Monitoring system for plants based on a smart plant pot

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Abstract. The occupations of the modern world neglect important things like the environment and sustainable development. This work develops a monitoring system for plants, based on a smart plant pot that can be supervised and configured through a mobile application. The electronic design consists of the use of two sensors that constantly send the temperature and humidity of the plant to the mobile application. In addition, a submersible pump provides water to the interior of the plant pot to monitor the condition of the plant. The optimal temperature and humidity settings will depend on the type of plant; these options can be configured remotely. Alerts are sent in the form of notifications or appear on the display of the plant pot when a different status than recommended is detected. Information is reflected locally on the plant pot display as facial expressions. The local operating code is designed so that the facial expression displayed on the screen changes automatically based on the conditions presented on the plant pot. As a result, adequate communication was obtained between the mobile application and all the devices installed in the smart plant pot. Finally, an acceptance test is applied that qualifies this proposal as suitable for domestic use.

Keywords: Smart plant pot, mobile application, monitoring system, Firebase

1 Introduction

Plants play a very important role in maintaining the ecological cycle and form the base of the food chain pyramid. Therefore, plants require adequate monitoring and control, based on an integrated and multidisciplinary design approach [1, 2]. The integration of a system for plant monitoring facilitates agriculture and makes use of the concept of ambient intelligence. In addition, the increasing adoption of the Internet of Things (IoT) in consumer, commercial, industrial and service applications allows their use in disciplines other than agriculture [3–5].

There are works on the design and development of monitoring systems capable of reporting several metrics of a common indoor plant, these metrics include temperature and soil moisture [2, 6]. In addition, sensors are used in smart plants that communicate and activate electronic devices to monitor and optimize individual plant productivity and resource use [7, 8].

This paper develops a smart plant pot with a display to show emotions according to plant status using low-cost technology. Sensors are installed inside the pot to provide information to be presented in a mobile application. The system is implemented with an internet of things card, and all the developed features are managed using the mobile application. For this purpose, the paper has been organized into 4 sections; starting with the current section containing a brief introduction to the topic; section 2 describes the methodology to be used; section 3 presents the results obtained, and section 4 contains the main conclusions.

2 Methods and materials

For the development of this work, an electronic board with wireless communication (WiFi) is used to control the different components, Fig. 1 shows the proposed scheme. This electronic card stores the necessary programming for the management of the intelligent plant. The installed modules are a temperature sensor and an analog hygrometer included inside the pot to obtain all the data coming from the temperature and humidity of the soil, respectively. There is also a submersible pump and an electrical relay to supply water to the plant. All data is sent to a mobile application through the cloud using the internet.

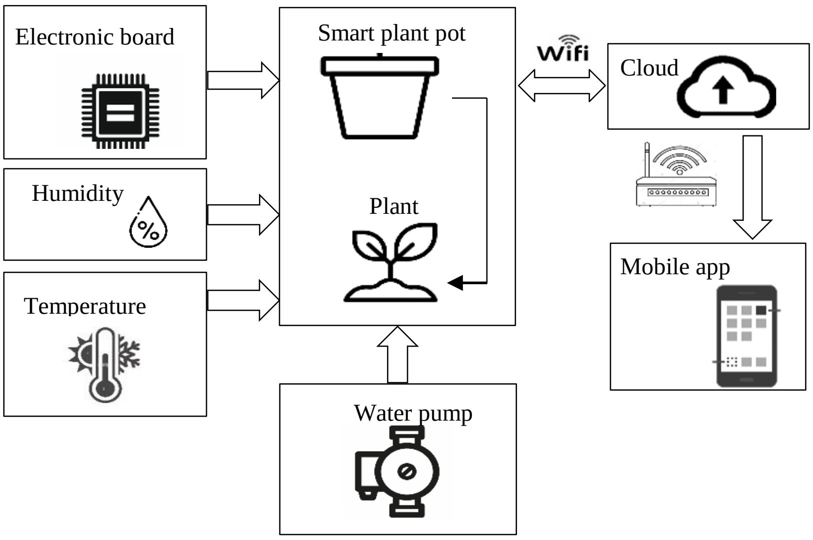

Fig. 1. General scheme of the smart plant pot

2.1 Electronic Design

The electronic design includes the connection of the sensors, such as the DHT-22, which is the temperature sensor connected to one digital pin of the ESP32 board. Similarly, the FC-28 hygrometer is connected to a port configured as an analog input. The display used is an I2C OLED of 128x64 pixels, this device is connected to the SDA and SCL ports of the I2C communication of the ESP32. For the submersible pump, a 12 volts DC supply is used and a relay connected to a digital output for power control.

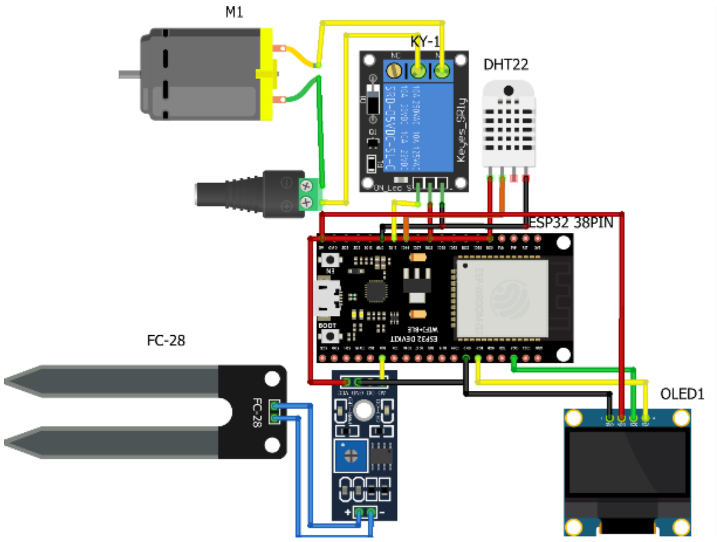

Fig. 2. Electronic Circuit

2.2 Program Design

The actions of the program implemented in the ESP32 are shown in the flowchart in Fig. 3. Once the program is started, the temperature and humidity sensor data are read, this information is sent to the Firebase database. Then the operating mode up-date is received, this data allows to define the actions of the manual or automatic mode. In manual mode, the user directly controls the pump operation. In automatic mode, the pump is activated only with values outside the moderate range for temperature and humidity. In either case, the pump activation is by time short (2 seconds) and not permanent. In addition, the status of the plant is shown on the OLED display in the form of a sad or happy face.

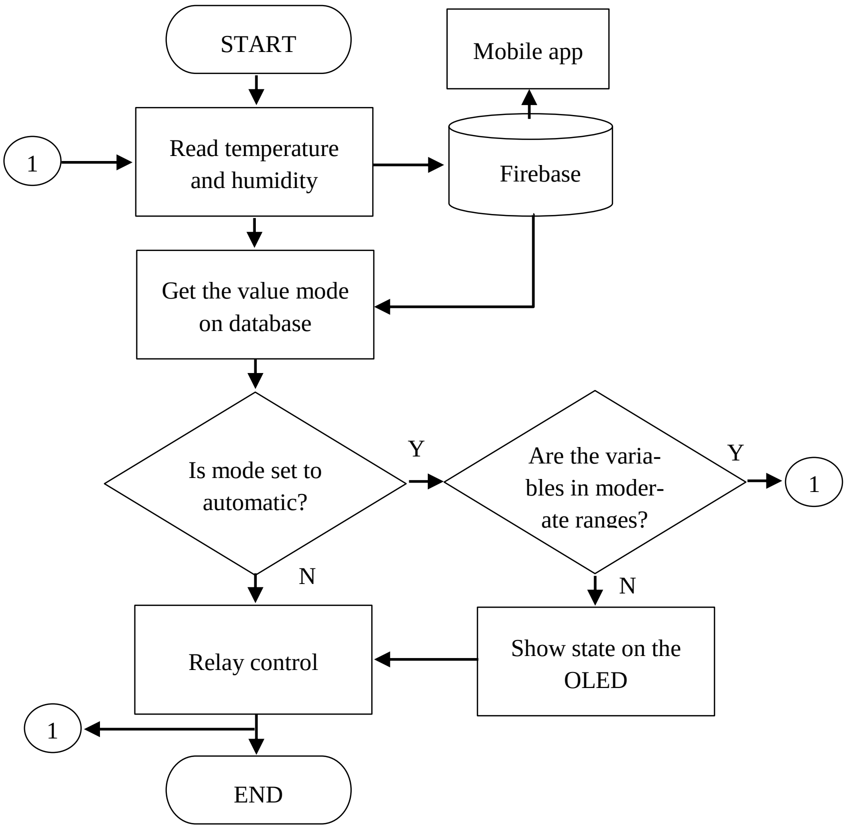

Fig. 3. Main program flowchart

2.3 Mobile Application Design

The user interface of the mobile application consists of the basic operating elements. Two labels display the temperature and soil moisture data, respectively. Two buttons allow to control the operating mode, in the manual mode the activation direct order for the pump is sent. Fig. 4 shows the arrangement of the elements for the user interface.

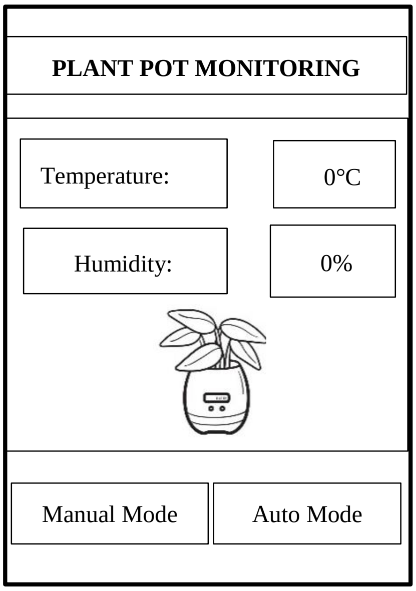

Fig. 4. User interface design

3 Results

3.1 Functional Tests

Fig. 5 shows images of the operation of the smart plant pot, highlighting elements such as the display and the submersible pump. On the other hand, the mobile application located in a remote location shows the temperature and humidity values. The different tests were carried out successfully, constantly acting on the values acquired by the sensors and with an immediate response when the control buttons were pressed.

3.2 Acceptance evaluation

To evaluate the characteristics of this proposal, an acceptance questionnaire was applied. The questionnaire consists of 7 questions to evaluate different components of the proposal. The questions are answered using a 7-level Likert scale, where 7 indicates strongly agree and 1 indicates strongly disagree. The results of the acceptance test are presented in Table 1, with a final rating of 85.71% acceptance, considered a favorable value for this proposal. The evaluation shows favorable reactions to the smart plant pot prototype, although it can be improved with its physical components and graphic interface.

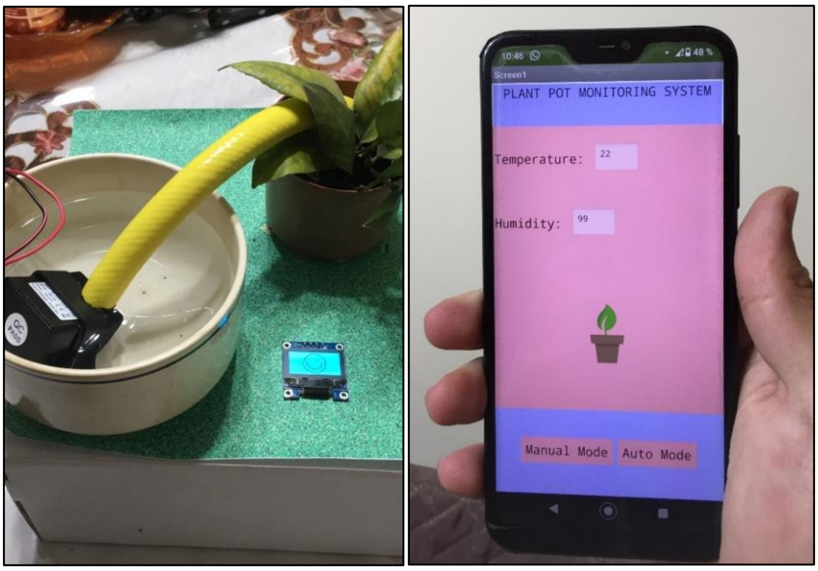

Fig.5. Images of the functional tests.

Table 1. Acceptance test

Question	Score
1.- You might use the smart plant pot properly.	7
2.- You are satisfied with the response time in the co-communication between the application and the device.	6
3.- It was easy to use the interface options in the application.	7
4.- It was easy to learn how to use the smart plant pot.	7
5.- It was not physically difficult to locate the smart plant pot.	5
6.- The indicators were efficient when using the system.	5
7.- Overall, I am satisfied with the system	5
Total	43/49 85.71%

4 Conclusions

This work presents a smart plant pot managed through a mobile application. This proposal is important in everyday life because the occupations of the modern world make people neglect the environment. Based on the acceptance test with a score of 85.71%, it is determined that the system meets the expectations raised, mainly because it is easy to use. The proposal has some limitations, the size of the plant pot is large, and the location of the devices is dispersed; in the future, the design can be simplified with a compact model that optimizes the space in the elements.

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