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REDUCTION OF WATER RESOURCES WASTE IN VEGETABLES THROUGH INTELLIGENT IRRIGATION SYSTEM

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ABSTRACT:
The technology is inserted in the agricultural sector, in order to promote automation in crop management and increase productivity. On the other hand, family farming requires technological resources that aim not only at research, but mainly at sustainability in agricultural practices. From this perspective, the automated irrigation project using the Arduino platform aims to reduce water waste and offer alternatives to improve family farming.
Keywords: Smart Irrigation, Waste of Water, Arduino

REDUÇÃO DO DESPERDÍCIO DE RECURSOS HÍDRICOS NO CULTIVO HORTALIÇAS POR MEIO DE SISTEMA INTELIGENTE DE IRRIGAÇÃO

RESUMO:
A tecnologia é inserida no setor agrícola a fim de promover a automação no manejo de culturas e aumentar da produtividade. Por outro lado, a agricultura familiar requer recursos tecnológicos que visem não somente a produtividade, mas, sobretudo, a sustentabilidade nas práticas agrícolas. Nessa perspectiva, o projeto de irrigação automatizado que utiliza a plataforma *Arduino* visa reduzir o desperdício de água e oferecer alternativas para o aprimoramento da agricultura familiar.
Palavras-chave: Irrigação Inteligente, Desperdício de Água, Arduino

INTRODUCTION

In the agricultural sector, new technologies make it possible to increase the quality and productivity of crops [1,2]. However, in family farming, agricultural activities are predominantly carried out through human labor, due to the high cost of acquiring the technologies available in the market and the need for the small farmer to have knowledge and/or technical guidance about the technology [3 ,4]. Consequently, some processes in family farming may have limitations or cause problems both in the economic and environmental spheres [4]. For example, in irrigation processes, it is difficult to establish how much water should be used for irrigation, which can lead to wasted water and even a deficit in crop productivity [3,4,5].

In Brazil, the sector that consumes the most drinking water is agriculture, and also the one that wastes the most. According to data from the United Nations Food and Agriculture Fund (FAO), agriculture alone is responsible for consuming 60\% of the country's water, with half

of this amount being thrown away during the cultivation process [10]. ,11]. Among the reasons why so much water is wasted are poorly executed irrigation and lack of control over water use [17,15].

Another problem observed in the national agriculture scenario refers to the excessive use of pesticides. According to the Ministry of the Environment, Brazil, since 2008, has been the largest consumer of pesticides in the world [19,7]. However, in 2016 there was a 20% increase in the number of consumers interested in organic foods [9,20]. In view of this, gardens are understood as good alternatives for the production of organic food.

From this perspective, the project to develop an "intelligent system" of irrigation will be directed to family farming for irrigation in organic gardens, without the use of pesticides, and aiming to reduce water waste and contribute to the production of food free of pesticides. Therefore, the main aim of the project is to ensure a natural and sustainable agricultural practice.

MAIN GOAL

Develop an automated irrigation system with Arduino to reduce water waste in growing vegetables

Specific objectives

- Develop an application to manage the data through the soil moisture sensor;
- Propose an alternative soil moisture sensor made from low cost materials;
- Produce a prototype of the irrigation system to be implemented in the school's organic garden.

METHODOLOGY

The project was developed using the Arduino UNO microcontroller, responsible for processing the data collected in the soil moisture sensor (fixed on the soil where the culture is) and then activating the relay [22, 24]. The relay module will control the solenoid valve, turning it on when the soil moisture is low (dry ground), or turning it off if the ground moisture is high (wet ground).

For the irrigation of the garden, we chose to use the drip irrigation technique, since this technique allows for localized irrigation, that is, it occurs under the root zone of the crop,

and requires low pressure (to move the water through the tubes) and low volume of water [25, 26]. Consequently, it results in a low rate of waste of water, energy and labor, as the water moistens the foliage or stem of the plant, thus irrigating it directly [16]. In addition, an application was created using the MIT App Inventor 2 to help the farmer monitor the parameters collected by the soil moisture sensor using a mobile device [8].

The "smart system" of irrigation must be implemented in the organic garden of E.E.M Francisca Pinto dos Santos. Only after the project will be made available to small farmers in the vicinity of the school. The activities will be divided into three stages: 1) Study of the vegetable garden: in which aspects such as temperature, luminosity, humidity and soil temperature will be studied. 2) Arduino UNO programming: development of the programming that will promote the collection of sensor data and the activation of the drip irrigation system. 3) Implementation of the system in the garden: Tests will be carried out after the implantation of the "smart system" of irrigation in the organic garden of the school to validate the prototype.

RELEVANCE OF THE PROJECT

It is a fact that plants lack water due to the metabolic activity they perform, consuming water from the soil through the roots, with a small part of this water integrated into the plant's plant body [21]. Thus, if this requirement is not met, plants can present numerous problems, especially regarding their growth [21]. In this sense, in agriculture, irrigation systems are essential to guarantee the productivity of a crop.

On the other hand, it is known that inadequate irrigation can cause damage to the crop, reducing productivity, which directly interferes with farmers' income [3]. Another aspect refers to the environmental impacts involving the inefficient use of water resources in irrigation [10]. From this perspective, water waste is noted as one of the main problems faced in irrigation processes [10]. If the water used in irrigation systems were used properly, there would be a saving of over 20% of the water used in agriculture [15]. Therefore, it is necessary to establish an efficient irrigation capable of supplying water to the plant only when it is lacking.

In view of this, the "smart system" of irrigation with Arduino will be a viable alternative to improve the management of the irrigation process aimed at family farming. Through this system, the essential parameters for irrigation (temperature, luminosity, soil moisture) can

be measured and used to guarantee the rationalization of water and the sustainability of the activity.

PROJECT/RESEARCH IMPACT

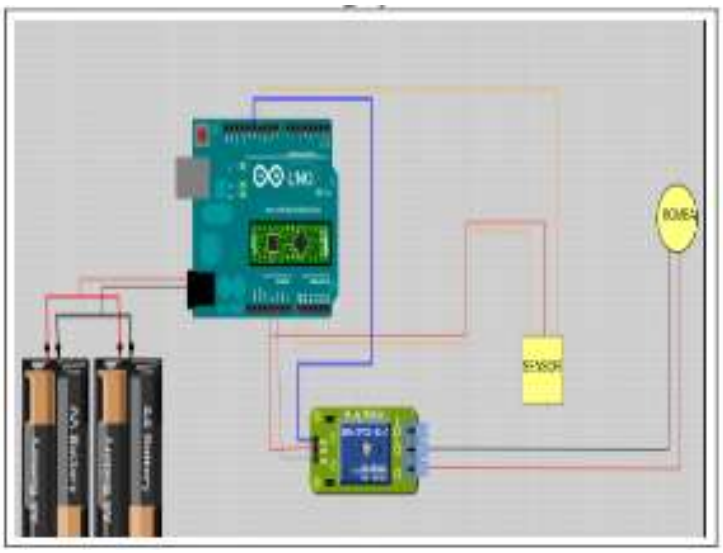
Many of the obstacles observed in the use of new technologies in family farming are the high cost and the need for specific knowledge and/or guidelines for the use of such technological resources [3, 4]. Many small farmers are completely unaware of new technologies or ways to incorporate them into their farming practices.

Although in family farming there is a greater focus on developing sustainable agriculture, often there are not enough resources to make them truly sustainable activities [3, 4]. The use of a “smart system” of irrigation ensures a sustainable agricultural practice by considerably reducing water waste.

SEARCH RESULTS

The prototype of the automated irrigation system was elaborated in the physics laboratory of the Francisca Pinto dos Santos School. The prototype consists of an Arduino board integrated with the soil moisture sensor and the relay module. A mini water pump was also used to simulate the control that will be performed on the solenoid valve (fig. 01).

Figura 1: Esquema do Protótipo do Sistema de Irrigação.



Autor, 2019

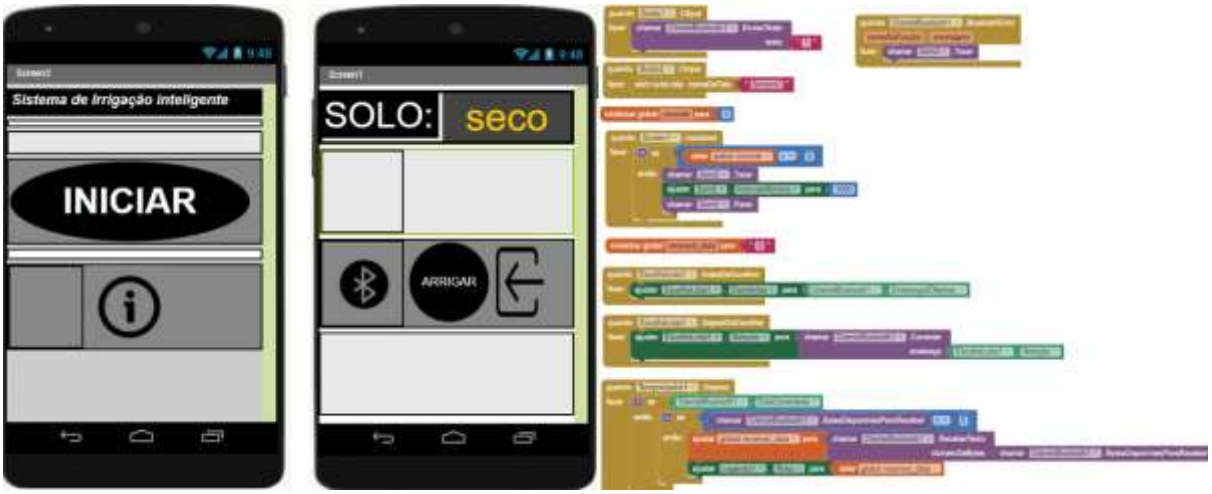
In order to reduce the cost of the project, an alternative soil moisture sensor was developed with easily accessible and low-cost materials. This sensor is composed of three copper wires which are paired: the wire in the center has the function of transmitting the electric current to the ground, and the other two wires (one on the right and the other on the left) serve to receive the current. electrical energy that is transmitted to the ground [23, 16].

Thus, the more moisture the soil has, the more electrical current will travel through the soil and reach the copper wires. Otherwise, if the soil is low moisture, the electric current will not be dissipated easily through the soil. Therefore, it was possible to analyze the state of the soil (dry or wet) from the verification of the difference between the electric current that enters and leaves the soil [16]. In the tests carried out in the laboratory, it was observed that the alternative soil moisture sensor is functional, being able to be used to determine the variation of soil moisture.

As for Arduino programming, it succeeded in its own IDE (Integrated Development Environment) which is a complete development environment [13, 14]. The programming logic used in the control of the “smart irrigation” system meets the need for monitoring soil moisture. Data collected by alternative soil moisture sensors is viewed in real time via a computer or mobile device. The information displayed on the computer (or cell phone) refers to soil moisture (wet or dry) and the valve's operating status (activated or deactivated). However, throughout the project it is intended to implement new monitoring resources.

As mentioned before, a mobile device can be used to verify the data obtained through the sensors. This is possible through the use of an application developed to help monitor and control the irrigation system. The application consists of two pages: the first page presents information on how to use it, while the second page shows information about the soil, as well as the option to turn the solenoid valve on or off (fig. 02).

Figura 2: Layout e Algoritmo do Aplicativo do Sistema.



Autor, 2019

Communication takes place between the cell phone and the Arduino board associated with the HC-05 Bluetooth module. This component allows the Arduino to communicate with other devices that have a Bluetooth connection. In other words, the application sends information to the microprocessor where it is read, interpreted and executed.

FINAL CONSIDERATIONS

The prototype of the "smart system" of irrigation developed in the study is capable of collecting soil moisture data and acting autonomously in the application of water to the crop. Throughout the study, the creation of an alternative soil moisture sensor proved to be a viable and functional option, as it is made of easily accessible materials and meets the project needs, in addition to contributing to cost reduction.

All tests carried out with the prototype took place on a laboratory scale, requiring further tests in a real environment to validate the prototype. Finally, it is concluded that the proposed automated irrigation system is a low-cost technology that can be incorporated into family farming in order to rationalize the use of water in the cultivation of vegetables.

Improvements were observed for the prototype which could be added to the project in future works:

○ Implement the feature for the farmer to receive notifications through a mobile device when the plant lacks water;

○ Improve the programming logic to make the irrigation system even more efficient;

○ Add light and temperature sensors to assist in the analysis of plant evapotranspiration;

○ Reduce the physical size of the prototype in order to make it more compact;

○ Provide electrical power to the irrigation system using solar or wind energy.

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