

**INNOVATION IN QUALIFICATION: THE COLLECTION, TRANSFER AND
RECOVERY OF TEMPERATURE AND HUMIDITY DATA ON A MOBILE
APPLICATION, FOR THE QUALIFICATION OF CLIMATIC AND
THERMOSTATIC CHAMBERS ACCORDING TO
STANDARD NF X 15-140**

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ABSTRACT

Environmental controls, especially for temperature and humidity, are essential to maintaining 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 non-compliant 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 non-compliant, and this in favor of 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

- Collecting data from the sensors;
- The transfer of these data to a database;
- Data recovery through the mobile application.

KEYWORDS: Wireless Sensor Network, Temperature, Humidity, Qualification, Climatic and Thermostatic Chambers
NF X 15-140

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 in 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 smartphones.

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 the society. Industrial processes, military tracking applications, habitat monitoring, and precision farming are just a few examples of a wide and varied set of possible applications for continuous monitoring offered by the CWHC.

OBJECTIVES OF THE STUDY

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.

METHODS

Recent advances in wireless and electronic technologies have resulted in the low-cost development of tiny, energy-efficient sensors (low-cost and low-power solution). These sensors have 3 main functions:

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



Figure 1: Centralized Architecture

A sensor node (called "mote" in English) is composed mainly of

- A processor
- A memory
- A radio transmitter/receiver
- A set of sensors
- A stack

Treatment Unit

We used the ESP8266 chip (Espressif Systems), which features

- Processor: Tensilica LX106, 32 bits @ 80 MHz
- RAM: 36KB
- Wi-Fi communication module: (802.11b / g / n using the 2.4 GHz ISM band)
- Flash memory: 16MB

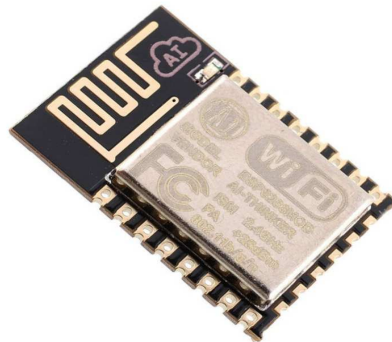


Figure 2: Microcontroller ESP8266

SENSORS

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.

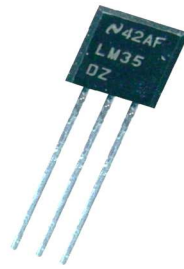


Figure 3: Analog Temperature Sensors LM35

The precision

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 $\pm 1^\circ\text{C}$ at 25°C and $\pm 1.5^\circ\text{C}$ at -55°C or $+150^\circ\text{C}$ 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 $\pm 0.5^\circ\text{C}$ at 25°C and $\pm 1^\circ\text{C}$ at -55°C or $+150^\circ\text{C}$.

Linearity

Another great strength of the LM35 sensor is its exemplary linearity: less than 1°C error over the full range of -55°C to $+150^\circ\text{C}$. As each degree Celsius corresponds to 10mV (or 0.01 volts) and the sensor output is (almost) perfectly linear.

2. Humidity

The HIH-5030-001 is a low voltage SMD moisture sensor. This device operates up to 2.7VDC 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 nearby sensors. It is ideally suited for very low consumption, battery operated systems with a typical current of the only $200\mu\text{A}$. The interchange ability of the waterproof sensor eliminates calibration costs. The HIH-5030-001 offers HR (Relative Humidity) instrumentation quality sensing performance, an wield able 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 5.5VDC
- Humidity ranges from 0% RH to 100% RH
- Accuracy of $\pm 3\%$ RH (best straight line)
- Response time of 5s ($1/e$ in slow moving air)
- Temperature range from -40°C to 85°C

3. The database

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

Many databases begin 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, an 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.

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 graphics 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.

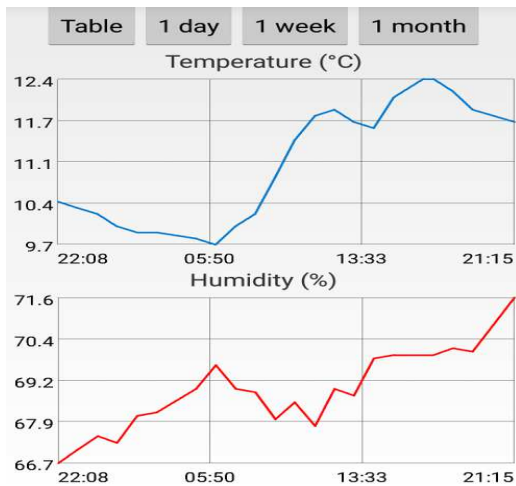


Figure 5: Curve IHM Mobile Application

Temperature C	Humidity %	Date
10.42	66.70	22:08
10.10	66.82	01:03
09.80	67.50	03:58
09.70	69.28	06:53
10.30	68.85	09:48
10.80	68.24	12:49
11.80	69.15	15:44
12.20	69.85	18:39
11.70	71.60	21:34

Figure 6: Data IHM Mobile Application

In this application we made two levels of security for the manipulators, the level 1 gives you the possibility for the visualization and the modification of the parameters, whereas the level 2, it allows you to see only the curve of the temperature and humidity without any modification.

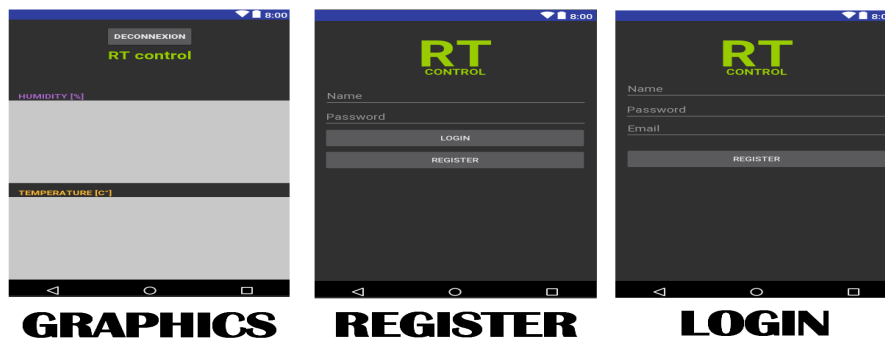


Figure 6: Graphics and Levels of the Mobile Application

CONCLUSIONS

Thanks to this mobile application, 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.

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