Smart GreenHouse

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Abstract

Smart Greenhouse is an innovative project of a temperature control system and soil humidity for greenhouse. Expanding the number of urban greenhouses means that there is the need to create automation systems to reconcile the urban lifestyle with the necessary time to take care of a greenhouse.

The solution was obtained by an Arduino microprocessor connected to two sensors: temperature sensor and moisture sensor, which analyzes the inner conditions of the greenhouse. After this analysis it resorts to two actuators, a fan to control the temperature, and a water pump coupled to an irrigation system to control soil moisture. This system can be programmed to any range of temperature and humidity.

A project of this kind has a social component, promotes sustainable living in the city, such as its implementation was held at the Cozinha Popular da Mouraria. This institution uses a small greenhouse for germination of plants, so Smart GreenHouse allowed the employees of the Cozinha Popular da Mouraria with less time spent better control of the process. The success of the product and its low cost allows you to have good expectations for future marketing.

Key words: greenhouse, automated system.

Introduction

This report describes the development of the project Smart GreenHouse since initial phase to implementation. The project is based on the development of an intelligent greenhouse - "Smart Greenhouse" - which was born in the discipline called for Experimental Methods in Energy and Environment (MEEA). It will address the following necessary steps and made to complete this project:

- **Analysis of ideas -** After being transmitted the goal, as well as the subject concerned, the group did a brainstorming meeting and after that presented and discuss with the monitor Nate Gilbraith.
- **Market analysis -** We analyzed several projects already installed and we tried to differentiate our project already on the market;
- **Establishing contacts -** Searching for a strategic partnerships in order to achieve the installation of a pilot equipment in an institution from Mouraria neighborhood;
- **Construction -** Work began on the construction of a prototype to be presented and tested by our "partners";
- Implementation - the prototype was installed inside Cozinha Popular da Mouraria facilities and we are monitoring the data.
- **Adaptative Changes -** several amendments were made to the initial project to better meet the needs;

Analysis of ideas

It is necessary to promote a sustainable way of life in cities and create more favorable conditions for the exploitation of rural/agricultural activities. People in the city needs to connect with their environment. Using gardening equipment they could growing their food without pesticides and chemicals. Promoting healthier food for themselves

Taking into account these facts we need to develop a type of intelligent greenhouse using electronic instruments which save water and selected the best way to watering and controlling the conditions in which the culture is developed. With this equipment people will not spend so much time in farming and can grow their own food combining agricultural activity to another. May be a solution for a growing market of organic farming.

Market Analysis

Researching existing greenhouses market quickly noted two things, this market is grow up very fast ([1], [2], [3]) and don't have intelligent automated kits for measure temperature and soil moisture for small domestic greenhouses. Checking the options which follow the traditional concept of Greenhouse we tried to create a product that is adaptable to all types of greenhouses and allowing the use of greenhouses by individuals, social institutions and restaurants that don't have time to spend in the control of a traditional greenhouse and wishing to use in their organization products free of pesticides and fertilizers.

Establishing contacts

Implementation of this project requires a testing phase a place where it can be promoted and presented to potential future users. Professor Manuel Heitor promoted our contact with various organizations, one of them was Associação Renovar a Mouraria. Dr. John Menezes from Associação Renovar Mouraria provided Mrs. Adriana Freire contact. She is a responsible for Cozinha Popular da Mouraria that has several gardens in the neighborhood of Mouraria and holds in their plans to build a greenhouse. Considering the foregoing, it was considered the ideal partner for the development of our product, not only for advertising but also by the essential tips that we could receive about the ideal conditions for the growth of crops and how program the correct configuration of sensors and actuators.

Construction

Our prototype consists of:

- **Structure:** Aquarium (50x25x30mm);

Fig 1 – Reconstruction and cleaning of the aquarium collected for the project.

- **Controller system:**
  - Arduino board;

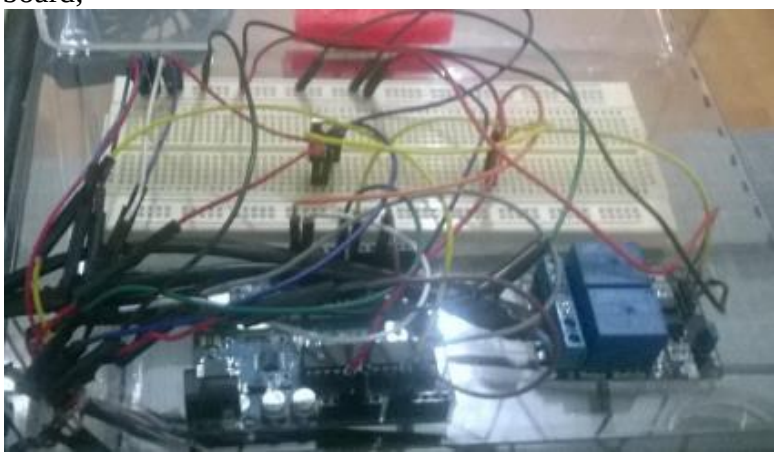


Fig 2 – Controller system currently mounted.

- **Automatic Watering System:**
  - Moisture sensor SEN0114;
  - Water pump;
  - Relay;
  - Water circuit.

Fig 3 – Tests to the moisture sensor.

Fig 4 – Water circuit construction.

SEN0114 moisture sensor measures the electrical conductivity of the soil and through its datasheet you can define that if the measured value is less than 300 should proceed to the watering because the soil is dry.

- **Temperature control system:**
  - Temperature sensor LM35;
  - 3 LEDS (green, yellow, red);
  - Fan.

Fig 5 – LEDs used in the circuit.

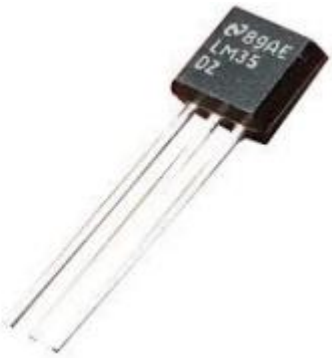


Fig 6 – Temperature sensor LM35.

After consulting the employees of the Cozinha Popular da Mouraria it was decided that the ideal temperature range for growing of various species was between 18 ºC and 26 ºC. To be able to verify that it was created a color system:

- Green LED ON – Temperature greater than 18 ºC;
- Yellow LED ON – Temperature greater than 22 ºC;
- Red LED ON – Temperature greater than 26 ºC.

When the temperature reaches 26 °C (Red LED ON) the fan located on top turns on to extract the hot air.

Implementation

The equipment was implemented in the Cozinha Popular da Mouraria facilities on 08 December and since then the equipment has proved it reliability and wasn't given any anomalies until the production of this report. By direct observation we could verify the good parameterization of the sensors.

As can be seen in figure nº7, in just one week we could see a rapid growth of many plants.

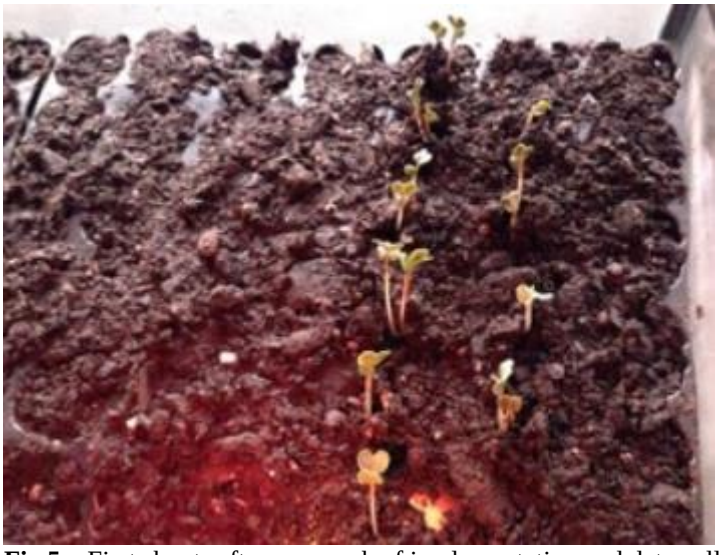


Fig 5 – First shoots after one week of implementation and data collection

Moving Forward

The project is maturing phase. The next step will be to use this system in greenhouse with larger dimensions (being built by the Cozinha Popular da Mouraria). After this experience we will take a decision about the capabilities of this product. If this project move forward we will need to develop a very flexible irrigation system and integrate of all electronic components in an inclusive board.

The main objective is change attitudes and promotion a sustainable lifestyle, so marketing of this product in beginning should be performed in institutions, schools, nursing homes, community kitchens, etc. Although the preferential market is institutions. Sales directly to individuals should also be considered due to the good feedback from the last presentation, in Associação Renovar a Mouraria. Several spectators showed great interest in the product.

Conclusion

The Smart Project GreenHouse is implemented in the Cozinha Popular da Mouraria and is working as an incubator for small plants. After the plants reach certain dimensions will be changed for a garden. The next step will be to use the same system of electronic components in a greenhouse with higher dimensions (about 9 m2 cultivation area). This last point has not been realized until now due to lack of financial capacity and others factors outside of work team.
As academic work this was very interesting project because it was possible the implementation of our ideas on the field, hands-on project. It was also important to demonstrate that the technological part of the project is only one factor to considered, and possibly the most easily controlled factor in terms of deadlines.

The highlights need to be the necessity to listen the people (future users/customers) and understand their needs and their timings. That was the biggest challenge of this project and we feel that was accomplished.

Feedbacks

"The germination and a very sensitive stage of the life of a plant. The temperature conditions and humidity are critical for success of this phase.
Having possibility of control the environment from germination give us precious advantage.
The idea of incorporating technology allows to put a "small greenhouse" in places where we couldn't provide a good monitoring. This permit a more flexible and productive integration of small farming structures within the city.
A cultivation environment needs to have thermal inertia and hygrometric to ensure stable growing conditions. The dynamic and automatic control helps to ensure that conditions. With this system we can obtain the most favorable conditions to germination".

Silvan, Collaborator of Cozinha Popular da Mouraria

References

[1] http://www.boasnoticias.pt/mobile/noticias.php?id=21762
[2] http://greensavers.sapo.pt/2013/06/09/lisboa-abre-concurso-para-mais-130-talhoes-de-hortas-urbanas/
[3] http://oglobo.globo.com/economia/imoveis/estufas-urbanas-futuro-da-horta-pode-estar-na-metropole-6510186
[4] http://www.biovilla.org/biovilla/

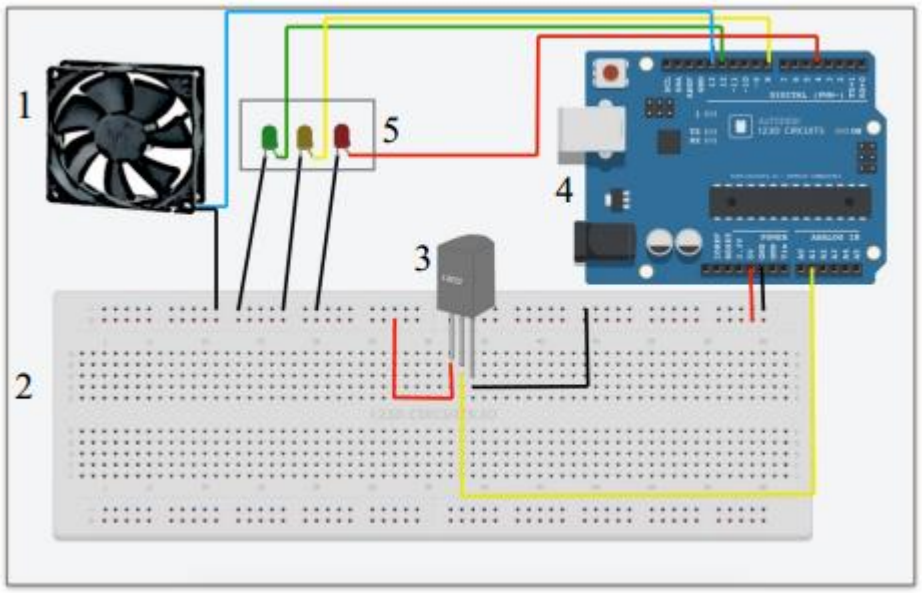
Attachments

Code used for temperature system:
Code:

```
float tempC;                          // temperature variable
int tempPin = 1;                      // Allocation of results (gates) to our variables
int ledamarelo = 8;
int ledverde = 12;
int ventoinha = 13;
int ledvermelho = 4;
void setup()                          // It is performed once at the beginning and start variables
{
Serial.begin(9600);                   // Start the communication (rate of 9600 bps)
pinMode (ventoinha, OUTPUT);          // Outputs
pinMode (ledverde, OUTPUT);
pinMode (ledamarelo, OUTPUT);
pinMode (rega, OUTPUT);
pinMode (ledvermelho, OUTPUT);
}
void loop()                           // The code will repeat successively until turned off
for(int i=0;i<60;i++)
{
tempC=tempC+(float)analogRead(tempPin);        // Reading of temperature sensor
delay(10);
}
tempC = (5.0 * tempC * 100.0)/1024.0/60.0;     // Conversion to Celsius degree.
Serial.print("Temperatura:");
Serial.print((byte)tempC);                     // Send data to computer
Serial.println("∫C");
Serial.print("\n");
if ( 26 < tempC )          // If the temperature exceeds 26 °C the Red LED and the fan are activated.
{
digitalWrite (ventoinha, HIGH);
digitalWrite (ledvermelho, HIGH);
}
else                                  // If temperature less than 26ºC Red LED and fan turn off.
{
digitalWrite (ventoinha, LOW);
digitalWrite (ledvermelho, LOW);
}
if ( 22 < tempC)                      // If temperature reaches 22ºC yellow LED turns on.
{
digitalWrite (ledamarelo, HIGH);
digitalWrite (ledverde, HIGH);
}
else                                  // If temperature less than 26ºC Yellow LED turn off.
{
digitalWrite (ledverde, HIGH);
digitalWrite (ledamarelo, LOW);
```

```
digitalWrite (ledvermelho, LOW);
digitalWrite (ventoinha, LOW);
}
if ( 18 < tempC)                    // If temperature reaches 18ºC green LED turns on
{
digitalWrite (ledverde, HIGH);
}
else                                // If temperature less than 18 green LED turns off.
{
digitalWrite (ledverde, LOW);
digitalWrite (ledamarelo, LOW);
digitalWrite (ledvermelho, LOW);
digitalWrite (ventoinha, LOW);
}
delay(3000);                        // Sensor reading all 3 seconds.
}
```

Assembly:



1. Fan
2. Breadboard
3. Temperature sensor LM35
4. Arduino Uno board
5. LEDs

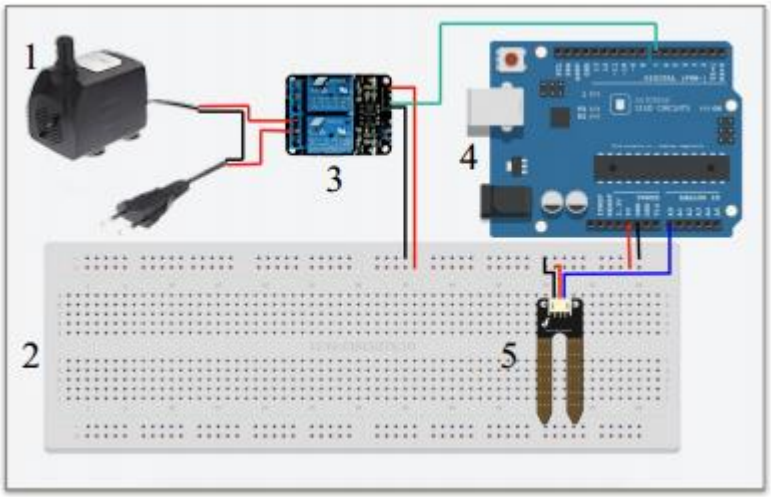
Code used to watering system:

Code:

```
/*
 # Values obtained from moisture sensor
 # 0 ~ 300 Dry ground
 # 300~700 Wet ground
 # 700~950 Very moist ground
*/
int rega = 7; // Relay connected at digital pin 7
void setup()
{
Serial.begin(9600); pinMode (rega, OUTPUT);
}
void loop()
{
Serial.print("Valor de humidade:");
```

```
Serial.println(analogRead(0));                  // Shows reading value on the pin in the A0 input
if ( analogRead(0) < 300)                       // If the value read is less than 300 starts the watering.
{
 digitalWrite (rega, HIGH);
 }
else
{
digitalWrite (rega, LOW);
}
}
 delay(3000);
}
```

Assembly:



1. Water pump
2. Breadboard
3. Relay
4. Arduino Uno board
5. M o i s t u r e s e n s o r SEN0114