STUDY ON THE USE OF SMART SENSORS TO MONITOR ENVIRONMENTAL FACTORS IN GREENHOUSES

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Summary: The purpose of this paper is designing a smart thermometer by using Arduino. This kind of thermometer would be used in greenhouses so the plants could thrive. The components of the circuit consist off: an Arduino board, a DHT 11 sensor and an LCD screen are used to display the temperature and humidity interpreted by receiving the signal. After the shell was designed in Catia, it was 3D printed and then the Arduino was placed carefully along the wires and the sensor.

KEY WORDS: Arduino, LCD screen, smart sensor, greenhouse, smart thermometer

1. Introduction

A greenhouse (or solarium) is a building special with glass or plastic roof and walls for housing and growing plants that do not stand the cold in the winter .Warming up the greenhouses is made in the differently ways : with hot water, water vapors, electrical energy etc. A classification of the obtained temperature depending of the plants' requirements is:

- -cold greenhouses with temperature in between 8 - 10 °;
- -temperate greenhouses with temperature in between 18 - 20 °;
- -warm greenhouses with temperature in between 25 - 30 °

So to see if temperature and the humidity falls in the normal parameters rule depending on the type of plants we want to grow, we made a smart thermometer that uses smart sensors which take in environmental and ambient data and processes them with the help of an Arduino board, and after processing it displays external data on an LCD screen so that it can be interpreted as well as changing temperature with the help of heating and humidification systems of the greenhouse.

2. The current stage

The current research was successfully completed, the thermometer prototype can to take over environmental information and display them. For the 3D model Catia V5 was used, where the virtual model of the thermometer was created. That's how the case was designed and it incorporated the LCD screen and smart sensor to take over environmental information . The case of the thermometer was made with the help of a 3D printer according to the virtual model.

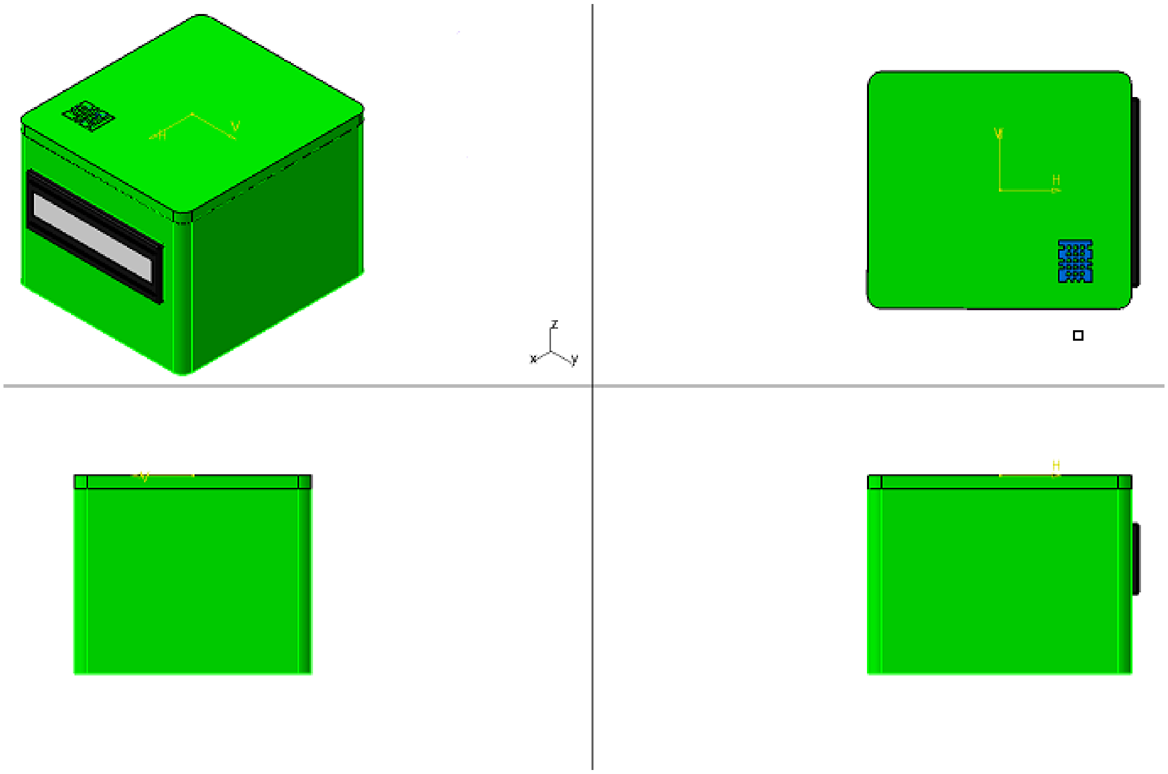

Fig. 1. Smart thermometer CAD model

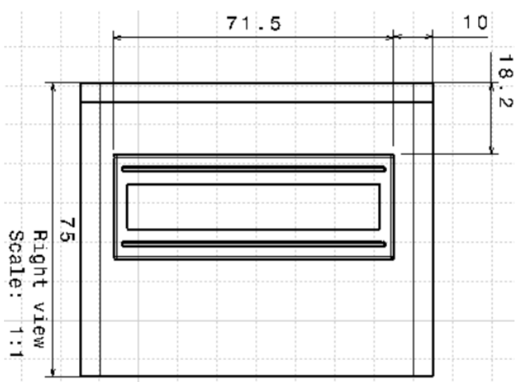

Fig. 2. Front view of the smart thermometer with overall dimensions

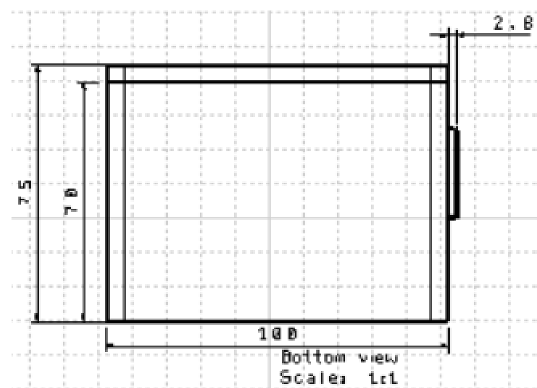

Fig. 3. The side of the smart thermometer with overall dimensions

The programming part was made with Arduino IDE software, where it was programmed to take over information provided by the humidity and temperature sensor DHT 11 and to display them on the LCD screen so that they can be interpreted. For making the scheme of the electrical components the Fritzing software was used, where connecting the smart sensor's Data pin to the MOSI pin of the Arduino board to provide data taken from the environment and to interpret it, was a crucial step. The connection of the LCD screen's SDA pin to A4 pin was intended for interpretation of the data received from the board and displaying them, and the connection of the SCL pin to the A5 pin of the board was intended for the transmission in real time of the data.

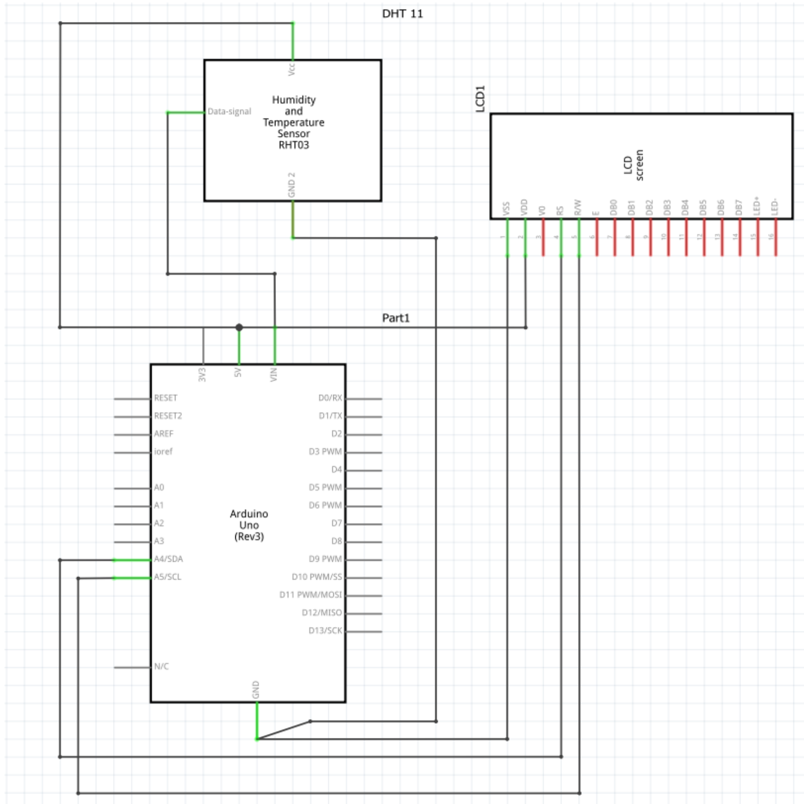

Fig. 4. Wiring diagram

After setting up every detail of the research, after connecting electrical components and uploading the code in the Arduino board, according to the virtual model created, the physical model was made as it follows:

Fig. 5. The physical model

The smart thermometer will be placed on different pillars of different heights to be able to monitor temperature from the ground level to the top floor of industrial greenhouses.

So the data can be shown on the display, the liquid crystal library will be used, and after the data will be received from the sensor it will be displayed as characters for temperature and humidity with the value interpretation of the DHT 11.

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);  // set the LCD address to 0x27 for a 16 chars and 2 line display
byte degree_symbol[8] =
              {
                0b00111,
                0b00101,
                0b00111,
                0b00000,
                0b00000,
                0b00000,
                0b00000,
                0b00000
              };
int gate=11;
volatile unsigned long duration=0;
unsigned char i[5];
unsigned int j[40];
unsigned char value=0;
unsigned answer=0;
int z=0;
int b=1;
void setup()
{
 lcd.init();                      // initialize the lcd
 lcd.init();
 lcd.backlight();
 lcd.print("Temp = ");
 lcd.setCursor(0,1);
 lcd.print("Humidity = ");
 lcd.createChar(1, degree_symbol);
 lcd.setCursor(9,0);
 lcd.write(1);
 lcd.print("C");
 lcd.setCursor(13,1);
 lcd.print("%");
}
```

Fig. 6. Liquid crystal library

3. Conclusions

In conclusion, the smart thermometer is a innovative method to monitorize humidity and temperature in industrial greenhouses, offering accuracy for the data extracted from the environment and maintaining optimal parameters for the development and growing of the plants we want to cultivate. The product is a compact one, having a low size and being easy to place in the greenhouse. Our personal contribution was making the virtual model, programming it and making the component interconnection scheme of electronic parts. We want to continue this research through integration of the thermometer in an automated vertical greenhouse.

4. Bibliography

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