Project µC – Part 2 – Humidity Sensor

1. Specifications

The humidity sensor must have a digital output and be affordable, first. Secondly, it must have a desirable humidity in the greenhouse would be somewhere around 80-83% RH and a temperature between 10℃ and 30℃.

2. Theme Description

The aim of the project is to build an automated greenhouse system with various systems and sensors, to monitor the temperature, the air quality and humidity, the soil acidity and moisture and the CO_2 levels. As well as tend to the needs of the plants.

3. Generic list of components

Sensors:

- Temperature sensor
- Humidity sensor
- Light sensor
- Moisture sensor
- Air quality/CO_2
- Soil pH sensors

Processing:

- Microcontroller
- Amplifier
- ADC

Input/output:

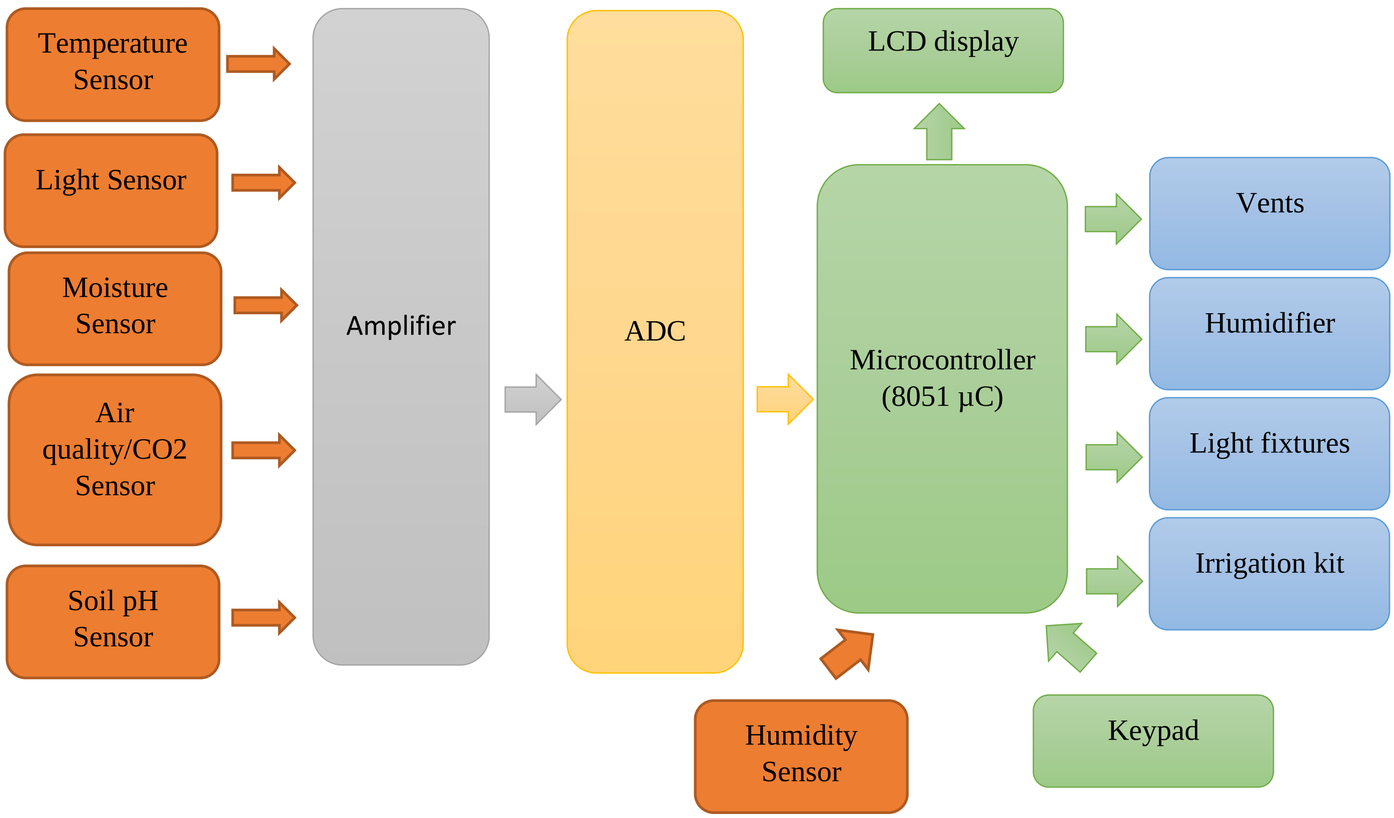
- Keypad
- LCD display

Other:

- Humidifier
- (Drip) irrigation kit

- Light fixtures
- Vents (cooling/heating/air circulation)

4. Block Diagram



5. Measurement methods

Capacitive humidity sensors – basic type of humidity sensors. Often used in applications where factors like cost, rigidity and size are of concern. In Capacitive Relative Humidity Sensors, the electrical permittivity of the dielectric material changes with change in humidity. [1][2]

It is composed of two metal plates or electrodes, separated by a thin layer of non-conductive polymer film. Capacitive sensors use these two electrodes to monitor the capacitance.[1]

This kind of sensors offer several advantages, such as low power consumption and high output signals, on the other hand, the distance from the sensor and signaling circuit is limited. They use capacitive measurement, which relies on electrical capacitance.[2]

Resistive humidity sensors – work on a similar principle to capacitive sensors, where electrical change is measured to produce a value for relative humidity. Although, resistive sensors, use a hygroscopic (moisture-absorbing) material. The difference to the capacitive sensors is that the resistive sensors measure the resistance change in the material, caused by the absorption of water vapor. [3]

They measure the change in electrical impedance in a hygroscopic medium such as a conductive polymer, salt, or treated substrate. [3]

Among the advantages of this sensor, are the linear output, low cost, small size, and the distance between the sensor and the signaling circuit can be large, but on the other hand they are sensitive to chemical vapors and other contaminants and the readings may shift if used with water soluble products.[3]

Thermal humidity sensors – also know as Absolute Humidity (AH) Sensors. They measure the thermal conductivity of both dry air as well as air with water vapor. The difference among this type of sensors stands only in the absolute humidity. [3]

Such sensors utilize two probes, one is encased in a chamber filled with dry Nitrogen while the other is exposed to open environment through small venting holes. When the circuit is powered on, the resistance of the two probes is calculated and the difference between those two values is directly proportional to the AH. [3]

They are exceptionally durable and are suitable for environments with high temperatures and for high corrosive situations. On the other hand, exposure to any gas with thermal properties different than Nitrogen, might affect the reading measurements. [3]

6. Proposed method

Considering all the information mentioned earlier, we can safely exclude the resistive humidity sensor base solely the fact that they are sensitive to chemical vapors and other contaminants, that might be used in some solutions in treating the plants. Therefore, we find ourselves, once again with just 2 choices left: capacitive and thermal humidity sensors.

Based on the information presented above, I think that the thermal humidity sensor would make a better fit because of the advantages that it brings to the table.

7. Sensor comparison

Model	HDC1010YPAT [7]	SI7021-A20-GM [6]	SHT31-DIS-B [5]
Output	Digital	Digital	Digital
RH operating range	0-100%	0-100%	0-100%
Stability	Excellent at high humidity	Excellent long term	High
Relative Humidity Accuracy	±2% RH	±3% RH	±1.5% RH
Temperature accuracy	±0.2 °C	±0.4°C	±0.1 °C
Operating temperature	-40°C to 85°C	-40°C to 125°C	-40°C to 125°C
Availability	Yes	Yes	Yes
Interface	I2C	I2C	I2C
Price	15.47 RON	15.50 RON	18.10 RON

Table 1. Sensor comparison

The I2C interface is a synchronous, multi-master, multi-slave, packet switched, single-ended, serial communication bus. It is widely used for attaching lower-speed peripheral ICs to processors and microcontrollers in short-distance, intra-board communication.

I2C is a serial communication protocol, so data is transferred bit by bit along a single wire (the SDA line). Like SPI, I2C is synchronous, so the output of bits is synchronized to the sampling of bits by a clock signal shared between the master and the slave. The clock signal is always controlled by the master.

8. Proposed sensor

Base on Table 1. we can see that all the three sensors are quite similar. All of them have a digital output, and the same interface. The only differences are observed at RH and temperature accuracy, operating temperature, and price.

When comparing the three sensors we can observe that the SHT is clearly the superior sensor, but also the most expensive out of the three. Therefore, I took into consideration the other two sensors, since they were cheaper and at the same price and not so far behind the SHT.

After careful consideration I decided to go with the HDC1010YPAT because it has a better accuracy that the SI sensor and the temperature range, be it smaller, it has no importance in our case, since the greenhouse will never reach such high values.

9. Bibliography

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