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Research Article

IoT: RESULTS OF AN EXPERIMENTAL SURVEY WITH NODEMCU, NEXTION, DS1307 AND NRF24L01+

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ABSTRACT

The Internet of Things is a new technology, where is possible to connect different kind of devices, this study presents the results obtained in an experimental survey, when using the device radio NRF24L01+, NodeMCU 12e, Tft Nextion and the RTC DS1307, was developed a simple application for communicate the different devices, simulating a transfer data. This study was developed during the period of 2017, the main object of this project is understand and demonstrate the resources when developing different solutions with the devices. The experimental survey was the methodology selected for this project, be applied when using the main tools, and when creating solutions for operate the devices The IEEE Xplore base and the IEE Latinomerica, was used as main bases of study and selection for bibliographies, was detected poor information about this kind of application and solutions, in this way, this project may contribute for the knowledge base, and information for new projects when using the Internet of Things. The results were satisfactory, showing a simple way for develop solutions with the devices, otherwise the low price has contribute for use the devices, with the results of this project will be possible to create solutions for different kind of objectives as human health monitoring, distance control, and to monitoring of devices from a long distance.

INTRODUCTION

ACRESCENT use of the internet of things in different types of applications, has contributed to the improvement of people's lives, enabling a wide variety of applications and device control, in this way this work has the general objective, the development of an application for the use of devices generally used for the internet of things, with the NodeMCU, Nextion, DS1307 and NRF24L01+ devices, these devices were selected for their ease of localization in the national market, as well as for their low price, these devices are usually used by solution developers to the internet of things.

For the specific objectives, solutions must be developed with the Arduino IDE tool [2], which uses the C++ language as standard, for the Nextion screen device a graphical interface with the application called Itead Editor [12] should be developed, in this way, a control must be used to configure and control the date and time for the DS1307 device, which will serve as the basis for the connection with other devices, such as the NRF24L01+, it should be used for remote communication between the different solutions and data transfer.

As a basis for the studies, research was done on works presented in IEEE Xplore, IEE Latin America, IEEE Computing Society and the IEEE Internet of Things Journal, other sources were also used, such as the base of Google Scholar, the basis of Scielo, among other newspapers and magazines that deal with relevant issues about computing and the internet of things.

The results should be presented in the form of commands, instructions and images for the use of the devices, so as to demonstrate the main functionalities that can be used in different types of projects for automation. Due to their low cost and ease of use, the devices were selected for this research because they are also easily located in the national and international market of electronics, not taking into account the size of the project, since it is understood that a suitability for the different types of situations, highlighting that in the year 2017, there are several sources of technical information about their different applications for the internet of things.

The importance and relevance of this work lies in the fact that the internet of things is a national and international highlight for the creation of a control network for devices and equipment in different locations, being applied in several areas such as health, residences, companies and educational institutions, providing an opportunity for research on the evolution and use of these devices.

Usually these devices are produced on a large scale, with Chinese and American origin, with the Chinese equipment being found in greater quantity in the domestic and international markets, it is also important to highlight the ease of interconnection between different types of residential and industrial devices and equipment, such as for robotics and industrial automation for the production of parts.

Another motivating factor is the use of these devices for education in robotics, computing and systems development for

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the creation of solutions that can collaborate for a control and facility for carrying out activities at a distance, usually conducted by humans, involving artificial intelligence among other paradigms of computational evolution.

Considering the variety of applications that can be developed it is intended to present a small application, which can be extended to other types of projects, with these basic concepts, it should be possible to demonstrate its main functionalities and applicability, which will provide a understanding of its possible resources, as well as its use in the various areas of technical knowledge.

Application of the Methodology

As a research methodology, the concepts presented by Marconi and Lakatos [20] were used for the development of an applied and technical research, because it is a technological question, the research should present the applications on certain devices, using techniques of systems development, as well as for the application of the knowledge acquired with the studies carried out, in this way it is intended to present the results in the form of codes, images and instructions on the processes carried out during this study.

As a basis for the study, basic researches were developed, considering bibliographies available in the IEEE Xplore database, using keywords for consultation, for example: NRF24L01+, NodeMCU, Nextion, IoT, DS1307. During the researches in the IEEE (IEEE Xplore Digital Library) databases, few amounts of information on the subject were found, in which keywords such as: NRF24L01+, Nextion, DS1307, NodeMCU were used, the number of papers presented during the research was not shown to be relevant to the study, serving as the basis for some topics separately, there were few results for the words: Nextion, NodeMCU, DS1307 and NRF24L01 +.

Also not found in other scientific study bases, some similar material that could present content relevant or even similar to that proposed in this work, so its relevance was shown to be interesting for an object of study.

With these results it was possible to identify an opportunity for the development of this study, to contribute to these research bases, among others developed in different bases, it was possible to identify also the little content of scientific material dealing with the subject on the internet of things, together with the devices shown.

With the methods used, together with the basic research, we intend to present sufficiently adequate data for a scientific analysis, considering the various technical materials, demonstrating the construction or assembly of the devices, following the best practices provided by the manufacturers, such as information specialists involved with projects for the internet of things, in different areas of applications.

Bibliography Review

The Internet of Things, or IoT (Internet of Things) is one of the main references on the technology of networks and communication between different equipment, this technology allows the communication between different "things" or equipment and devices that are normally used in the day- to-day life of people, such as home appliances, which usually have electronic equipment, or even enable the deployment of new devices for communication on a network in people's homes, in this way the internet of things enables a revolution in communication between devices, enabling remote control and monitoring of environments.

In the IEEE Internet Journal of Things Journal, the Internet of Things is presented as a network infrastructure that allows communication between devices, and this connection allows the transfer of data between different media, such as the Internet, enabling a control of remote form, allowing the creation of a variety of control solutions, through different means of communication, in this way it is possible to attend a great variety of projects, such as: projects in the area of health for patient monitoring; projects for automation of companies and residences, projects for environment monitoring; robotics and industrial automation.

The main group dealing with internet related matters, which was the basis for this study is the Telecommunication Standardization Sector (ITU-T) [14], other studies were carried out on the works available in the database of the IEEE Xplorer, mainly on the basis of IEEE Latin America, the work developed by Kara [15], Lohr [18], Minerva [21], Niyato et al [24] and Larrucea et al. [16], Hgai et al. [11], Yang et al. [34], Wolf and Dimitrios [33], Mukhopadhyay and Wolf [22], Ebling and Want [7], Mung et al. [23], Veloso et al. [30], Pino [28], Zanella [35], Verikoukis [31], Vicente [32], were also considered studies on materials made available by the European Research Projects on the Internet of Things (CERP IoT) being considered also one of the main references on the Internet of the things in the world.

During the studies the rapid evolution in the use of the Internet of things around the world was highlighted, this is due to its low cost and wide production, like the international market of China, which is the biggest distributor of electronic devices in the world, of this the studies collaborated in the identification of solutions that can meet a different type of public and market, and the adequacy of the project for each type of situation to be presented.

During the survey of materials for study, it was possible to perceive the scarcity of scientific content in national databases such as the IEE Latinamerica, among others, due to the fact that this technology is still evolving in Brazil, thus providing an opportunity for study of the application of this technology in the different sectors, such as commerce, industry and education, the few pertinent results did not deal directly with the peripherals, but in an application in a more specific context, as in a residential automation.

In other studies on the application of the internet of things, the materials presented by Oliveira and Bastos-Filho [27], Mantovan [19], Lino [17], Abreu [1], Battisti [4], Dornelas, Oliveira and Campello [6] and Santos [29], which demonstrate the application of the internet of things in residential automation models, having a more robust content, also serving as the basis for the development of this work. Due to the wide variety of devices available in the market, the most common ones have been chosen, with lower price and availability in the national market.

In addition to the studies on the material presented which involved bibliographies, videos and technical materials made available by the manufacturers and specialists of each device were also studied, serving as support and complement for the development of the applications, as well as for the tests applied.

RESULTS AND DISCUSSIONS

The first step in the project was the installation of the components in the Arduino interface, first the NodeMCU device [25] was used, which should act as an Arduino, because it has a higher capacity and speed than the Arduino, besides having a sensor WiFi was already integrated, as informed by the manufacturer, it was necessary to install the packages for the location of the device and its updates: http://arduino.esp8266.com/stable/package_esp8266com_index. json This configuration must be done in the configuration of the IDE, for the correct device detection.

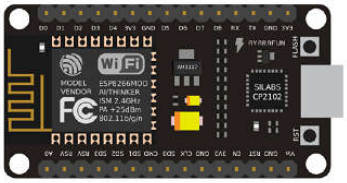

Figure1: Device NodeMCU 12e. Veloso et al. [30].

For the development of the project, the following libraries, available in GitHub [8], GitHubLibDS1307 [9] and GitHubLibNextion [10] were used: NRF24L01.LIB [26]. Two device kits were also used, one to simulate the transmission and another to simulate the reception.

```
#include "Wire.h"
#include <DS1307.h>
#include <Nextion.h>
#include <NextionPage.h>
#include <NextionText.h>
#include <NextionButton.h>
#include <NextionVariableString.h>
#include <NextionVariableNumeric.h>
#include <SoftwareSerial.h>
```

The DS1307 watch has been selected for this project due to its ease of configuration as well as its low cost, being easily found in the national market.

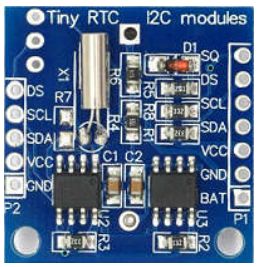

Figure2 DeviceDS1307. br-Arduino.org[3].

The DS1307 should use the following default address:
#define DS1307_ADDRESS 0x68
Using the following command to access DS1307:
Wire.beginTransmission (DS1307_ADDRESS);
Wire.write (zero); // Stop in the CI so that it can receive the data

The Nextion touch lcd screen device was selected for this project because, due to previous and comparative studies with other devices, it was demonstrated with greater ease and operation features, besides the presented quality:

Figure 3 DeviceNextionNX3224T024. Itead[12].

The following code was used to configure the device:

```
SoftwareSerial nextionSerial(D3, D4);
Nextion nex(nextionSerial);
Wire.write(ConverteParaBCD(segundos));
Wire.write(ConverteParaBCD(minutos));
Wire.write(ConverteParaBCD(horas));
Wire.write(ConverteParaBCD(diadasemana));
Wire.write(ConverteParaBCD(diadomes));
Wire.write(ConverteParaBCD(mes));
Wire.write(ConverteParaBCD(ano));
Wire.write(zero); //Start no CI
Wire.endTransmission();
```

The variables used to send the date and time information to the DS1307 were recorded as a byte, which is: seconds, minutes, hours, diary, diary, month, year.
To capture the objects on the Home screen (Settings), which should display and send the date and time data to the lcd device, use the following structure:

```
// Settings screen, Date / Time and Send buttonNextionButton
t14_vb0(nex, 14, 6, "b0");
NextionText t14_vt2(nex, 14, 7, "t2");
NextionText t14_vt3(nex, 14, 8, "t3");
NextionText t14_vt4(nex, 14, 9, "t4");
NextionText t14_vt5(nex, 14, 10, "t5");
NextionText t14_vt6(nex, 14, 11, "t6");
NextionText t14_vt7(nex, 14, 12, "t7");
NextionText t14_vt8(nex, 14, 13, "t8");
```

To display the current date and time on the Arduino IDE terminal screen, use the following commands:

```
v_clock=Mostrarelogio();
Serial.println(v_clock);
```

The NRF24L01 + device was selected for the need to transmit data outside a connection via the Internet, thus allowing a greater range and independence of a local network, such as a WiFi, this model of wireless connection, provides better performance, lower power consumption charge in batteries, in addition to having a greater range, during the tests was registered a range of 20 meters, in a place with walls.

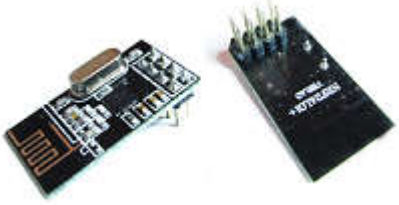

Figure 4 Device NRF24L01+. br-Arduino.org [3]

For the NRF24L01 + device, the following libraries were used:
#include <nRF24L01.h>

```
#include <RF24.h>
#include <SPI.h>
RF24 radio(D0,15); // PinsD0 and 15 for NodeMCU
const uint64_t pipe = 0xE14BC8F474LL;
char pipeserial[10];
```

The pipe constant is used to identify the device address, the following commands demonstrate the steps for checking whether the NRF24L01 + device is connected or not, if it is not connected an error message should be displayed.

```
if (radio.begin())
{
  Serial.println(F("Radio ok..."));
t7_vt1.setBackgroundColour(NEX_COL_GREEN);
 radio.setChannel(100);
 radio.openReadingPipe(1,pipe);
 radio.getDynamicPayloadSize();
 radio.startListening();
}
else
{
 Serial.println(F("Erro radio..."));
t7_vt1.setBackgroundColour(NEX_COL_RED);
}
```

The next commands receive the data sent by the sensor, and the Serial.print command is used to display the values in the send terminal in the NodeMCU IDE:

```
if (radio.available())  //Verify radio
  {
Serial.println(F("Receiving Radio ..."));
if (t7_vt0.getText(buffer, 10)) { Serial.println(buffer);
stat=buffer;}

if (stat!="SENSOR+"){
t7_vt0.setForegroundColour(NEX_COL_BLACK);
t7_vt0.setText("SENSOR+");
t7_vt0.setBackgroundColour(NEX_COL_GREEN);
    }

bool done = false;
    radio.read(&recebidos, sizeof(recebidos));
dados = recebidos [0]; //valuereceived
dados1 = recebidos[1]; //value of battery

    Serial.print("Dados 0: ");
    Serial.println(recebidos [0]);
    Serial.print("Dados 1: ");
    Serial.println(recebidos [1]);
}
```

For the transmission of data the following commands were used in the NRF24L01 + transmitting sensor:

```
#include <SPI.h>
#include "nRF24L01.h"
#include "RF24.h"

int dados[2];
int sonda = (A0);
int Bat = (A3);
unsigned long valSensor;
unsigned long valSensor1;
unsigned long valBat;
unsigned long valBat1;

RF24 radio(9,10);
const uint64_t pipe = 0xE14BC8F474LL;

void setup()
{
pinMode (13, OUTPUT);
digitalWrite (13, LOW);
 radio.begin();
 radio.setChannel(100);
 radio.openWritingPipe(pipe);
 radio.getDynamicPayloadSize();
}

void loop()
{
valSensor = analogRead(sonda);
valSensor1 = map (valSensor, 709, 931, 0, 100);
dados[0] = valSensor1;  // trocar dados para envio
valBat = analogRead (Bat);
valBat1 = map (valBat, 561, 652, 10, 100);
dados[1] = valBat1; //trocar dados para envio
 radio.write (dados, 4);
}
```

The following diagram shows the connection between the devices, according to the standards presented by the manufacturers, the results did not show any type of problem or conflict between the connections:

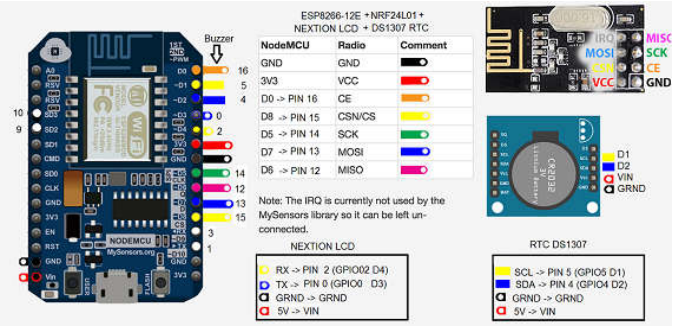

Figure 5 Conection SchemawithdevicesNodeMCU, Nextion, DS1307, NRF24L01+.Developted bythe author

Following the guidelines of the device manufacturers, the connections were used as presented by Itead [12], DS1307 [9], Nextion [10], NodeMCU [25] and NRF24L01.LIB [26], after performing the necessary tests, it was possible validate the connections and adaptations for the correct functioning of the devices.

The program was developed with the Itead Editor software [12], this process is necessary to load the code to the Nextion device, using a MicroSD memory card, in this process the compiled code is transferred to the folder the microSD memory, it must be inserted into the memory coupling of the Nextion screen, immediately after the device is switched on, the Nextion device, the device counts the percentage while charging the code, then the device is restarted, the code is displayed correctly.

In the NodeMCU device, the steps presented on the manufacturer's website [25] were followed for the code update, the other devices were disconnected so that there were no

conflicts, in this case Nextion and DS1307, then the connection was made via Arduino IDE [2], the Arduino libraries were updated to the 4 devices (NodeMCU, Nextion, DS1307 and NRF24L01 +), the code loading was successful, just after that the USB port number has been selected correctly.

First the tests were performed on the NodeMCU in isolation, using the examples made available by the manufacturer in the IDE, soon after the tests were performed on the DS1307, the tests with the sample codes were successfully performed, soon after the tests were performed. In the last step the NRF24L01 + radio transmitter was tested. In this last step, another NodeMCU 12e device was built in conjunction with another NRF24L01 + radio, in order to simulate the transmission and reception of data.

After successful testing of the isolated devices, the final codes for the NodeMCU 12e and the Nextion lcd were loaded using the Arduino IDE [2] together with the Nextion Itead Editor [12] screen editor, for the test two simple screens were developed, only to represent the reception and transmission of data, validating the process.

The screen developed in Itead [12] for the Nextion, allows the monitoring of the results, for tests of the sending of data, in the case of this project, the values were fictitious serving as basis for comparison and tests in different situations, for example, sending if the received data exceeds a certain value, as in the example:

Figure 6 Monitoring screen for data reception, Developted by the author using the IteadEditor [12].

This way the system will also alert on the screen about the loss of connection with the transmitter NRF24L01 +, in addition to changing values defined in the lines of code, such as sending a value captured by a sensor or battery charging information, which comply with a predetermined criterion.

CONCLUSIONS

The functionalities and adaptations for the developed project presented results that allowed to analyze the configurations and uses of the devices NodeMCU, Nextion, DS1307 and NRF24L01 +, the solution presented feasible and viable results for the use of these devices together, for applications in more complex projects, for example, in a hospital network for patient monitoring and special care of people in bed, or even in homes with children, the elderly, or people with special needs.

The experiences obtained with the project enabled a more detailed study of the functionality of the different types of devices developed for the internet of things, seeing a wide possibility of application in different areas, which need remote devices, that allow a constant monitoring and sending of data, which can be accessed by different means of communication, such as a cell phone or even in distant places with an internet.

The results made possible a more detailed understanding of these new technologies, which may aggregate in future projects, observing a more robust environment, with different types of equipment, due to its vast platform, as well as the internet communication, which enables communication between different types of devices, it is intended as a future project, to present the results of a more detailed study that involves the security part of the information, since the large amount of equipment accessed remotely, can provide ways to obtain data during the transmission of information, this provides a new opportunity for study.

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