Impact Factor (SJIF): 5.301

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 5 , Issue 2, February-2018

IoT: Results of an experimental survey with NodeMCU 12e, TFT Nextion and RTC DS1307

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Abstract — ***With the increase use of the devices for Internet of Things, this study presents the results obtained in an experimental and applied survey, using the device NodeMCU 12e, Tft Nextion and the RTC DS1307 clock, showing a simple application for adjust and show date and time information. Developed in the period of 2017, focusing mainly on the personal experience, evaluating the main characteristics, when using the different devices. The methodology used to obtain the data was an experimental survey with the devices, using the main tools, create to operate the devices, applying the systematic review on the IEEE Xplore base mainly, considering the personal experience when using these types of equipment on different proposals. After applied the experiments, was proceeded to consolidate, discuss and analyze the results. With the experience obtained, was possible demonstrate the results with these kind of devices and your application. Were identified the facilities when using these kind of devices, with the results was possible to demonstrate a way to use and create new solutions for different proposals when studying or using the Internet of Things.***

Keywords-component; NodeMCU; IoT; Nextion; DS1307; Display; Automation.

I. INTRODUCTION

The general objective of this work is to present the results of an experiment to study the application and use of NodeMCU 12e devices together with the Nextion display and the time and date control device called RTC DS1307 (Real Time Clock) These devices are usually used in the creation of solutions for residential automation, industrial, robotics, among others.

As a specific objective, an Arduino graphical interface (IDE) [1] should be developed, as well as the creation of a small application using C ++, in conjunction with the Nextion display interface, called Itead Editor [9]. a control for date and time, serving as an example for the development of future projects, usually the date and time control is necessary for the recording and sending of events, or incidents, during a data collection, as for example in devices that They measure temperatures, blood pressure, heart rate, humidity. This work was developed by applying research mainly on the IEEE Xplore database, considering studies presented by articles based on the IEEE Computing Society and the IEEE Internet of Things Journal, among other external sources of research such as the Scielo, Google Scholar, among other magazine bases focused on computing and robotics.

The results should be presented in the form of instructions and use of the devices, thus allowing an analysis of the necessary steps and considerations that must be taken before the creation of a more detailed project, since the set of devices depends on the type of project and business to the which should be applied.

The devices were selected for their low cost, which can be located in the national and international market, usually these devices are used for projects and studies involving the internet of things, thus allowing the construction of solutions for automation or robotics, for different types of applications.

The relevance and importance of this work involves the fact that the use of devices for IoT (Internet of Things) is growing, it is still a recent and growing technology in the world, passing through a phase of evolution and suitability for the different types of applications. be used in companies of different sizes, for specific studies, simulations and remote control, as well as human monitoring, with special attention to health.

II. METHODOLOGY

Marconi and Lakatos [16] explain that an experimental research is an observational method, and can somehow reflect the feeling and the experience with the problem, observing applicable hypotheses with realistic suggestions, that can contribute with data and information to be analyzed and compared, thus having a focus on the object of study. In a technical or applied research, experiments are carried out with the use of equipment, which allow a knowledge about the possibility of solving problems, or applying knowledge in situations where different types of equipment are required to confront the results.

For the treatment and analysis of the experimental results, the study was developed on a systematic review considering bibliographies available mainly in the IEEE Xplore site, the following key words were used to consult the base: NodeMCU, Nextion, IoT, DS1307.

One of the highlights during the systematic review was the non-localization of pertinent subjects presented in the search tool for the IEEE (IEEE Xplore Digital Library) base, in which the keywords Nextion, DS1307, NodeMCU were searched together, with none occurring objective result on the subject, not demonstrating mainly results during the use of the word NodeMCU 12e, together with the word Nextion, thus providing a research opportunity on the project involving the types of touch screen type displays, for the internet of things and Arduino, as well as the use of the words DS1307 and NodeMCU 12e.

With the results obtained during this study, it is intended to develop an application and demonstration, besides a validation of the devices, serving as experience and model for new projects.

On the other hand, considering all years and all words, nine articles were found involving only the NodeMCU keyword, and no occurrence was found for the Nextion keyword, together with the NodeMCU and Nextion keywords, was not found no results were found for the search involving the keyword DS1307, 10 articles were found, when searching the keywords: DS1307, NodeMCU and Nextion, no occurrence was found, thus reinforcing the research opportunity for this study.

In other study bases, no studies were also found to suggest the existence of some similar material, considering all the keywords, or that could support the development of this study. In this way, isolated studies were found that could complement the studies, supporting in isolation.

III. LITERATURE REVIEW

IoT (Internet of Things), is an infrastructure that uses different devices. IoT (Internet of Things) is an infrastructure that uses different devices , which connect, allowing the transfer of data, by different means of communication, offering resources for control and configurations of devices remotely, also allowing the development of a variety of solutions to meet the different types of projects.

The groups such as Telecommunication Standardization Sector (ITU-T) [11], among other studies available in the IEEE Xplorer, were also analyzed, among others studies on the work presented by Kara [13], Lohr [14], Minerva [17]], Niyato et al [20], Larrucea et al. [12], Hgai et al. [8], Yang et al. [28], Wolf and Dimitrios [27], Mukhopadhyay and Wolf [18], Ebling and Want [3], Mung et al. [19], Veloso et al. [24], Pine [23], Zanella [29], Verikoukis [25], Vicente [26], and studies on the European Research Projects on the Internet of Things (CERP IoT) [2].

The authors highlight the growing use of devices for the Internet of things in the coming years, reinforcing the recognition of an infrastructure that allows the connection of different types of objects or "things", usually these objects are residential, the connection between the devices a residence, allows a better control over their functions, for example: the automatic firing of a fireplace in a winter, soon after the arrival of its inhabitants, the preparation of a bathtub, before the resident arrives at home, from a control center, or even remotely through a web page, you can make resources available for your use.

Some projects such as those presented by Oliveira and Bastos-Filho [22] and Mantovan [15], on the internet of things in homes, highlight the main characteristics about the construction of a smart home, presenting its main characteristics, when using this type of technological infrastructure.

IV. RESULTS AND DISCUSSIONS

Na interface de desenvolvimento do Arduino, foi adicionado o dispositivo NodeMCU [21] para que fosse possível a sua identificação e compilação e carregamento dos códigos, as configurações foram adicionadas pelo site: http://arduino.esp8266.com/stable/package_esp8266com_index.json como informado pelo fabricante do Arduino e NodeMCU, esta configuração deve ser realizada na tela da interface, no menu Arquivo, Preferências e Configuração, preenchendo com o endereço do link na opção para adicionar placas.

Para o desenvolvimento do projeto, foram utilizadas as seguintes bibliotecas, disponíveis em GitHub [4], GitHubLibDS1307 [5] e GitHubLibNextion [6]:

```
#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 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 lcd should use the following access settings:

```
SoftwareSerial nextionSerial (D3, D4);
Nextion nex (nextionSerial);

// The lines below write in the CI the values of
// date and time that were placed in previous variables
Wire.write (ConverteForBCD (seconds));
Wire.write (Converte For BCD (minutes));
Wire.write (ConverteParaBCD (hours));
Wire.write (ConverteParaBCD (dyday));
Wire.write (ConverteParaBCD (diadomes));
Wire.write (ConverteForBCD (month));
Wire.write (ConverteParaBCD (year));
Wire.write (zero); // Start no CI
Wire.endTransmission ();
```

The variables used to send the information about the date and time were recorded as byte, which are: seconds, minutes, hours, diáriosemana, diadomes, month, year.

To capture the objects on the Home screen (Settings), which should display and send the date and time data for the device, the following structure is used:

```
// Settings screen, Date / Time and Send button
NextionButton 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 DS1307 data, the following function is used:

```
String ShowLog ()
{
  Wire.beginTransmission (DS1307_ADDRESS);
  Wire.write (zero);
  Wire.endTransmission ();
  Wire.requestFrom (DS1307_ADDRESS, 7);
  int seconds = ConverteparaDecimal (Wire.read ());
  int minutes = ConverteparaDecimal (Wire.read ());
  int hours = ConverteparaDecimal (Wire.read () & 0b111111);
  int diaysomes = ConverteparaDecimal (Wire.read ());
  int diadomes = ConverteparaDecimal (Wire.read ());
  int mes = ConverteparaDecimal (Wire.read ());
  int year = ConverteparaDecimal (Wire.read ());
  // Show date in Serial Monitor
  Serial.print ("Date:");
  Serial.print (diadomes);
  Serial.print ("/");
  Serial.print (month);
  Serial.print ("/");
  Serial.print (year);
  Serial.print ("");
```

```
Serial.print ("Time:");
Serial.print (hours);
Serial.print (":");
Serial.print (minutes);
Serial.print (":");
Serial.print (seconds);
switch (biweekly)
  {
    case 0: v_week = "Dom";
    break;
    case 1: v_week = "Seg";
    break;
    case 2: v_week = "Have";
    break;
    case 3: v_week = "Wed";
    break;
    case 4: v_week = "Thurs";
    break;
    case 5: v_week = "Sex";
    break;
    case 6: v_week = "Sab";
  }

v_clock = String (diadomes) + "/" + String (month) + "/ 20" + String (year) + "" + String (v_week) + " " + ":" +
String (seconds);
 return v_clock;

}
```

To format the data to be displayed on the clock, the following function is used:

```
String Form_request (String v_clock_sql)
{

 Wire.beginTransmission (DS1307_ADDRESS);
 Wire.write (zero);
 Wire.endTransmission ();
 Wire.requestFrom (DS1307_ADDRESS, 7);
 int seconds = ConverteparaDecimal (Wire.read ());
 int minutes = ConverteparaDecimal (Wire.read ());
 int hours = ConverteparaDecimal (Wire.read () & 0b111111);
 int diaysomes = ConverteparaDecimal (Wire.read ());
 int diadomes = ConverteparaDecimal (Wire.read ());
 int mes = ConverteparaDecimal (Wire.read ());
 int year = ConverteparaDecimal (Wire.read ());
 year = year + 2000;
 String x_segundos = String (seconds);
 String x_minutos = String (minutes);
 String x_horas = String (hours);
 String x_diadomes = String (diadomes);
 String x_mes = String (month);
 String x_ano = String (year);
 if (x_segundos.length () == 1) {x_segundos = "0" + x_segundos;}
 if (x_minutos.length () == 1) {x_minutos = "0" + x_minutos;}
 if (x_horas.length () == 1) {x_horas = "0" + x_horas;}
 if (x_diadomes.length () == 1) {x_diadomes = "0" + x_diadomes;}
 if (x_mes.length () == 1) {x_mes = "0" + x_mes;}
 v_clock_sql = x_ano + "-" + x_mes + "-" + x_diadomes + "% 20" + x_horas + ":" + x_minutos + ":" +
x_segundos;
 Serial.println ("SQL Time:");
```

```
  Serial.println (v_clock_sql);
  return v_clock_sql;

}
```

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

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

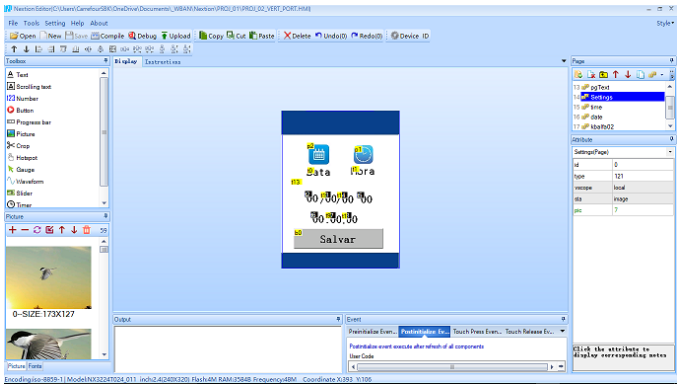

Figure 1: Application development screen with Itead Editor [9] for the screen that should display the selected date and time. Adapted by the author.

In this initial screen, information about the date and time should be displayed after selecting the data, when using the Date and Time icons, pressing the <Save> button should call the function:

```
  nex.init ();
  t14_vb0.attachCallback (& t14_callback0);
```

After the objects are initialized, it is checked if the <Save> button has been pressed, the data about the date and time are now validated before being recorded using the following commands:

```
int res = value_data (I_D_DD, I_D_MM, I_D_YY);
if (res == 1) {
  t14_vb0.setText ("SAVED !!!");
  Select TimeDate (I_D_DD, I_D_MM, I_D_YY, I_D_WW, I_H_HH, I_H_MM, I_H_SS);
  }
else
{
  t14_vb0.setText ("DATE ERROR !!!");
}
```

In this way the function to store the date and time is called, to write the data in the device DS1307, as follows:

```
int SelectsDatetime (int dd, int mm, int yy, int ww, int h_hh, int h_mm, int h_ss) // Set the date and time of the DS130
{
  byte seconds = byte (h_ss); // Values from 0 to 59
  byte minutes = byte (h_mm); // Values from 0 to 59
  byte hours = byte (h_hh); // Values from 0 to 23
  byte diadasemana = byte (ww); // Values from 0 to 6 - 0 = Sunday, 1 = Second, etc.
  byte diadomes = byte (dd); // Values from 1 to 31
  byte month = byte (mm); // Values from 1 to 12
  byte year = byte (yy); // Values from 0 to 9
  Wire.beginTransmission (DS1307_ADDRESS);
  Wire.write (zero); // Stop in the CI so that it can receive the data
```

```
  // The lines below write in the CI the values of
  // date and time that were placed in the above variables
  Wire.write (ConverteForBCD (seconds));
  Wire.write (Converte For BCD (minutes));
  Wire.write (ConverteParaBCD (hours));
  Wire.write (ConverteParaBCD (dyday));
  Wire.write (ConverteParaBCD (diadomes));
  Wire.write (ConverteForBCD (month));
  Wire.write (ConverteParaBCD (year));
  Wire.write (zero); // Start no CI
  Wire.endTransmission ();
}
byte ConverteParaBCD (val byte) {// Converts the decimal number to BCD
  return ((val / 10 * 16) + (val% 10));
}
```

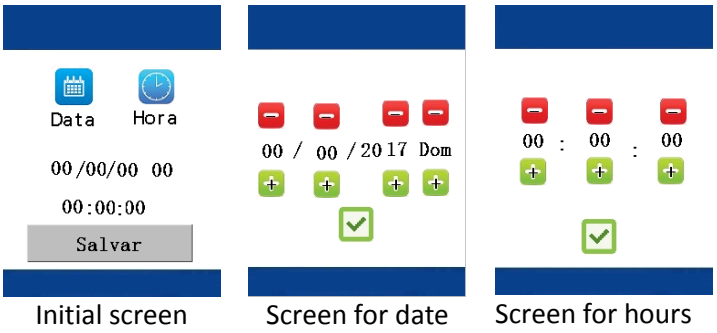

Figure 2: Screens used for setting date and time information to record on the DS1307 device. Developed by author with Itead Editor.

As a result after making the necessary changes to the storage of information about the date and time, you have:

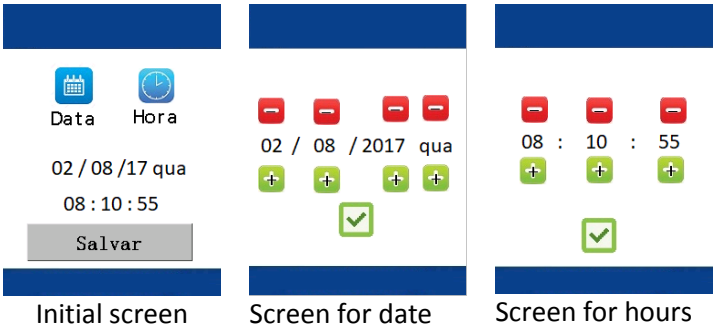

Figure 3: Updated screens with date and time information for recording on the DS1307 device. Developed by author with Itead Editor

In the displayed screens, pressing the plus icons (positive sign in green) adds a numeric digit in the relevant information to the date, or time, as well as the year and day of the week, by pressing the icon with the a subtraction of the value in the displayed field, such as a reduction of the date, time, year or day of the week, by pressing the Check icon in green, the data is sent to the Initial screen, to be subsequently recorded on the DS1307 device by pressing the <Save> button.

After the tests and analysis of the documents involving the Nextion device, the solution for the transfer of data between screens, as presented in the documentation of Itead Editor [9], involved the transfer of data between objects of type box of text, this was demonstrated for the data transfer requirement between screens.

In this way, to transfer the time and date data between the screens, pressing the Accept button (green), and after selecting the correct information, the values are stored in text box fields, considering the selected values, for transmitted between the screens, the following are some of the main commands used:

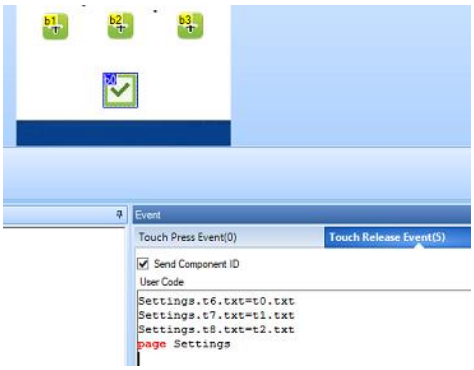

Figure 4: Commands used to transmit data between Nextion monitor screens, using Itead Editor. Developed by the author

In this example, the data should be transferred to the initial screen (Settings), this being the main screen that will send the data to the NodeMCU by pressing the <Save> button, the same system was used for the configuration of the Date screen, which you should send the System Dates information (day, month, year and day of the week).

The following scheme was used for the connection between the devices, following the standards presented by the manufacturers, and the tests applied did not demonstrate connection problems, among other difficulties for the assembly of the scheme and communication between the devices:

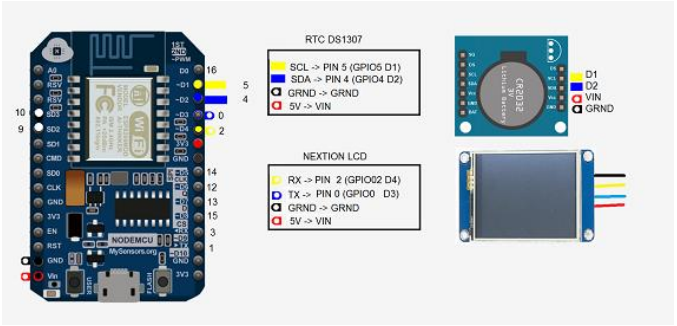

Figure 5: Connection diagram between NodeMCU, Nextion and DS1307 devices. Developed by the author

The scheme of connection between devices follows the guidelines presented on the manufacturer's website in Itead [9], DS1307 and Nextion [9] and NodeMCU [21].

After the settings in the Itead Editor project, the compilation of the program was performed, this process is necessary to perform the loading of the code on the Nextion screen, for this process the compiled code was transferred to the root folder in a MicroSD memory type, after copying, the MicroSD memory was inserted into the Nextion screen coupling, soon after the device was connected, in this process the code is loaded into the Nextion device, after restarting the device the screen showed the correct load.

In order to update the code on the NodeMCU device, the steps presented on the manufacturer's website [21], with the device disconnected from the Nextion and the DS1307, were followed in order to avoid any conflict between them, then the cable connection mini USB, a notebook with Windows 10, in the Arduino IDE [1], the Arduino libraries have bee

n updated to the 3 devices (NodeMCU, Nextion and DS1307).

The initial tests were performed with the devices in isolation, the Nextion screen was first tested, following the examples and code models and screens of the manufacturer, it did not demonstrate any type of conflict or configuration problems.

Soon after, the tests with the DS1307 were done, using examples of libraries and commands presented by the manufacturer, nor did it show any problems with the installation or configuration.

After the isolated tests were carried out successfully, the complete code was loaded, with all the libraries for the NodeMCU device, using the Arduino IDE loading menu, the code was loaded 100% without any errors. The final tests demonstrated the correct functioning of the device and its peripherals, changing hours, dates and saving on the equipment, turning on and off several times, for storage conferencing.

V. CONCLUSIONS

After the installation and configuration of the devices, it was possible to perceive the functionality of the features presented by NodeMCU, Nextion and DS1307 together, these results should serve as the basis for the construction of new projects, to meet different types of situations, such as for monitoring of people's health, as well as for remote control of people in bed, or even in special situations, as well as for the care and monitoring of the elderly or children.

In addition to the experience with development tools, and with device configuration, the possibilities have proven to be large-scale because there is a huge variety of devices available on the market, the results of this study also provided the experience that a high-cost device to build effective solutions that can deliver quality of life for people in general.

With the validation of the configurations, equipment installation, and experiments carried out, it is concluded that the objective of this work was fulfilled, by demonstrating an installation process and tests performed on the equipment together, usually used for the internet of things, presenting a simple application, but that can collaborate for larger projects, contributing to new and different research projects and technicians.

The ease of building screen layouts with the Itead Editor tool provided a pleasant experience, facilitating a process in which it could be very complex, involving extensive code for the construction of screens, as presented in other touch devices available in the market.

As a future project, new deployment and configuration tests, with devices for reading temperature, humidity, heart rate and blood pressure, as well as other tests with data transfer between different types of local networks and devices, using Wi-Fi networks, among others.

REFERENCES

Example:

[1] Arduino. (2017). Site oficial da IDE para o Arduino. Disponível em: <https://www.arduino.cc> acesso em 01/09/2017.

[2] CERP. (2009). IoT – Internet of Thinsgs of European Research Cluster. Internet of things: Strategic Reserach Roadmap, Disponível em:<http://www.internet-of-things-research.eu/pdf/IoT_Cluster_Strategic_Research_Agenda_2009.pdf> Acesso em: 26 set. 2017.

[3] Ebling, Maria R.; Want, Roy. (2017). Pervasive Computing Revisited. IEEE Computing Society. 1536-1268.

[4] GitHub. Site oficial das bibliotecas para os dispositivos. Disponível em: <https://github.com/nodemcu/nodemcu-firmware> Acesso em: 22 set. 2017.

[5] GitHubLibDS1307. Biblioteca para o dispositivo DS1307, disponível no banco de dados do GetHub. Disponível em: < //https://github.com/filipeflop/DS1307 > Acesso em: 05/07/2017.

[6] GitHubIteadLib. Bbiliotecas para o Nextion. Disponível em: < https://github.com/itead/ITEADLIB_Arduino_Nextion > Acesso em 01/09/2017.

[7] GitHubLibNextion. Biblioteca para o dispositivo Nextion, disponível em: < https://github.com/DanNixon/NeoNextion >Acesso em 20/06/2017.

[8] Hgai, Edith C.H.; Dressler, Falko; Leung, Victor; Li, Mo. (2017). Guest Editorial Special Section on Internet-of-Things for Smart Cities and Urban Informatics. IEEE Transactions on Industrial Informatics, VOL. 13, NO. 2, April 2017.

[9] Itead. Studio. Nextion Development Software and Informations. Disponível em: < https://nextion.itead.cc/ > Acesso em: 02/10/2017.

[10] IteadLibNextion. Biblioteca e exemplos do dispositivo Nextion. Disponíve em: < https://github.com/itead/ITEADLIB_Arduino_Nextion > Acesso em 10/07/2017.

[11] ITU-T. (2012). Internet of Things Global Standards Initiative. Disponível em: http://www.itu.int/ITU-T/recommendations/rec.aspx?rec=y.2060. Acesso em: 28/09/2017.

[12] Larrucea, Xabier; Combelles, Annie; Favaro, John; Taneja, Kunal. (2017). Software Engineering for the Internet of Things. IEE Software.

[13] Kara, Sami.; Li, Wen. (2017). Methodology for Monitoring Manufacturing Environment by Using Wireless Sensor Networks (WSN) and the Internet of Things (IoT). Published by Elsevier B.V. CIRP Conference on Life Cycle Engineering doi: 10.1016/j.procir.2016.11.182. Procedia CIRP 61 (2017) 323 – 328.

[14] Lohr, Charles. (2016). Turning Music Into Colors A WiFi Chip has Unexpected Power. Resources. Spectrum.iee.org. North American. August 2016.

[15] Mantovan, Thiago Chidoni. (2016). Protótipo de Uma Central de Controle para Automação Residencial compatível com o projeto IoTivity e controlada por aplicativo Android. Universidade de São Paulo. Escola de Engenharia de São Carlos. Departamento de Engenharia Elétrica e de Computação. São Carlos.

[16] Marconi, M.; Lakatos, E. (2010). Fundamentos de metodologia científica. 5. ed. São Paulo, Brasil: Ed. Atlas, 2010. p. 310 ISBN: 8522433976 ISSN: 9788522457588.

[17] Minerva R, Biru A, Rotondi D. (2015). Towards a definition of the Internet of Things (IoT). IEEE Internet Initiative, Torino, Italy. 2015 May 13.

[18] Mukhopadhyay, Saibal; Wolf, Marilyn. (2017). VLSI for the Internet of Things. IEEE Computer Society. 0018-9162.

[19] Mung, Chiang; Sangtae, Ha; Chih-Lin, I; Fulvio, Risso; Tao, Zhang (2017). Fog Computing and Networking: Part 2. In: IEEE Communications Magazine, vol. 55 n. 8, p. 13. - ISSN 0163-6804.

[20] Niyato, Dusit; Maso, Marco; Kim, Dong In; Xhafa, Ariton; Zorzi, Michele; Dutta, Ashutosh. (2017). Practical Perspectives on IoT in 5G Networks: From Theory to Industrial Challenges and Business Opp ortunities. IEEE Communications Magazine.

[21] NodeMCU. (2017). Site oficial do dispositivo e suas documentações. Disponível em: < https://nodemcu.readthedocs.io/en/master/ > Acesso em: 18/08/2017.

[22] Oliveira, Rodrigo F. A. P. de; Bastos-Filho, Carmelo J. A. (2017). Uma Arquitetura de Microserviços de Internet das Coisas para Casas Inteligente. Universidade de Pernambuco / Escola Politécnica de Pernambuco. Recife. Pe. Revista de Engenharia e Pesquisa Aplicada (2017) Vol.2 No.2.

[23] Pinho, João P. R. (2016). Framework Blueprint for Building Energy Management Systems.IFT Ténico Lisboa. Dissertação de mestrado.

[24] Veloso, Artur F.; Sousa, Beatriz A.; Braz, Arleide R.; Rabelo, Ricardo A. L.; Brito, Elizângela M.; Lima, Erick M. S. (2017). Prototipação com nodeMCU para Internet das Coisas em Smart Cities: Uma pesquisa. III Escola Regional de Informática do Piauí. Livro Anais - Artigos e Minicursos, v. 1, n. 1, p. 105-110, jun, 2017.

[25] Verikoukis, Christos; Minerva, Roberto; Guizani, Mohsen; Datta, Soumya Kanti; Chen, Yen-Kuang; Muller, Hausi A. (2017). Internet of Things - Part 2. IEEE Communications Magazine.

[26] Vicente, Thiago P. R. (2016). Universidade de São Carlos. Controle Inteligente de Vagas para Estacionamento Utilizando o Conceito de Internet das Coisas. Escola de Engenharia de São Carlos - Departamento de Engenharia Elétrica e de Computação. São Carlos.

[27] Wolf, Marilyn; Serpanos, Dimitrios. (2017). Safety and Security of Cyber–Physical and Internet of-Things Systems. Vol. 105, No. 6, June 2017. Proceedings of the IEEE.

[28] Yang, Qing; Wang, Honggang; Dohler, Mischa; Wen, Yonggang; Xue, Guoliang.(2017). Guest Editorial Multimedia Communication in the Internet of Things. IEEE Internet of Things Journal, VOL. 4, NO. 2, April 2017.

[29] Zanella, Andrea; Bui, Nicola; Castellani, Angelo; Vangelista, Lorenzo; Zorzi, Michele. (2014). Internet of Things for Smart Cities. IEEE Internet of Things Journal. Vol I, No. I. February 2014. DOI: 10.1109/JIOT.2014.2306328.