Implementation of Device for the Activation of Automatic Irrigation for Domestic Plants

Laura Camila Prada Pérez[1], Octavio José Salcedo Parra[1, 2], Alberto Acosta López[1]

[1]*Faculty of Engineering - Universidad Distrital Francisco José de Caldas, Bogotá D.C., Colombia.*

[2]*Faculty of Engineering - Universidad Nacional de Colombia, Bogotá D.C., Colombia.*

Abstract

This article discusses the design of a device with humidity sensor connected to the Arduino Uno board, to notify via WiFi to the email account user the lack of water for irrigation system for houseplants.

The device is able to maintain the soil moisture in different types of plants, causing that these maintain a good condition, compared to irrigation provided by a person, which is performed with low frequency.

Keywords: Arduino, Irrigation System, Houseplants.

INTRODUCTIÓN

A common problem for people who have domestic plants such as flowers, bulbous plants garden, aromatic plants and indoor plants, is to be sure when they have received the right amount of water. Through an irrigation system, it is possible to save the amount of water used in this task, since it goes to the floor with a specific volume. To provide a solution to this problem is to design a device with a sensor of humidity in the soil, connected to an Arduino Board, which shall contain information on irrigation (carnations, tulips and daisies) flowers and ornamental plants (ticket, Aloe, cactus), to activate the automatic irrigation by means of a solenoid valve and notify by email to the user the need to supply water for irrigation.

BACKGROUND

Estimation of Energy Harvestable from Vehicle Waste Heat: this articl presents the modeling, simulation, and experimental estimation of green energy harvestable from the residual heat of the vehicle. The heat flow through the waste of coolant and exhaust gas are considered. We have developed two models, written in Matlab, to estimate the power in real time the coolant and exhaust gas. Heat kW power is estimated as a function of the rate of mass flow, specific heat capacity, and temperature. The instantaneous power of heat integrated into a driving cycle resulted in estimated kWh energy. We have obtained rates of mass flow and the temperature of the coolant from the on-board diagnostics data records (OBD) vehicle. Exhaust gas temperature was measured wirelessly, in parallel with the OBD data record, using an infrared temperature sensor and an Arduino-one microcontroller with datainterface wireless Xbee. The dynamic specific heat capacities of leak and refrigerant gases are estimated as the order 5 polynomial functions of corresponding temperatures. We have found that the usable energy per hour of driving of the refrigerant is approximately 8.44 kWh lead-city cycle; and it is about 16.77 kWh of energy in a series of highway driving. He is expected that similarly can extract energy from the exhaust gases.

Open Source Building Science Sensors (OSBSS): A low-cost Arduino-based platform for long-term indoor environmental data collection: the precise characterization of the parameters that influence indoor environments often is limited to the use of hardware and proprietary software, which can negatively affect costs, flexibility and integration of data. The following describes the open source of construction project sensors Science (OSBSS), which we have created to design and develop a set of devices of source of low-cost, open, based on the Arduino platform to measure and record long term operational and environmental data. The objective of OSBSS is to allow greater flexibility in the timing of a large number of measurements with high spatial and temporal resolution in a cost-effective manner for use in research projects, and finally in the construction, automation and control. The project currently includes a variety of sensors and recorders of data designed to measure a series of important parameters in buildings, including the temperatures of the air and the surface, relative humidity of the air, human occupation, intensity of light, CO2 concentrations, and a data logger generic voltage which can connect data from a variety of other sensors such as differential pressure sensors. Also described the results of the tests of co-location with each data logger installed for a week in an educational building along with their commercial counterparts, that children demonstrate excellent performance to costs substantially.

To low-cost Smart irrigation control system: this article focuses on intelligent irrigation that is profitable and a farmer of class media that uses it in the agricultural field. Today we are living in the 21st century where automation is playing an important role in human life. Automation enables you to control the automatic control devices. It provides not only comfort but it saves energy, efficiency, and time. Today's industries use automation and control machines that are expensive and are not suitable for use in the agricultural field. So a technology of smart irrigation of low cost that is usable by the farmers of the India is also designed. The objectives of this work were automatically control the water engine and select the direction of the water flow in the pipe with the help of the soil moisture

sensor. Finally, send (operation of the engine and direction of water) the farm through mobile messages and gmail's user account information.

Smart drip irrigation system using pi and arduino raspberry: this investiagtion proposes a design for a home automation system using ready-to-use, cost-effective and efficient, including raspberry pi, microcontroller, arduino, XBee modules and relay cards. The use of these components results in the effective, scalable, and robust implementation of the system. Users commands are processed in in raspberry pi using the Python programming language. Arduino microcontrollers are used to receive signals on/off of the raspberry pi using the zigbee Protocol. Star topology server ZigBee serves as backbone for communication between the pi raspberry and end devices. The raspberry pi acts as central coordinator and end devices as several routers. Drip irrigation system is low cost, makes efficient use of energy and serves as a proof of concept. The design can be used in large fields of agriculture, as well as in small gardens by sending an email to the system to water the plants. The use of ultrasonic and electromagnetic sensors makes an irrigation system drip intelligent. In the document of explains the complete installation of the system, including the hardware and software aspects.

Web based service to monitor automatic irrigation system for the agriculture field using sensors: the document describes the automatic irrigation system using the arduino microcontroller with humidity sensor and water flow sensor. You will be established using the Zigbee Protocol communication and control will be based on the level of soil moisture using the arduino microcontroller. Two XBee radios used in the network will be treated as a slave in combination with arduino. When a particular humidity depending on the value of the humidity level is reached, the level of the water flow will be allowed in the pipeline and the range of flow, the water pressure will be updated along with the time in a database and will be displayed on the web portal. The owner of the agricultural field can check at any time the humidity level and the condition of the engine. Functionality of the engine status will be sent to the cell of the farmer using GSM.

Water pipeline monitoring system using vibration sensor: this article presents the development of the surveillance system of water pipes using the vibration sensor. The MPU6050 sensor is selected to measure the vibration that occurred along the pipes. In this study, the water pipe which is used is high pressure, one inch of Acrylonitrille butadience adhesive Styrene (ABS) at 10 meters in length. The plate of the arduino controller then processes the data from the accelerometer sensor vibration and transmitted (Tx) data through ZigBee wireless networks. The water supply system is examined on the basis of two States, which are (i) no way out of the tube, and (ii) a size of 1mm of leakage in the pipes. In the experiments, the pressure is varied for three different levels, 0.6, 0.8, 1.0 kgf/cm2. The results show that the water pressure of 0.6 kgf/cm2 a significant difference in the vibration signal is shown between the pipes without leakage and a pipe with 1 mm of flight. However, this is not the case of for the other 2 pressure 0.8 and 1.0 kgf/cm2 in which vibration signals obtained are similar to tube leaking

as the normal pipe. This is due to the fact that the high water pressure resulted in low water flow and therefore the vibration of the pipe is not as significant as when there are leaks.

Prototype to automate a system of crop irrigation: irrigation plant provides water essential for their growth and development; to ensure proper irrigation, but making the most of the available flow of water, irrigation with programming of automatic control systems, can be used to ensure delivery when and in the amount that the plant needs, to avoid wasting water. This paper is intended to show a functional prototype, based on the integration of three technologies, computing, communications and electronics to automate the control of irrigation for closed or open systems. Information of the soil (percentage content of sand, clay, organic matter and bulk density): and crops (type, duration, functions of root growth and Kc). This information is made with a water balance, which results in the decision of watering or not any crop. When, as a result of the function of depletion of water in the soil in conjunction with the water balance, it determines that it must irrigate, software sends serial RS232 from a computer to an electronic device, digital output port signals to trigger the physical irrigation and complementary devices (v. gr. solenoid valves, fans, lamps.) Joined a subsystem of two-way PC-Modem GSM-phone, which allows you to turn on / turn off a device using remote commands from a cell phone, as also the sending of alarms and warnings that indicate the current state of the system, via cell phone text messages and emails. The automation system is designed in modules, which allows suits several applications that are susceptible to automation and control. Describes the devices and programs that make up the system, inputs, outputs and process controlling automated irrigation.

Control of temperature of a greenhouse to scale using Arduino programming: this paper presents practical implementation of a control system of temperature for a greenhouse to scale using the Arduino platform as a card for the acquisition and processing of data. To emulate the conditions of the increase in temperature due to a tomato crop is made using the technique of floor heating, which is for the hot water flow through a distributed pipeline at the bottom of the greenhouse, while temperature-lowering ventilation system is applied by forced air.

Automation, monitoring and remote control of a system of agricultural irrigation with open source: the objective of the research is to get a prototype of low-cost agricultural irrigation automated, monitored, and controlled remotely from anywhere in the world where there is cellular service. The main tools used are: Android and Arduino. Arduino is responsible for the automation of the system and Android will facilitate interaction with the user, showing you the data of the system, giving you the option to be able to monitor and control the irrigation system over the internet from anywhere in the world, achieving security and flexibility to the farmer.

Remote irrigation systems monitoring by electric pumping for crops of rice in the Department of Huila: has developed a comprehensive system that is responsible for monitoring the

condition of the main variables of a system of irrigation (water, temperature and magnetic State of pumping engine flow) and send this information in real time to the end-user via the Internet through a web page that is designed for this purpose. The system is composed of three sensors (temperature, flow and magnetic State), which are connected to an electronic card development (Arduino) responsible for the acquisition and processing of the magnitude of the variables, two modules of wireless transmission (XBee) that breakout eCard with a computer (web server), which with a connection to the Internet is responsible for sending this information to the user or administrator of the system by E-mail. The system of monitoring is raised Electrohuila S.A E.S.P to offer it as a value-added service to agricultural users with electric pumping irrigation systems. Electrohuila S.A E.S.P is the company responsible for the distribution of electrical energy in the Department of Huila, Colombia.

Developments using the arduino platform are multiple alarm fires, systems of ventilation, sterilization of biological material, home automation and internet of things can be found among these; there are multiple applications made for leisure, involving issues such as video games, music, robotics and development for mobile devices. But as it's mainly projects of innovation and creativity, is little documentation that you can find on the subject.

For this project is that there are different irrigation systems, such as systems for farms, monitoring system of water pipes through vibration, temperature control in greenhouses and electric pumping irrigation.

As advantages can point out some aspects such as: energy saving, efficiency and time, send information to the user account, systems of intelligent drip through use of solenoid valves and processing of data using the arduino Board.

As disadvantages in the development of these projects include: use of expensive machines and which are unsuitable for the tasks that are required, difficulty coping developments with proprietary software, complexity in the code to program the devices and the use of GSM technology which currently has high costs.

METHODOLOGY

The following components will be used for the performance of the device:

Arduino UNO: is a platform open-source based on hardware and software easy to use. Arduino boards are able to read inputs and transform them into outputs. The plate can be set by sending a set of instructions to the micro-controller integrated into this.

Then the Arduino UNO sheet:

Table 1: Technical data of Arduino one

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

WiFi module: Module Wifi Serial ESP8266 offers a complete, cost-effective solution for systems connecting to Wi-Fi networks, allowing the designer to delegate all the functions related to Wi-Fi and TCP/IP of the processor running the main application. The wifi module serial ESP8266 is capable of functioning as a "network adapter" in systems based on micro-controllers that communicate with it via a UART interface [12].

Features of the module Wi-Fi Serial ESP8266:
- Protocols supported: 802.11 b/g/n.
- Wi-Fi Direct (P2p), Soft Access Point.
- Integrated TCP/IP Stack.
- Regulators and power steering units integrated.
- Output power: + 19.5dBm in mode 802. 11b.
- Built-in temperature sensor.
- Consumption in low-power mode: <10 uA
- Integrated 32-bit processor, can be used as application processor.

PHP: An acronym for PHP: Hypertext Preprocessor, is a very popular open source especially suitable for web development language and which can be embedded in HTML.
PHP is mainly focused on the programming of the server-side scripts, so you can perform tasks such as collect form data, generate dynamic content pages, or send and receive cookies, among other applications [13].

12V solenoid valve: valve normally closed plastic solenoid. This can be installed at any angle, despite this, it is recommended to place it in horizontal direction. Used to automatically control the flow of water, it works with a voltage of 12V. Despite its small size, it is very practical, since it reaches a good level of pressure reaching 0.2mpa when water is added to this device.

Table 2: Solenoid valve 12V DC sheet

Mark FUD	FUDI
Operating voltaje	12V DC
Operation mode	direct action
Type of drive	normally closed
Size port	10.5MM
Water outlet pressure	0Mpa~0.2Mpa
Temperature of operation	-5°C~+60°C

Hygrometer Arduino module: this sensor has the ability to measure the humidity of the soil. By applying a small voltage between the terminals of the module YL-69 does pass a stream that basically depends on the resistance that is generated on the ground and this depends on humidity. Therefore to increase the humidity the current grows and lowering the current decreases.

Table 3: Specifications module hygrometer Arduino

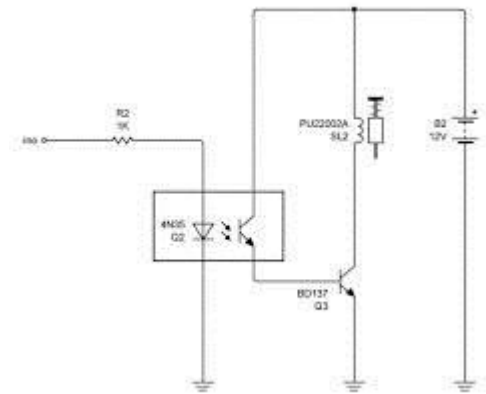| Input Voltage	3.3 – 5 VCD
Output Voltage	0 ~ 4.2 V
Current	35 mA
VCC	supply voltage
GND	Earth
Dimensions YL-38	30 x 16 mm
Dimensions YL-69	60 x 30 mm

Arduino Water Sensor: A simple sensor of water/rain, which produces an analog signal proportional to detected moisture, or water containing.

It is a small sensor designed to detect rain water or small modifications of water (a couple of cm) level to detect seepage or leakage of liquid [16].

Optocoupler 4N25: The 4N25 is a led of infrared of arsenide of gallium, along with a Silicon phototransistor. An opto Coupler, also called optoaislador or insulator coupled optically, it is a device of transmission and reception which functions as a switch activated by the light emitted from a led that saturates a component opto electronic, normally in the form of phototransistor or TRIAC. So are combined in a single semiconductor device, a transmitter photo and a receiving photo whose connection between them is optical. These elements are within a package it is usually DIP type. They are often used to isolate electrically sensitive devices [17].

Specifications:
- Power supply controllers.
- Digital logic inputs.
- Inputs the microprocessor.
- Number of channels: 1
- Isolation voltage: 5 kV
- Type optocoupler output: Phototransistor
- Input current: 50 mA
- Output voltage: 30 V
- Package: DIP
- Pin no.: 6

- Mount type: Through Hole
- RoHS Compliant: Yes

Process:

1. It must take into account that the solenoid valve drive a higher working voltage provides that plate Arduino UNO, so it is necessary to create an additional circuit with an 4N25 optocoupler and an NPN transistor, to provide the necessary voltage.

Figure 1. Optocoupler circuit. Soruce: [18].

2. Set up an account on a server, can be free. In this case the https://www.000webhost.com/ site will be used.
   After you set up the account on the server, is to create a domain by means of which email alerts will be sent. In this case the address of the domain is: http://alarmaplantas.comli.com/
3. Then create the folder "mailing" which will contain the script for sending emails. Thus the domain address is thus: http:// alarmaplantas.comli.com /mailing/
4. Load following code, called mail.php to the "mailing" folder:

```
echo $correo;
$mail = "Tu planta no está recibiendo la
cantidad suficiente de agua, por favor
llena la botella";
//Titulo
$titulo = "¡PLANTA SECA!";
//cabecera
$headers = "MIME-Version: 1.0\r\n";
$headers .= "Content-type: text/html;
charset=iso-8859-1\r\n";
//direccion del remitente
$headers .= "From: AlarmaPlanta <
Alarmaplanta >\r\n";
//Enviamos el mensaje a tu_direccion_email
$bool =
mail($correo,$titulo,$mail,$headers);
if($bool){
    echo "Mensaje enviado";
}else{
    echo "Mensaje no enviado";
}
?>
```

5. For the testing of the script is accessed the address:
http://alarmaplantas.comli.com/mailing//mail.php?correo
=correo@ejemplo.com
Once the script is run, the alert is sent to the entered email
address.

Figure 2. E-mail notification information.
Source: Authors
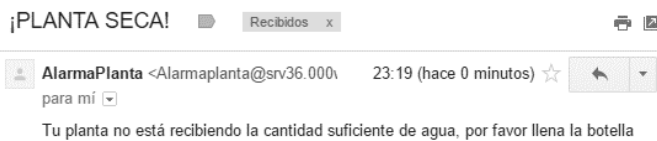
Figure 3. Preview of notification by email.
Source: Authors.

6. Download the IDE open source Arduino Software to
compile and write the following code in the Arduino:

```
#include <SoftwareSerial.h>
#include <EEPROM.h>
SoftwareSerial WIFI(3, 2); // RX | TX
const int Higo = A0;
const int Nivel = A1;
int TipoPlanta=0;
String Correo="";
void setup() {
    Serial.begin(9600);
    WIFI.begin(9600);
    Serial.println("Bienvenido");
    sonidoSirena(2);
    verificarWIFI();
    verificarCorreo();
    verificarPlanta();
}
void loop() {
    if(TipoPlanta==1){
        if(Higo<150){
        digitalWrite(13, HIGH);
        }else{

    digitalWrite(13, LOW);
}
    }
    if(TipoPlanta==2){
        if(Higo<250){
        digitalWrite(13, HIGH);
        } else{
```

```
    digitalWrite(13, LOW);
}
    }
    if(Nivel<20){
        enviarCorreo(Correo);
    }
}
String sendData(String command, const int
timeout, boolean debug)
{
    String response = "";
    WIFI.print(command); // Envia el caracter
leido al modulo
    long int time = millis();
    while( (time+timeout) > millis())
    {
      while(WIFI.available())
      {
        // El modulo tiene datos para mostrar
        char c = WIFI.read(); // lee el
siguiente caracter.
        response+=c;
      }
    }
    if(debug)
    {
      Serial.print(response);
    }
    return response;
}
String solicitarTexto(String mensajePeticion){
    Serial.println(mensajePeticion);
    String Mensaje;
      boolean ab=true;
      while(ab==true){
        char c=' ';
        if (Serial.available()) //Comprobamos si
hay algo esperando
                {
                    while( c != '\n') //Si lo
hay, lo leemos hasta el intro
                        {
                            Mensaje = Mensaje +
c ; // Añadimos lo leído al mensaje
                            c = Serial.read();
//Leer 1 carácter
                            delay(25);
                        }
Mensaje=Mensaje.substring(1,Mensaje.length()-1);
                    ab=false;
                }
        }
        return Mensaje;
    }
void verificarWIFI(){
  String
respuesta=sendData("AT+CWJAP?\r\n",1000,false);
     if(respuesta.indexOf("No AP")>0){
        Serial.println("No Conectado");
        Serial.println("Detectando Redes");
        String
listaAP=sendData("AT+CWLAP\r\n",3000,false);
        Serial.println("AP
Disponibles\r\n"+listaAP.substring(listaAP.index
Of("\r\n+CWLAP:"),listaAP.length()-4));
        String conexion;
```

```
       int indice=-1;
         while(indice<0){
           String AP=solicitarTexto("Por favor
ingresa el nombre de tu red");
           String Password=solicitarTexto("Por
favor ingresa la contraseña de tu red");
           String
conexion=sendData("AT+CWJAP=\""+AP+"\",\""+Passw
ord+"\"\r\n",7000,false);
indice=conexion.indexOf("WIFI CONNECTED");
           if(indice<0){
             Serial.println("Ha habido un
problema");
           }
         }
       }else{
      Serial.println("Conectado");
         }
   }
 }
void enviarCorreo(){
  String
respuesta=sendData("AT+CIPSTART=\"TCP\",\"planta
s.net16.net\",80\r\n",1000,false);
  int largo=58+Correo.length();
if(respuesta.indexOf("CONNECT")>0){
respuesta=sendData("AT+CIPSEND="+String(largo)+"
\r\n",1000,false);
    if(respuesta.indexOf(">")>0){
      respuesta=sendData("GET
http://plantas.comli.com/mailing/mail.php?correo
="+Correo+"\r\n",2000,false);
      if(respuesta.indexOf("Mensaje
enviado")>0){
        Serial.println("Mensaje enviado");
      }
    }
  }
}
  void verificarCorreo(){
   if(Correo==""){
    Correo=solicitarTexto("Por favor digite la
direccion de correo electronico al cual se
enviaran las notificaciones");
    }
  }
   void verificarPlanta(){
   if(TipoPlanta==0){
    Correo=solicitarTexto("Por favor digite el
numero de la planta que posee: \n
1.Flores(Claveles, Tulipanes, Margaritas) \n
2.Plantas ornamentales (Billete, Sabila,
Cactus)");
    }
  }
```

Explanation of the code

In the method void loop() humidity levels for the two types of plants that operate the device are configured. Critical water level is also set to send the notification to the user.

In the method void verificarWIFI() is the module configuration WiFi where is requested the name and password of the network you wish to to connect.

The method voidEnviarCorreo() is configured using commands AT the URL of the server in PHP in charge of sending the alerts.

In the method void verificarCorreo() will enter the email address to which the user wants to which the alert is sent to you.

The method void VerificarPlanta() requests the user to select the type of plant that has and you want to use the device.

- Test the operation of the connections and the algorithm.

Figure 4. Connection between Arduino board, Wifi module and solenoid valve. Source: Authors

Test

The device was tested with a plant of Aloe Vera, which was transplanted into a pot in November of 2015, in Bogotá, Colombia.

Aloe is a plant that can withstand the cold but not the moisture, so it must be located in places where good drainage, as the ground slopes or pots with gravel can be guaranteed. Nor should place is to the light direct from the Sun. This plant has a life cycle of approximately 12 years [19].

The Aloe Vera plant needs to be watered once a month. To check the need for irrigation is enough to bury a finger on Earth and observe it; If it is wet irrigation, is not necessary if it is dry irrigation is necessary.

Table 3: Botanical classification of the aloe plant

Kingdom	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Asparagales
Family	Xanthorrhoeaceae
Subfamily	Asphodeloideae
Gender	Aloe
Species	Aloe Vera

RESULTS AND DISCUSSION

It was found that the device is capable of keeping the soil moisture in different types of plants, promoting these to maintain good condition, compared with irrigation provided by a person, which is carried out with low frequencies.

This device has as variables soil moisture and water from irrigation container level, both are taken by the module hygrometer and the water sensor, respectively.

In [3] shows a prototype of an automated irrigation system. The prototype includes a sensor node and a node's control. The sensor node detects the values of soil moisture and sends them to the controller node. When humidity value does not have the required value turns on the engine for the irrigation of the field and sent an alert registered mobile phone.

In [4] the intelligent drip irrigation system automates and regulates the irrigation without any manual intervention. The sending of emails can be automatically or manually depending on the climatic conditions. Any failure of the system or its components must be reviewed manually.

In [5] implements a network of wireless sensors based on soil moisture level to control the flow of water in a pipe. You can be performed through technologies and web services, remote monitoring and updating details of the sensor. The sensor data and the level of water flow are sent to the user via SMS to your mobile phone.

In [6] implements a wireless system for monitoring pipelines using a vibration sensor and an accelerometer. It is that the relationship between the pressure of the water and the vibration is reversed for pipeline leakage. When the pressure is high, it is difficult to distinguish if the piping is in normal or abnormal conditions. The leak in the pipeline can only be detected when the pressure is low, by means of the vibration sensor.

In [7] to turn on and turn off devices through cell phones, the automation of the irrigation is made possible in real-time, taking into account variables such as soil, climate and culture.

Most devices are designed for irrigation of crops or sectors related to agriculture, for which this project presents a different application, taking into account that there is domestic use.

In relation to notifications, these are subject to the congestion of the site's hosting server that hosts, in addition the rapidity with which notifications are sent is variable, depending on the radio and the power of the WiFi signal from the user.

With respect to the device that is presented in this article highlights the use of readily available materials and economic. But this limits its functionality since you don't have machinery for measuring temperature or to supply the necessary water for irrigation.

The operation of the device is very simple, it has set up two types of plants, for which there is a humidity value that makes that activates the solenoid valve and proceed with the process of irrigation. If the required humidity values are not reached, the solenoid valve remains idle.

CONCLUSIONS

- The development of this device is an advance that contributes to the implementation of intelligent homes and offices, which have been very well received at present, due to the level of self-sufficiency, and savings in long-term maintenance costs.

- As future work, this project can have integrations with others of the same type, which will allow the development of larger systems that collaborate in the maintenance of plants not only in homes, but in medium and large institutions.

- The value of moisture in the soil can vary significantly for the same type of plant, if factors such as temperature or location within the house are taken into account. What makes it difficult to establish a periodic frequency of irrigation.

- This same implementation can also be done with an ESP 8266 module, ESP-07, which has a higher cost than the module used in this development, and has the NodeMCU firmware, which works under the LUA language, characteristics that would make this project can significantly reduce their physical dimensions.

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