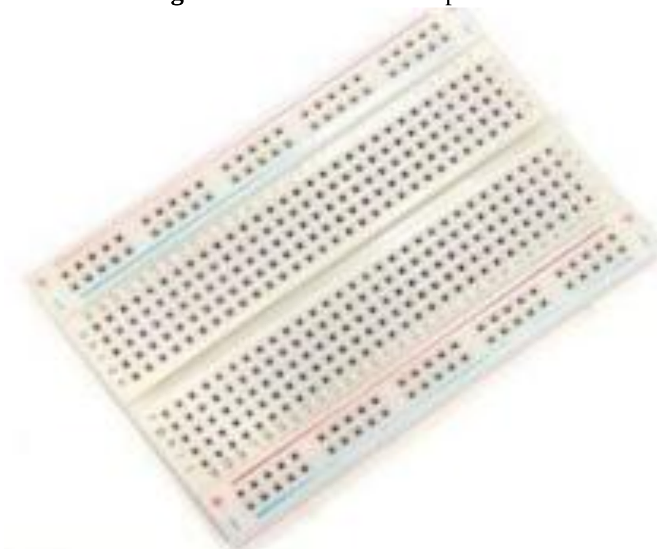
Source: Embarcados, 2018.

Materials And Methods:-

For the development of an automated irrigation system prototype, the following components are required: breadboard, 16x2 lcd display, relay module, potentiometer, resistors, led, solar panel, dht11 (digital temperature humidity module), solenoid valve, temperature sensor soil moisture, VRLA battery 12v 4.5Ah, controller charging board the solar panel mppt to 12v dc 1-1000Ah and voltage converter from 12v/24v to 9v.

Breadboard:
It is a board for mounting your electronic circuits. It has several holes for inserting components and these holes in turn are interconnected in order to facilitate connections between components, according to (VIEIRA; FARIAS; CARVALHO, 2018).

Figure 3:- Breadboard 400 points.



Source: Eletrogate, 2017.

Display LCD 16x2:
This component allows us human beings to read data that are inside the Arduino. It has 2 lines that hold up to 16 characters that can be filled in by letters and numbers, according to (VIEIRA; FARIAS; CARVALHO, 2018).

Figura 4:- Display LCD 16x2.

Source: Eletrogate, 2017.

Relay Module:
It is an interface to adapt Arduino pins to connect other devices with a voltage greater than five volts, according to (VIEIRA; FARIAS; CARVALHO, 2018).

Figure 5:- Relay Module.

Source: Eletrogate, 2017.

Potentiometer:

It is an electronic component that creates a limitation for the flow of electric current that passes through it, and this limitation can be adjusted manually, being able to be increased or decreased, it has three terminals and a rotating shaft to adjust its resistance, according to (VIEIRA ; FARIAS; CARVALHO, 2018).

Figure 6:- Potentiometer.

Source: Eletrogate, 2017.

Resistors:

Their function is to limit the amount of electric current according to the specific need. The resistors handled in this project contain a code that defines the resistance value from values defined in color bands, according to (VIEIRA; FARIAS; CARVALHO, 2018).

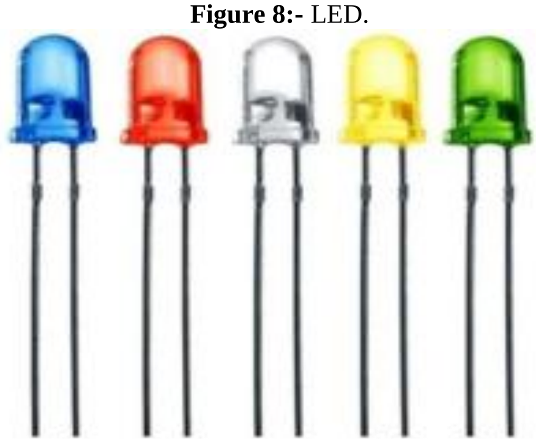
Figure 7:- Resistors.

Source: Eletrogate, 2017.

Led:

It is also known as a light emitting diode. It works like a small light bulb that emits light when an electric current flows through its terminals. The intensity of the light beam depends on the amount of current flowing through its terminals. This component has polarity, which means that it has a positive and a negative terminal, according to (VIEIRA; FARIAS; CARVALHO, 2018).

Figure 8:- LED.

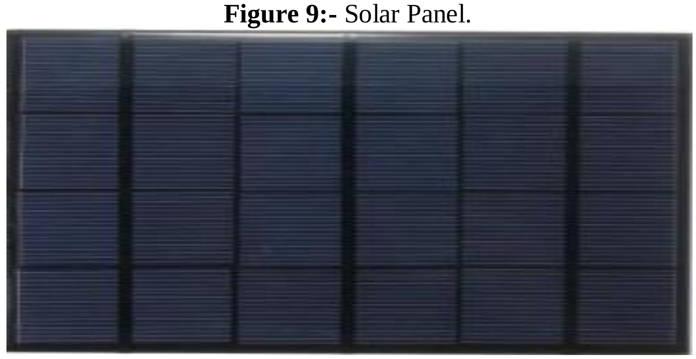


Source: Tetracomp, 2022.

Mini solar panel:

It is used to generate sustainable energy through sunlight, which is very efficient nowadays. The electrical energy produced is converted through solar cells integrated into the mini solar panel and responsible for capturing sunlight.

Figure 9:- Solar Panel.



Source: Eletrogate, 2017.

DHT11 Digital temperature humidity module:
This sensor includes a moisture meter component and an NTC component for temperature, both connected to an 8-bit controller. What is interesting about this component is the protocol used to transfer data between the MCDU and DHT11, as sensor readings are sent using only a single bus wire.

Figure 10:- DHT11 module.

Source: Eletrogate, 2017.

Solenoid Valve:
It is an electromechanical device used to control the flow of liquid or gas. The solenoid valve is controlled by electrical current passing through a coil. When the coil is energized, a magnetic field is created, causing a plunger inside the coil to move.

Figure 11:- Solenoid Valve.

Source: Eletrogate, 2017.

Soil Moisture Sensor:
According to Oliveira, this component is an electronic module developed with the purpose of detecting/measuring changes in soil moisture. If the soil is dry, the sensor keeps the (digital) output at a high level and when the soil is wet, the (digital) output remains at a low level. To measure the variation of soil moisture, it is recommended to use the analog pin available on the sensor in conjunction with a microcontroller that has a digital analog converter.

Figure 12:- Soil Moisture Sensor.

Source: Eletrogate, 2017.

VRLA battery 12V 4.5Ah:
Battery is an essential element for the operation of the project itself, and the selection of a quality battery is very important for the proper functioning of this equipment. Therefore, the Stationary Battery VRLA 12V 4.5Ah Mod.UP1245 will be used, supplying power to the Arduino and the Solenoid Valve.

Figure 13:- 12V 4.5Ah battery.

Source: Unipower, 2022.

MPPT solar panel controller charging board for 12V DC 1-1000Ah:
Its main purpose is to control the charge of the batteries, so they work to keep the charge in the batteries at safe levels, managing both the charges that are entering and the charges that are leaving the battery. This component is used so that the 18V solar panel is converted to 12v that will be used for the battery, according to (VIEIRA; FARIAS; CARVALHO, 2018).

Figure 14:- Battery charger module.

Source: Banggood, 2020.

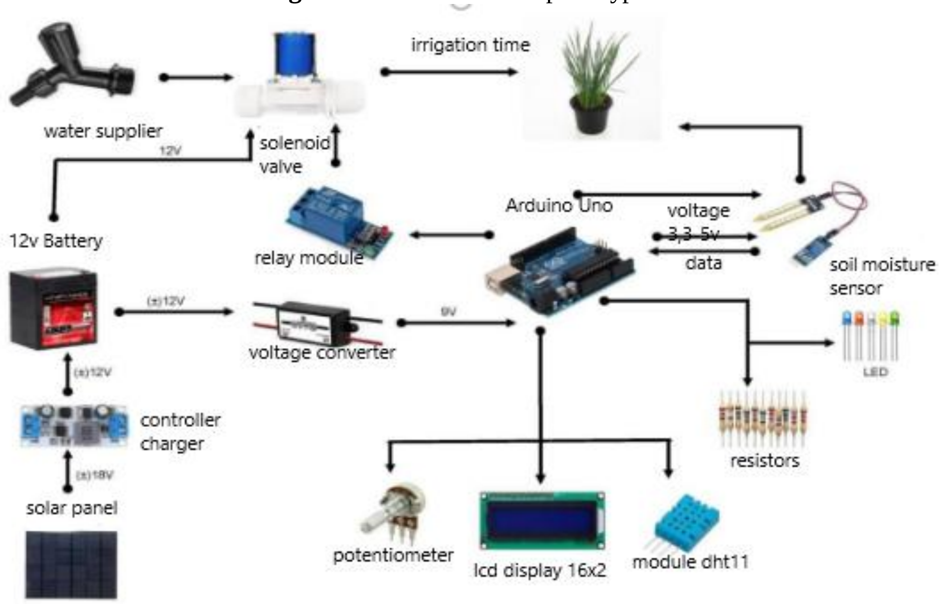
Voltage Converter From 12v / 24v to 9v - 5 A:
More precisely a Voltage Converter, whose main function is to convert an initial voltage level into another secondary level. In general, it has the function of regulating the output voltage in relation to an input voltage. Component used to convert 12 Volts from the battery to 9 Volts for the Arduino, according to (VIEIRA; FARIAS; CARVALHO, 2018).

Figure 15:- 12V/24V to 9V Voltage Converter.

Source: Eletrogate, 2017.

Below, a flowchart illustrates, in a very simple way, the operation of the equipment (Figure 16).

Figure 16:- Sketch of the prototype.



Source: Authors 2022.

1. The soil moisture sensor and the DHT11 module will send the values referring to soil moisture, relative air humidity and ambient temperature to the Arduino board with a time interval of 1 second during 60 minutes.
2. Upon receiving data from the humidity sensor and the DHT11 module, the Arduino microcontroller performs the functions established in the programming. It sends in real time to the display the percentage of soil moisture, relative humidity and room temperature according to the pre-established rules in the programming, if the soil moisture value is below the established limit, the red LED will light up indicating a low level of humidity, followed by the yellow LED that will identify the activation of the relay module and, consequently, the solenoid valve wetting the soil.
3. When starting the irrigation process, the pump will not be turned off until the soil reaches 70% humidity, that is, when the surface humidity level is suitable for the good development of the crop, the blue LED will light up indicating that the soil does not need irrigation and two messages with the words “SOIL HUMID” and “PUMP OFF” are displayed.
4. After the soil reaches 70% moisture, the pump will be turned off and the irrigation process will return to the beginning.

Results:-

Our work results were successful, the team is fully engaged in the project, there are some basic issues, but the project is completed and in good working order.

The automated stove is in full functional condition, the programming part works as expected and the welded parts are intact, ensuring that the stove operates in a practical and objective way.

Next, a table will be presented containing the monetary value of each of the components used to assemble the prototype (Table 2).

Table 2:- Price list.

COMPONENT	PRICE
Breadboard	R$25,11
Display LCD 16x2	R$60,85
Potentiometer	R$19,90
Relay Module	R$1,42
Resistors	R$15,00
Led	R$16,98
Solar panel	R$30,90
DHT11 (Digital Temperature Humidity Module)	R$13,99
Solenoid Salve	R$59,67
Soil Moisture Sensor	R$13,30
Battery VRLA 12v 4.5Ah	R$97,90
MPPT Solar Panel Controller Charging Board for 12v DC 1-1000Ah.	R$55,00
Voltage Converter from 12v/24v to 9v-5A	R$75,00
TOTAL	R$596,2

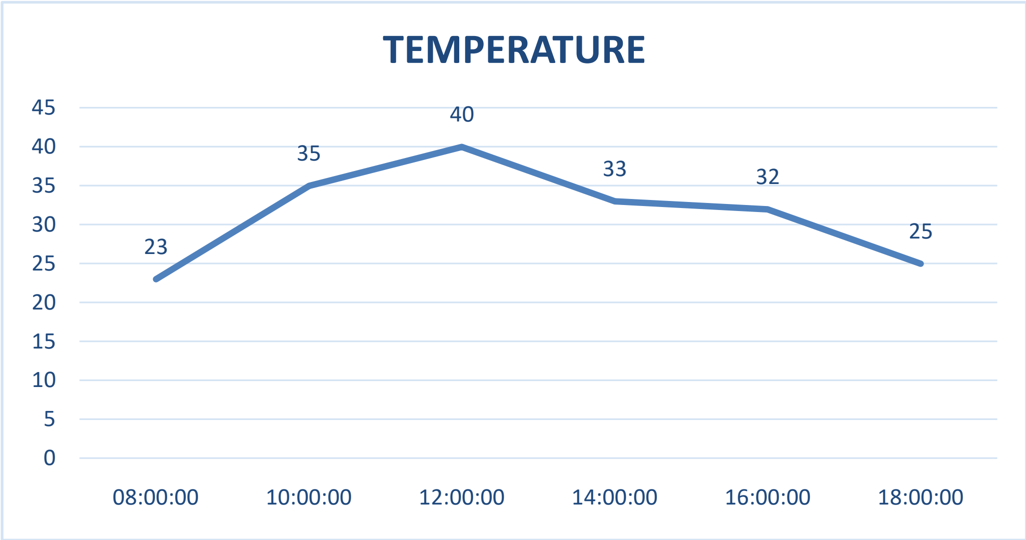
Source: Authors2022.

Since the focus was on accessibility, we tried to optimize the cost of the prototype as much as possible, making the cost-benefit ratio one of the best on the market.

Air Temperature And Humidity

Soon after, the temperature parameters were tested. With the DHT11 sensor, real results are obtained. It is noteworthy that with greater exposure to sunlight, the increase in temperature was significantly greater than that found by meteorological sources such as SIMEPAR (SIMEPAR - Technical and Environmental Monitoring System of the State of Paraná, 2020), because in specific environments there is an incidence direct sunlight, the temperature is much higher and the sensor is accurate to the geofence. The monitoring of this sensor is captured in real time and displayed on the LCD Display. The graph shown in (Graph 01), shows temperature data recorded from the application throughout the day:

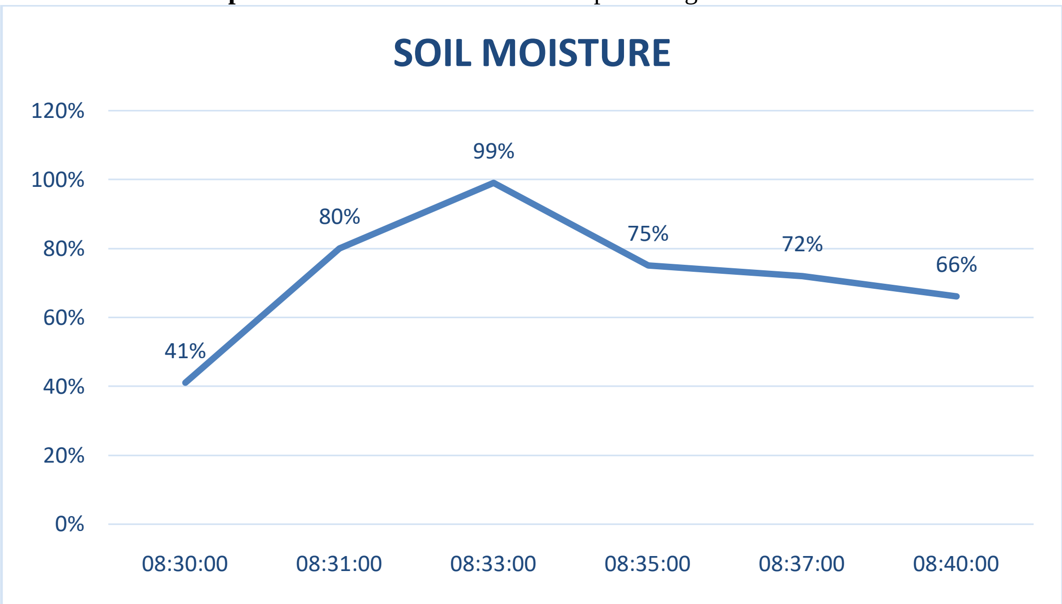
Graph 01:- Temperature Variation in degreesthroughout the day.



Source: Authors 2022.

Soil Moisture
A test was carried out and the values noted in a table during the first ten minutes after watering the plants, and the results are shown in the graph captured in (Graph 02).

Graph 02:- Soil moisture variation in percentage over ten minutes.



Source: Authors 2022.

Conclusion:-

Clean energy allows for a healthier environment, this technology becomes an essential element for society, just as agriculture is important for population livelihoods. In this regard, technology can be associated with agriculture, so that this artifice facilitates the agronomic means of production and provides a more sustainable world.

In this way, this work sought to produce an idea of a lower cost prototype with satisfactory results, which aim to improve agricultural activities and, consequently, transform the lives of several farmers. Therefore, this work makes it possible to contribute to the development of agronomic sustainability, aiming at a beneficial future for all.

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