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Using Temperature and Humidity Wireless Sensor and An Arduino Board to Characterise and Verify Climatic and Thermostatic Chambers on A Webpage According to Standard NF X 15-140

Lamkharbach Yassine[1*], Berrada Mohammed[1], Bazi Fathallaah[1], Bouamrani Mouna Latifa[1], Brighal Hajar[2], Bassiri Mustapha[3]

[1]Hassan II University Casablanca, Morocco
[2]The Department of Electrical Engineering, National School of Electricity and Mechanics Casablanca
[3]Faculty of Sciences Ben M'Sick. Hassan II University of Casablanca, Casablanca, Morocco

Abstract:

Environmental controls, especially for temperature and humidity, are essential to maintain the safety, purity and effectiveness of drugs. The measurement of humidity can be particularly difficult and important in climatic and thermostatic chambers (warehouses, ovens, cold rooms, fridges, drying rooms, insulated boxes, etc.(.

The old method of monitoring and qualification of climatic and thermostatic chambers requires placing a defined number of recorders, then programming and store them. After that, to examine the values recorded to revolve the status of the climatic and thermostatic chambers, if they are compliant or not-complaint at any time, so all that goes to waste time and efficiency of values.

We can do the monitoring and qualification of climatic and thermostatic chambers; we can verify the status of our chambers compliant or not-compliant, and this in favor to an original system that we developed.

Our system can be used to allow staff to qualify and receive warnings or to autonomously regulate our physical quantities when environmental parameters do not meet specifications.

Our work consists of 3 distinct steps:

.1 Collecting data from the sensors;
.2 The transfer of these data to a database;
.3 Data recovery through the web page [1].

Keywords: Qualification, Climatic and thermostatic chambers, NF X 15-140,

1. INTRODUCTION

The emergence of new wireless technologies opens up new opportunities for Wireless Sensor Networks (WSN). New modes of operation (architecture and organization) can be envisaged and are to be defined for the provision and presentation of the data collected to the end user such as temperature, humidity, vibration, etc. However, the use of these new technologies will not solve all the existing problems.

The wireless sensor remains a device with limited resources (energy, memory and computing power) that does not allow the use of Internet data publishing systems applied to other entities such as smart phones.

A Wireless Sensor Network (WSN) consists of a set of on board processing units, called "motes", communicating via wireless links. The general purpose of a WSN is the collection of a set of environmental parameters surrounding the motes, such as the temperature or pressure of the atmosphere, in order to route them to processing points that may be a base of data.

The need for continuous monitoring of a given environment is quite common in various activities of society. Industrial processes, military tracking applications, habitat monitoring, and precision farming

*Email: lamkharbachyassine@gmail.com

are just a few examples of a wide and varied set of possible applications for continuous monitoring offered by the CWHC. The purpose of this article is to find a solution to qualify the thermostatic and climatic enclosures used in the pharmaceutical industry from a distance, so our article is based on embedded development, and is part of the Internet of Things.

2. MATERIALS AND SOFTWARE:

Our work consists of three distinct steps:

1. Collecting data from sensors;
2. Transfer of these data to a database;
3. The recovery of these data by the web page.

Recent advances in wireless and electronic technologies have resulted in low-cost development of tiny, energy-efficient sensors (low-cost and low-power solution). These sensors have three main functions :

- Capture data (Temperature & humidity).
- Calculate information using these collected values.
- Communicate them through a sensor network (Central- ized Architecture).

Figure 1-Centralized architecture.

2.1 Materials

2.1.1 Microcontroller ESP8266

In our practical tests, we use the NODEMCU board based on the ESP8266, it is a microcontroller integrated circuit with WIFI connection, to process and communicate the physical graders measured at the sensors using the http protocol

The ESP8266 can be programmed in several ways:

- In C ++, with the Arduino IDE;
- In JavaScript, with the Espruino firmware;
- In MicroPython, with MicroPython firmware;
- In C, with the Espressif SDK.

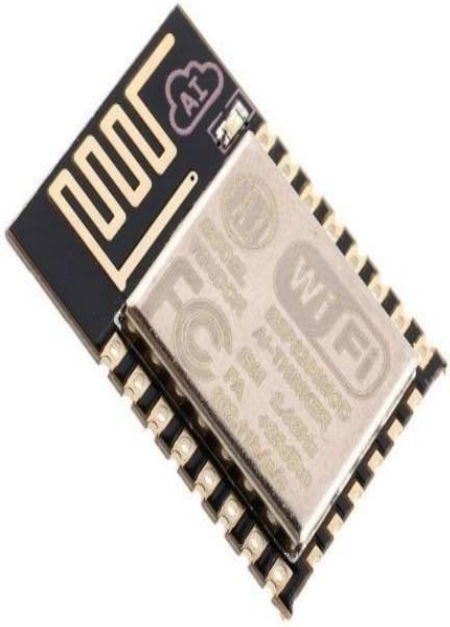

Figure 2-Microcontroller ESP8266.

2.1.2 Sensors

2.1.2.1 Temperature

The LM35 temperature sensor is an analog temperature sensor manufactured by Texas Instruments. It is extremely popular in electronics because it is:

- Accurate;
- Low cost;
- Simple in use;
- Reliable.

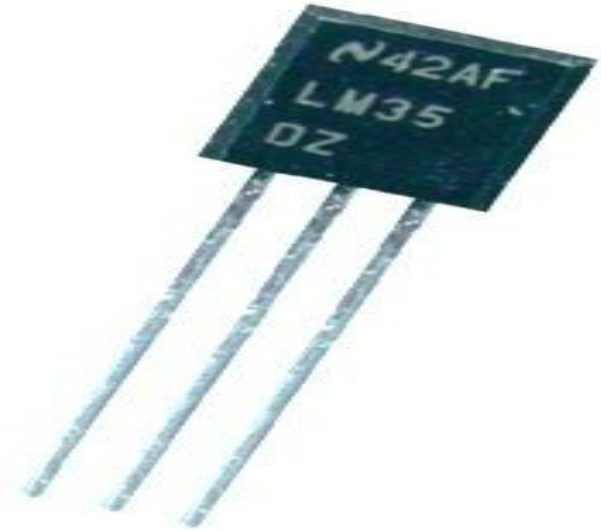

Figure 3-Analog temperature sensors LM35.

One of the great strengths of the LM35 sensor, which is its popularity, is its pre-calibration at the factory. All LM35 sensors are calibrated in degrees Celsius during manufacture.

The accuracy guaranteed by the manufacturer is +/- 1 °C at 25 °C and +/- 1.5 °C at -55 °C or +150 °C for the least accurate version, which is largely sufficient for most applications. The more precise version of the LM35 (named "LM35A") has a guaranteed accuracy of +/- 0.5 °C at 25 °C and +/- 1 °C at -55 °C or + 150 °C. Another great strength of the LM35 sensor is its exemplary line- arity: less than

1 °C error over the full range of - 55 °C to + 150 °C. As each degree, Celsius corresponds to 10 mV (or 0.01 volts) and the sensor output is perfectly linear.

2.1.2.1 Humidity :

The HIH-5030-001 is a low voltage SMD moisture sensor. This device operates up to 2.7 VDC and is ideal for battery-powered systems with a nominal voltage of 3VDC. The HIH-5030-001 is designed specifically for high volume OEM users (Original Equipment Manufacturer). Direct input to the controller or other device is made possible by the linear voltage output of these near- by sensors. It is ideally suited for very low consumption, battery operated systems with a typical current of only 200 μA. The interchangeability of the waterproof sensor eliminates calibration costs. The HIH-5030-001 offers HR (Relative Humidity) instrumentation quality sensing performance, a wieldable SMT package at a competitive price. This HR humidity sensor is a laser controlled thermosetting polymer capacitive sensing element with integrated on-chip signal conditioning.

Figure 4-Moisture sensor HIH-5030-001

- Thermosetting molded plastic housing;
- Resistant to chemical components;
- Low power design and increased accuracy;
- Fast response time;
- Stable performance, low drift;
- Power supply range from 2.7VDC to 5.5VD;
- Humidity range from 0% RH to 100% RH;
- Accuracy of ± 3% RH;
- Response time of 5s;
- Temperature range from - 40 °C to +85 °C.

A database is a tool that collects and organizes information. Data- bases can store information on people, products, orders, but also environmental measures from our network of sensors to end used by an HMI (Human Machine Interface) for example.

2.2 Software:

Creating many databases begins with the definition of a list in a word processing program or spreadsheet. As the list grows, redundancies and inconsistencies begin to appear in the data. These become more difficult to understand in the form of a list, and methods for searching or retrieving subsets of data for consultation purposes are limited. When these problems occur, it is recommended to transfer the data to a database created by a database management system (DBMS), such as MySQL.

MySQL is the most popular open source database in the world. Because of its proven performance, reliability, and ease of use, MySQL has emerged as the obvious choice of database for Web applications, used by the biggest names on the Internet, such as Facebook, Twitter, YouTube and the first five websites. It is also widely used as an embedded database, distributed by thousands of ISVs and OEMs.

MySQL is therefore a Relational Database Management System (abbreviated RDBMS). That is to say a software that can manage databases, and therefore manage large amounts of information. It uses for that the language SQL. It is one of the most known and used RDBMS (Wikipedia and Adobe use for example MySQL).

SQL (acronym for Structured Query Language) is therefore a standard computer language used to exploit relational databases. MySQL can be used alone, but is mostly combined with another programming language: PHP for example for many websites (as in our case), but also Java, Python, C ++, and many, many of them.

3. RESULTS AND DISCUSSIONS:

This is the design and implementation of a wireless data acquisition system (Temperature & Humidity) allowing graphical readings to be visualized on a Web HMI at the start and end of acquisition, the upper and lower limit of the temperature and humidity as well as the set point.

A human-machine interface (HMI) makes it possible to exchange information between the human user and the machine, which can be a computer, smart phone, server, robot, etc. For this communication to be the easiest to do and to do, we use different elements. Input devices such as the keyboard, mouse, microphone or scanner allow humans to give information or orders to the machine. Output devices such as the display, diodes, speakers, or the printer enable the machine to respond to orders and display information.

The screen is an important element and can display simple text as well as graphic interfaces. One of the goals of the discipline is to provide tools and elements to better shape this environment, and thus allow humans to interact more human and more effective with the machine.

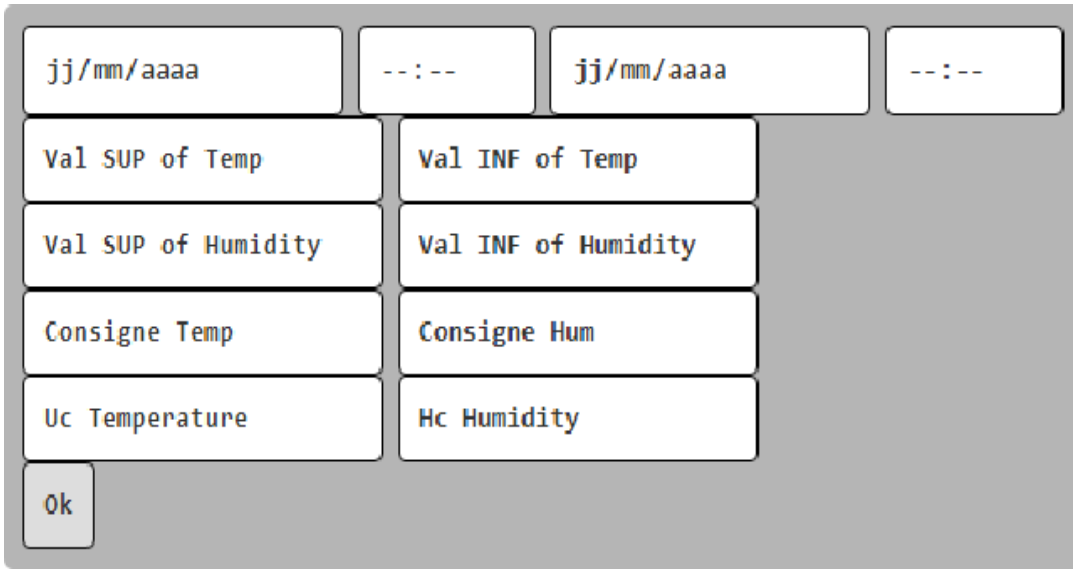

Figure 5-The data of the characterization

In this table, we can determine the duration of the qualification; just choose a date for the options given in this page. After the fillings of data for the date of qualification, the results of the parameters of the qualification are automatically given and after the choice duration of the characterization [1]

After the fillings of data for the date of qualification, the results of the parameters of the qualification are automatically given and after the choice duration of the characterization.

The parameters, which will be calculated, are:

- Homogeneity;
- Stability;
- Setpoint deviation;
- Indication error.

Temperature and humidity measurements

Temperature_1 [C°]	Humidity_1 [%]	Temperature_2 [C°]	Humidity_2 [%]	Temperature_3 [C°]	Humidity_3 [%]	Temperature_4 [C°]	Humidity_4 [%]	Date-time
21.31	62.43	21.34	60.34	21.43	62.56	22.74	62.89	26/02/2018 21:26:02
21.322	62.45	21.34	60.34	21.53	61.23	22.24	62.23	26/02/2018 21:26:13
21.32	62.78	21.32	60.34	21.87	62.73	22.24	62.23	26/02/2018 21:26:22
21.42	63.23	21.32	60.34	22.21	62.43	22.34	62.34	26/02/2018 21:26:32
21.56	63.44	21.31	60.34	22.21	62.43	22.34	62.76	26/02/2018 21:26:44
21.75	64.25	21.21	60.4	22.21	63.43	22.24	62.1	26/02/2018 21:28:55
22.15	64.25	21.51	61.03	22.21	63.54	21.86	62.23	26/02/2018 21:29:02
21.45	62.25	21.51	61.2	22.21	63.54	21.86	62.23	26/02/2018 21:30:23
21.45	62.25	21.51	61.23	22.24	63.54	21.82	62.43	26/02/2018 21:30:26
21.35	62.67	21.31	61.45	22.24	63.63	21.82	62.43	26/02/2018 21:30:41
21.55	63.12	21.42	61.61	23.24	63.02	21.53	62.65	26/02/2018 21:30:56
21.53	63.12	21.42	61.61	23.14	62.53	21.53	62.65	26/02/2018 21:31:02
21.53	63.89	21.22	61.7	23.14	62.53	21.55	62.85	26/02/2018 21:31:07
21.13	63.76	21.22	62.32	22.74	62.12	21.55	63.14	26/02/2018 21:31:39
21.55	63.12	21.42	61.61	23.24	63.02	21.53	62.65	26/02/2018 21:30:56
21.53	63.12	21.42	61.61	23.14	62.53	21.53	62.65	26/02/2018 21:31:02
21.53	63.89	21.22	61.7	23.14	62.53	21.55	62.85	26/02/2018 21:31:07
21.13	63.76	21.22	62.32	22.74	62.12	21.55	63.14	26/02/2018 21:31:39
21.43	62.56	21.42	62.32	22.74	62.89	21.52	63.43	26/02/2018 21:31:49

Figure 6-The data of the characterization

3.1 Homogeneity

The characterization of the homogeneity of the temperature in the working space makes it possible to determine during the
duration of the measurements the homogeneity of the temperature values given by the sensors [2].

Resultats Temperature

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Vérification de l'homogénéité de la température à 21°C :

X_air	GX_E	GX_M
21.5366333333333	1.8022276775496	1.8492719999683

Figure 7-The characterization of the homogeneity of the temperature in the web page.

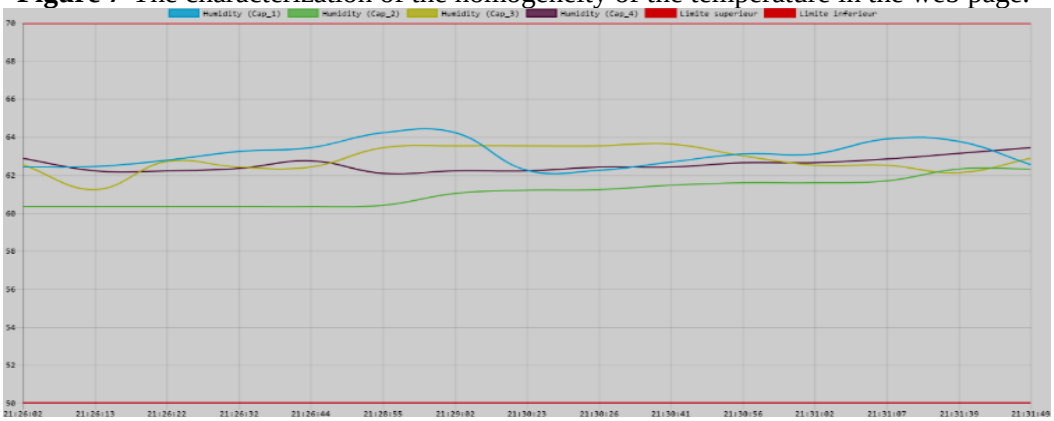

Figure 8- The homogeneity curve during characterization in the web page.

3.2 Stability

The characterization of the stability of the temperature in the working space makes it possible to determine the maximum

temperature variation at a measurement point of the working space during the measurement period [2].

Calcules statistiques :

	Temperature cap 1	Humidity cap 1	Temperature cap 2	Humidity cap 2	Temperature cap 3	Humidity cap 3	Temperature cap 4	Humidity cap 4
Valeur maximal	22.15	64.25	21.51	62.32	23.24	63.63	22.74	63.43
Valeur minimal	21.13	62.25	21.21	60.34	21.43	61.23	21.52	62.1
Valeur moyenne	21.483466666667	63.096666666667	21.358666666667	61.104666666667	22.357333333333	62.81	21.945333333333	62.572666666667
Stability	1.02	2	0.3	1.98	1.81	2.4	1.22	1.33

Vérification de la stabilité de la température à 21°C

Stability maximal
1.81

Figure 9-The characterization of the stability of the temperature in the web page.

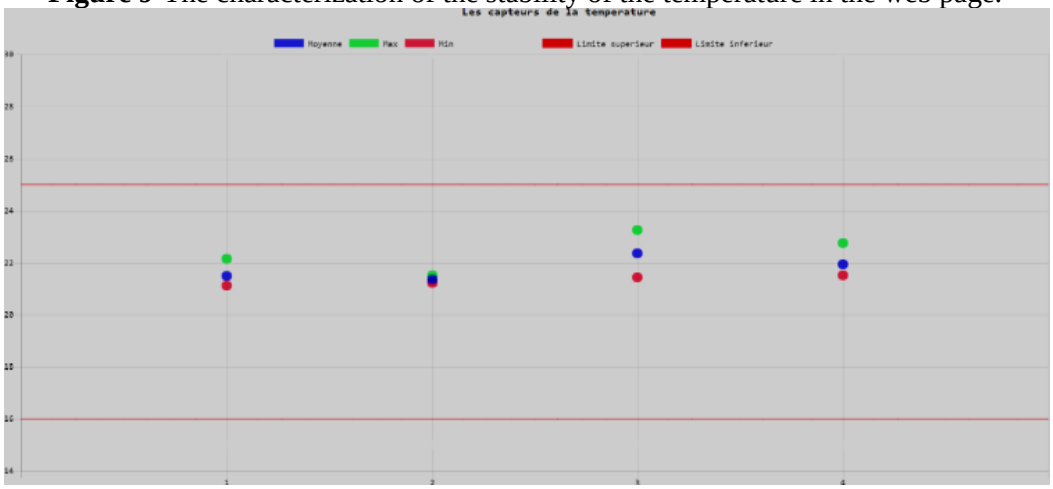

Figure 10-The stability curve during characterization in the web page.

3.3 Setpoint deviation:

The difference between the setpoint value and the air temperature or it is the setpoint deviation, which makes it possible to know the correction to be made to the setpointvalue when using the enclosure to obtain the desired or otherwise specified condition [2].

Setpoint deviation:

$$\Delta X_{co} = X_{co} - X_{air} \quad (1).$$

Détermination de l'écart de consigne de la température à 21°C:

X_air (°C)	21.536533333333
X_co (°C)	21
U (°C)	1.3902624153042
|X_co - X_air| (°C)	0.53653333333334
Norme	|X_co - X_air| ≤ U
Ecart de consigne Statut (C/NC)	C

Figure 11-the setpoint deviation of temperature measurement in the web page.

3.4 Indication error

This is the difference between the value of the indicator and the air temperature, the indication error makes it possible to characterize the representativeness of the values displayed by the environment al indicator [3].

Indicator deviation: □Xin = Xin – Xair (2). [3].

Détermination de l'erreur d'indication de la température à 21°C:

X_air (°C)	21.536533333333
X_co (°C)	21
U (°C)	1.3902624153042
X_co - X_air (°C)	-0.53653333333334
Norme	|X_co - X_air| ≤ U
Ecart de consigne Statut (C/NC)	C

Figure 12-The indication error of temperature measurement in the web page.

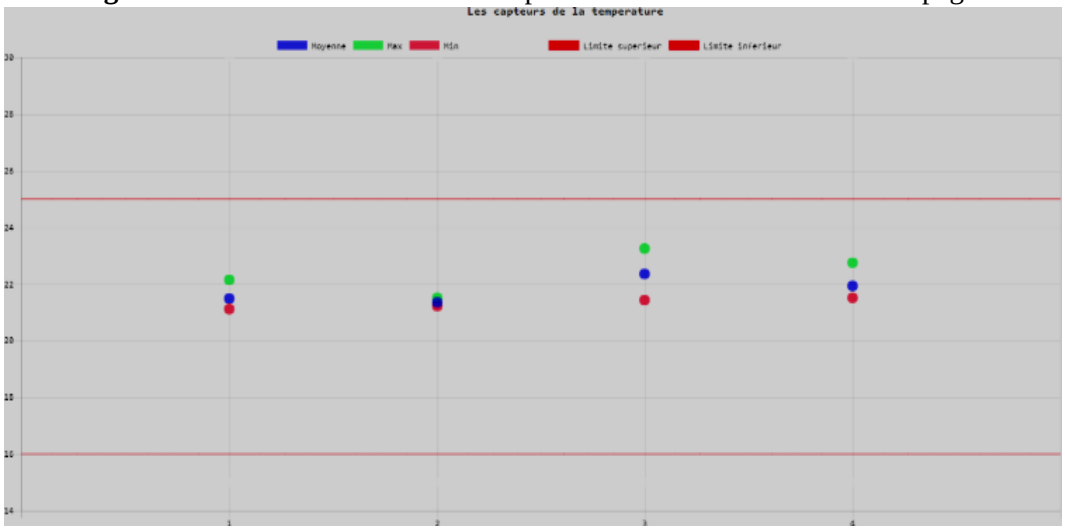

Figure 13-The stability curve during characterization in the web page.

4. CONCLUSION

Thanks to this web page, we can do the monitoring and qualification of climatic and thermostatic chambers in any moment and keep traceability of the data in a database. Now we are sure that it can be possible to measure and store the values measured by the recorder in a database, furthermore we can verify the status of our chambers compliant or non-compliant

Finally, the noun of this new application is RTC it is the abbreviation of the Real Time Control [1].

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