

## TRANSMISSION AND STORAGE OF DATA FROM A SMART ENVIRONMENT, IN THE CONTEXT OF INTERNET OF THINGS

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**Abstract:** In recent years, Internet of Things (IoT) concept won more space and more people from different domains of activities. The easiest way to get into this fascinating world of smart objects is to try to capture and transmit data using a sensor connected to a platform dedicated to this purpose. In this article I will show how we can measure the temperature and air humidity in a room and where we can store this data.

**Keywords:** Internet of Things, microcontroller, Arduino, communication, cloud, PHP, MySQL

### INTRODUCTION

The concept of Internet of Things (IoT) appeared in 1999 and may be viewed as a network of heterogeneous things that can transmit useful data to people or to other objects. Furthermore, the services offered may provide companies improve efficiency and minimize expenses or to usual users a higher quality of life.

There are many estimates that lead to the same idea: IoT will consist of a very large number of devices being connected to the Internet. Some believe that there will be nearly 26 billion devices (which exclude PCs, tablets and smartphones) on the Internet of Things by 2020 [1]. Others estimate that more than 30 billion devices will be wirelessly connected to the Internet of Things by 2020 [2], and others predict that the number of connected devices will surpass 15 billion nodes by 2015 and reach over 50 billion by 2020 [3], with a value that will reach 1900 billion.

The concept of smart environment is defined like a small world where sensor-enabled and networked devices work continuously and collaboratively to make lives of inhabitants more comfortable [4].

With the help of hardware that runs a software program that can have a few lines of code, we can turn a simple object such as a book, a tree, or a fridge into a smart object. From here it is just a step to transform a room, a house, a university or a city into a smart environment.

### HARDWARE AND SOFTWARE

**Board.** There are many types of platforms that can be used, but the most common are Arduino and Raspberry Pi, each with different models, such as the Arduino Uno, Due, Leonardo, Mega 2560, Yun, Raspberry Pi Model A+, Model B+, Pi 2 Model B, etc. All currently available models for Arduino and Raspberry Pi boards are on the official websites, at the addresses <http://arduino.cc/en/Main/Products>, respective <http://www.raspberrypi.org/products/>.

Next I will refer only to Arduino-compatible boards.

**Sensors.** There are plenty of sensors that can be connected to an Arduino platform type: temperature and humidity sensors, barometric pressure, noise, light levels, motion detection, etc.

Also, for each parameter measured, there are several types of sensors. A sensor can measure one or more features. For example, for simultaneous measurement of two characteristics, such as temperature and humidity it may be used sensors like DHT11, DHT21, DHT22, AM2302 (wired DHT22) etc. which are different from many reasons such as: range of reading values, accuracy, sampling rate, cost etc. Because barometric pressure changes with altitude, it can be used one sensor (BMP085 or BMP180) to obtain three values: temperature, pressure, altitude.

**Internet shield.** If the data is transmitted directly to a PC, there is no need for any additional shield, but only a simple cable connected between the board and PC. Generally, the data from the sensors are transmitted to an object or directly into a storage form via the Internet using a gateway. To achieve this, in case of Arduino boards, we need a shield that can be like Ethernet, WiFi, CC3000, GSM, etc.

**Accessories.** To make connections between hardware elements mentioned above, we need hookup wires of various types, lengths and colors. Also, we can use other accessories such as resistors, transistors, capacitors, diodes, photoresistors, pushbuttons, TFT LCD screens, breadboards, potentiometers, etc.

**Software.** There is an open-source software like Arduino Software (IDE) that make it easy to write code and upload it to a

board. This software can be used with any Arduino board and runs on both Windows and Mac OS X or Linux.

For Windows, the installation and configuration of an Arduino board, as well as the running a simple example are described in detail on the Arduino's official site [5].

### TRANSMISSION AND STORAGE OF DATA

One of the simplest examples is the transmission of values temperature and humidity of a room with an Arduino Uno board and a sensor DHT11.

Wiring diagram can be achieved using the software named Fritzing, which can be downloaded at <http://fritzing.org/>.

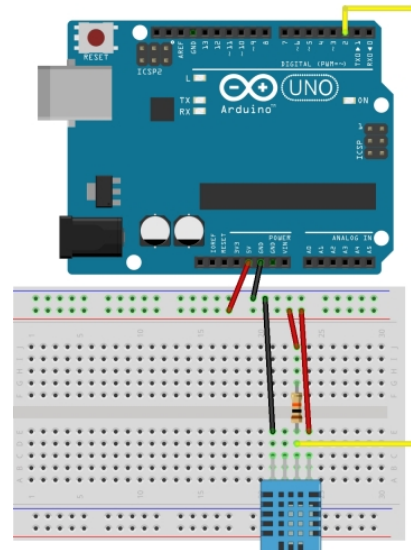


Figure 1 Connection diagram

DHT11 PIN	Arduino PIN
1	5V
2 + 10K Resistor	5V
2	Digital Pin 2
3	-
4	GND

Table 1 Connections between board and sensor

Depending on the intended purpose, data can be stored locally or in the cloud.

**Storing data in a file.** Data can be transmitted from the sensors to a file (.csv, .txt, .xml, etc.) which can be located on a SD card or directly to a computer.

The first option requires an Ethernet shield, which has an onboard SD slot. After initializing of the SD card, data can be sent directly using print() function:

```
AnmbFile = SD.open("AnmbData.txt", FILE_WRITE);
...
AnmbFile.print(temp);
AnmbFile.print(",");
AnmbFile.println(humi);
AnmbFile.close();
```

To send data directly to a file which is found on a PC, it can be used a web server and a small .php file, for example:

```
$ AnmbFile = ' AnmbData.txt';
file_put_contents($AnmbFile,
utf8_encode('temp='.$_GET['temp']).','.'humid='.$_GET['humid'].'\n');
;
```

Whenever you want, the SD card can be removed from the slot, can be inserted into a PC and data can be imported into a spreadsheet file. Next it can be generated graphs that will help to analyse data.

**Storing data in a database.** Storing data in a MySQL database primarily involves its creation, through lines of code or using a tool (phpMyAdmin).

Into the sketch file that runs on Arduino board must be a function that contains something like:

```
int err;
float temp, humi;
if((err=dht11.read(humi, temp))==0)
{
Serial.print("temperature:");
Serial.print(temp);
Serial.print(" humidity:");
Serial.print(humi);
Serial.println();
sprintf(strURL,"GET
/arduino_cm/temp.php?t=%5.2f&h=%5.2f HTTP/1.1", temp,
humi);
client.println(strURL);
```

### Conclusions

In this article I wanted to show the possibility of connecting sensors and communication boards like Arduino platform and the rapid implementation of sketch programs that help retrieving, transmitting and storing the actual data of a given environment.

The next step consists in the processing and presentation of data stored in various forms (graphs, maps, statistics etc) in order to show the real utility of such a device.

Although IoT presents many problems that can be considered, from the security problems to people privacy problem, this is the indisputable future that awaits our world.

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```
client.println("Host: 192.168.1.195");
client.println("Connection: close");
```

Data can be received and sent by the .php file into the database:

```
if(isset($_GET['t']) && (is_numeric($_GET['t']))) {
$temp = $_GET['t'];
$humid = $_GET['h'];
$query = "INSERT INTO temp(temp,humid)
VALUES('$temp','$humid)";
mysql_query($query);
mysql_close();
}
```

In general, data can be stored in a file or in a database on a local server if data security is very important or when incoming data does not take a large storage space or the evolution in time is not so important to be seen.

**Storing data in cloud.** Cloud technology is very important for IoT. There are several options for data storage in the cloud, including Xively or Google Drive, using platforms such as Temboo or PushingBox.

Regardless of the storage method chosen, the values can be processed both in the form of text and especially graphical form. Moreover, when it can be achieved a previously set breakpoints, the messages can be sent in various forms, such as classical messages or notifications by e-mail directly on your smartphone. It is also possible to operate various actuators, devices responsible for the operation of another mechanism or system.