https://dx.doi.org/10.22161/ijaers.5.11.26 ISSN: 2349-6495(P) | 2456-1908(O)

An Experiment with 3 Layers Development for IoT with NodeMCU12e + Nextion

Antonio Carlos Bento[1], Norberto dos Santos[2], José Carmino Gomes Júnior[3]

[1]Department of Informatics, Universidade Nove de Julho, Brazil
Email: acb01@hotmail.com
[2]Department of Informatics, Universidade Nove de Julho, Brazil
Email: projetosns@gmail.com
[3]Department of Informatics, Universidade Nove de Julho, Brazil
Email: mat.jose.carmino@gmail.com

Abstract*—*This paper presents the results of an experimental research with the development of a 3 layer solution for the Internet of Things using the NodeMCU12e controller and the Nextion touchscreen display to provide monitoring projects for individuals who require remote monitoring and special care, involving the health area, monitoring of patients, children or people who are in medical treatment who need a remote monitoring. The results demonstrated the possibilities for creating solutions that could serve as a basis for new projects with greater amplitude, contributing to more robust solutions that can meet different types of products that can collaborate with the health of the population in general.

Keywords*—*IoT; NodeMCU12e; Nextion; development; layer.

I. INTRODUCTION

Due to the increase in the development of new solutions for the creation of products for the Internet of Things, this work has as main objective to present the results obtained with the development of experiments with the use of programming in 3 layers, using devices for monitoring of individuals requiring special care, which can be monitored remotely using devices developed for the Internet of Things or IoT.

As specific objectives, a solution should be presented using the C ++ programming language, usually used with development of solutions for the Arduino controller, the PHP development language, for building the business layer, the AppInventor tool for building the interface on a Smartphone device, a database developed with MySQL

The motivation for the development of this project came from the observation during the participation on health projects, in which the absence of solutions and academic materials was identified, which could collaborate to create solutions in which there is a need for distance monitoring of patients, who need special needs, such as the elderly, people who are injured, children, or even people who are bedridden, for some temporary period.

There are many technical materials, but few have characteristics and content aimed at developing a solution for the Internet of Things, especially with the object of scientific research, for this fact this work intends to contribute to the development and improvement of solutions that can serve as a basis for academic and scientific studies.

The concept of Internet of Things is mainly used when thinking about creating solutions for residential and industrial automation, a few materials deal with the application of the Internet of Things to the health area, because it is a study that involves different areas such as electronics, computing, software development, database and internet, the creation of projects to address this type of solution, is characterized as very complex.

This project presents the technical results obtained with the creation of a solution for the application of software development technologies in the period of 2018, in which the knowledge about the studies carried out was applied, proposing a model that could be used in different types of projects , allowing a coupling or extension of its resources in new models that use 3 layers of development.

II. BIBLIOGRAPHY REVIEW

The materials available in the IEEE Xplore library, IEEE Latinamerica, were used as a study base, which did not present significant contents which could contribute to the development of this project, presenting a gap for the contribution of academic material that can collaborate with the development of solutions more robust, with similar characteristics, or even to complete other studies to be developed.

Based on studies of the Internet of Things, as explained by CERN and ITU-IT, it is considered the use of devices that can be connected between different

https://dx.doi.org/10.22161/ijaers.5.11.26 ISSN: 2349-6495(P) | 2456-1908(O)

objects, such as those used in residences, companies, among other places. The connection between these objects, or things, allows the individual to control the different objects remotely, or even controlled according to their profile.

When using three-tier development, it is possible to create a database infrastructure, a layer to control the business rules, this being the programming code itself, on the other hand, there is the creation of graphical interfaces, so that the platform can be accessed in different places, with different devices.

The studies about IoT (Internet of Things) were developted about authors as: Kargin et al. [3]; Rajalakshmi & Shahnasser [4]; CERP [7]; Minchev & Dimitrov [8]; Hejazi et al. [10]; Miladinovic et al. [11]; ITU-T [15]; Raj & Sankar [16]; Özgür et al. [17]; Poongothai et al. [18]; Srinivas et al. [20]; Singh et al. [12]; Hlaing et al. [25].

For the devices operations were used technical materials, as documents, manuals, technical references from manufactorers, and others as: Arduino [6]; Škraba et al. [5]; Bento [1]; Bento [2]; Oliveira et al. [9]; Singh et al. [12]; Itead [13]; IteadlibNextion [14]; Srivastava et al. [21]; Saha & Majumdar [24]; Pakalapati et al. [23]; Barai et al. [22].

During the research, the IEEE Xplore databases, IEEE LatinAmerica, the Scopus database, were used as the information base. During the research, the key words that involved this study were used during the research, but few references were found on the subject addressed, references on the devices for the Internet of Things, were found in few quantities in these bases, the few that were located, were used during this study, thus this lack of research papers, provided an opportunity for the development of this study.

III. METHODS AND MATERIALS

As a methodology, the experimental research was used, in which experiments were developed with the selected devices and tools, considering the hypothesis for the creation of a solution that can be used in different environments, serving as the basis for the development of more complex projects, the which can be adapted with different types of resources. Usually used for solutions that meet the needs of individuals who need to control or monitor objects in different locations, or even people.

After the studies on the devices and tools, the experiments were applied considering the connection and data transmission during the testing phase, prototypes were created considering the technical documentation and operations manuals provided by the manufacturers. In addition to other scientific materials that were used as a research base, providing an understanding of the processes required to create the solution.

As tools were used the Windows 10 operating system; the IDE to build the screen for the Nextion display; the Arduino IDE for the construction of the algorithm for the controller; the 000WebHost webpage server includes the construction of pages in the PHP language, also for the creation of the MySQL database; the AppInventor MIT tool for creating the interface used with a smartphone.

The devices used are: a Compaq Presario notebook with Windows 10 64 bits; a NodeMCU12e device as controller and WiFi network access; a Nextion touchscreen display device; a Samsung Galaxy SmartPhone with Android; a WiFi network for remote data transmission and replay.

IV. RESULTS AND ANALISYS

With the three-layer design, there is the structure of a three-way communication, such as a layer for interface, in this layer solutions are developed for access to the business layer, this being the second layer, used for treatment of the business rules created with the necessary algorithms for the validation of the data, being this the third layer, for storage and access to the data.

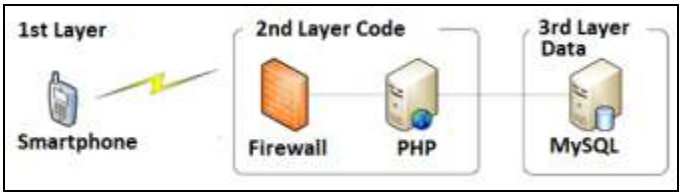

Fig. 1.Three layer development model.

The NodeMCU12e controller was selected for its low cost, compared to other devices available in the national and international market, due to its specific characteristics, in which it already has an integrated WiFi devices, considering its high capacity of storage, processing and size , these being its main advantages compared to other devices like the Arduino Uno. Considering the studies developed by Bento [1].

The Nextion touchscreen display was used in this project because it has advantages in comparisons with other devices, such as a proprietary IDE, has a reduced number of connection cables, with reduced size, storage and processing capacity, superior to other models, considering the model ILI9341, comparative results of a study developed by Bento [2].

https://dx.doi.org/10.22161/ijaers.5.11.26 *ISSN: 2349-6495(P) | 2456-1908(O)*

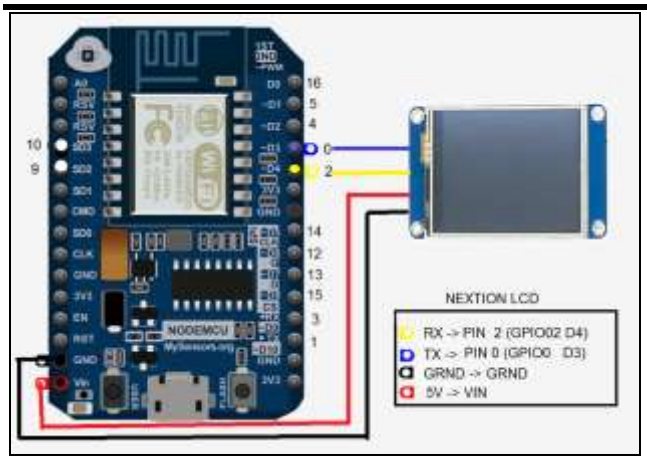

Fig. 2.Connection scheme with the devices NodeMCU12e and the Nextion touchscreen display.

The following is part of the code used for accessing the WiFi network by the NodeMCU12e device, firstly the configuration of the email and password for accessing the WiFi network is performed, soon after the attempt is made to access the network, as demonstrated in the algorithm. After access the data is transferred to the data layer.

```
int loop_wifi_get(String v_dev, String v_sensor, String v_radio, String v_dtrec)
{ if (WiFi.status() != WL_CONNECTED) {
Serial.println(F("Error during connection...\r\n"));
Serial.println(esid.c_str());
Serial.println(epass.c_str());}
      Else {
       WiFiClient client;
        // Attempt to make a connection to the remote server
        if ( !client.connect(HOST_NAME, HOST_PORT) ) {
          Serial.println(F("Not success..."));     }
         Serial.println(F("Tentando enviar GET..."));
         // Make an HTTP GET request
        //cod_sensor    val_sensor val_reg    event_date event_message cod_patient
         v_dtrec=Formata_relogio("");
Serial.println("GET /_action.php?txt_v_dev="+String(v_dev)+"&txt_v_sensor="+String(v_sensor)+"&txt_v_radio="+String(v_radio)+"&txt_v_dtrec="+v_dtrec+" HTTP/1.1");
client.println("GET /_action.php?txt_v_dev="+String(v_dev)+"&txt_v_sensor="+String(v_sensor)+"&txt_v_radio="+String(v_radio)+"&txt_v_dtrec="+v_dtrec+" HTTP/1.1");
client.print("Host: "
client.println(HOST_NAME);
client.println("Connection: close");
client.println();}}
```

A. First layer (the interface)

With the algorithm in the NodeMCU12e devices, it was possible to send data, such as for pulse control, humidity, heart rate, then send the device code so that it can be used to create reports in future consultations , allowing the presentation by graphics, images, or even in reports with filters, all this information is stored in the layer of data, which receives the data sent through the internet, using the algorithms of the business layer.

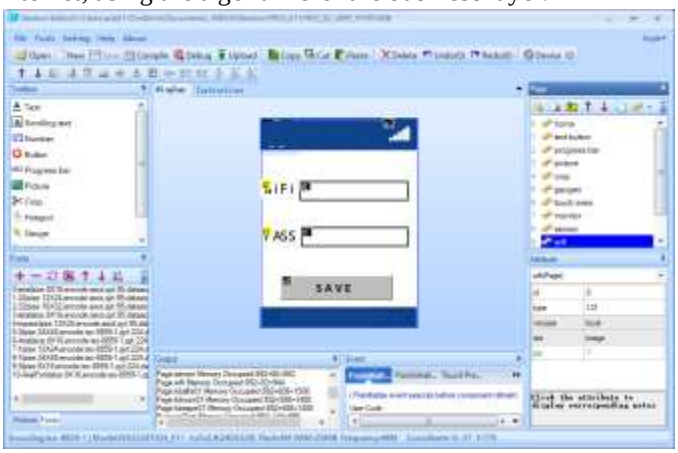

Fig. 3.ITEAD editor for Nextion display screen project created for the solution, to validate the WiFi access.

The following screens were created to allow access to the settings for the WiFi network, allowing the entry of Login ID and access Password for the WiFi devices, in this way it is possible to start the data for tests. This data was used for reading at the business and data layer with the Smartphone.

Fig. 4.The main screen for entry login acces and password, created with ITEAD editor for Nextion display.

This interface layer was created to facilitate the configuration of the NodeMCU12e device, enabling the validation of access and transmission of collected data during a patient monitoring process, served as a communication medium for the internet transmission to the business layer, the which should receive the

https://dx.doi.org/10.22161/ijaers.5.11.26 *ISSN: 2349-6495(P) | 2456-1908(O)*

transmitted data, at this point the data is validated by the router of the residence, the data on the WiFi network and password should be recorded in the device NodeMCU12e for future access.

Another layer of interface was created to allow the user access that should monitor the data remotely, using a smartphone device with the Android operating system, so it is possible that even the distance monitoring is possible, for the development of the solution was used the platform of IT AppInventor, developed for programming in blocks, facilitating the understanding of the process.

Fig. 5.Appinventor screen for user and password authentication.

In the screen of the appinventor that is used in the mobile phone, only the user and password information that is registered in the main system are validated, after the validation of the user the other screens should be possible, allowing the visualization of the reports.

The appinventor works with the development of algorithms in the form of blocks, allowing to drag the components to compose a rule of validation of the steps to be used during the process. Some of the main rules that were used during the project are presented.

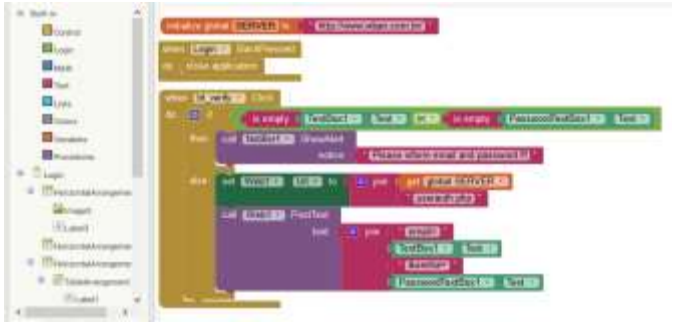

Fig. 6.Part of the algoritm created with the AppInventor for user and password validation.

During the creation of the screens with the appinventor, it is necessary to carry out the construction of the solution using the tools menu, after the creation of the project package, which should have the .APK file extension, the created file can be sent by email, or directly to the cell phone via USB cable, or even through the internet with the access by QRCode, another way, is to send the package by email, soon after this should be installed on the smartphone.

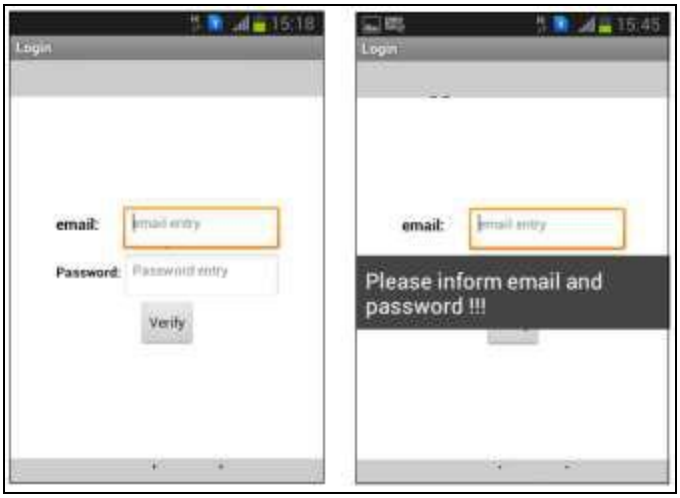

Fig. 7.The smartphone interface screen for user and password validation.

After confirmation of access to the user and password registered in the system, the user should be directed to a monitoring screen, in which should be alerted if there is any occurrence of the type increase in temperature or of the patient's heart rate, in this way who is monitoring can monitor the events immediately and take some action to check if the patient needs any special care.

At this point the smartphone performs the internet access, sending the user data and password, from the other page the page server which has the codes in PHP, perform the validation of the username and password, giving the interface a message, informing if the access was successful or not, if it has been successfully completed the system in smatphone should release access to pass next pages.

B. Second layer (the algoritm)

The second layer was developed with the PHP development language, for the application was created an algorithm to verify the user's email and password, registered in a database with the MySQL Database Management System, this being the storage used in the third layer, which should be presented next. The algorithm in the second layer allows access using an internet network, in which data is sent by the Post or Get methods, depending on the model adopted.

```
<?php
$db = "dbname";
$dbuser = "dbuser";
$dbpass = "dbpassword";
$connection = mysqli_connect("dbservernameorlocalhost", $dbuser, $dbpass) or print (mysqli_error());
```

https://dx.doi.org/10.22161/ijaers.5.11.26 ISSN: 2349-6495(P) | 2456-1908(O)

```
mysqli_select_db($connection,$db) or
print(mysqli_error($connection));
$vemail=$_POST['femail'];
$vpass=$_POST['fpass'];
$sql = "SELECT * FROM user_regs WHERE
user_email='$vemail' and
aes_decrypt(user_pass,'passencript')='$vpass'";
$result=mysqli_query($conection, $sql) or die
(mysqli_error());
$row=mysqli_num_rows($result);
if ($row>0) {
while($cons = mysqli_fetch_array($result)) { }
echo "<center>Success</center>"; }
else { echo "<center>Error</center>"; }
mysqli_close($connection);
?>
```

The algorithm was made available in a web environment, in the case 000WebHost, a web hosting service, also had a MySql database system integrated to the environment, which facilitated the construction of the solution. The algorithm makes the call on the database server, the access settings must be entered correctly during access.

After access is sent a message on the page informing if the connection and the access data are correct, returning the message Sucess, in case of success and Error in case of failure during the validation of the email and password.

The second layer must be available in a web environment, to facilitate access in different devices, providing portability and accessibility in different locations and devices, in the case of this project an application developed with AppInventor is who should perform the interface between the algorithm and the database that is in the third layer.

C. Third layer (the database)

The creation of the third layer was done using the web access environment, by the db4free site, which allows the creation of database structures in MySQL for testing and validation of programs, another alternative is the use of the environment 000WebHost, which also allows the creation of environments for testing, the steps for the creation are the same, changing only the access address for the servers, username, password and database name.

The following algorithms demonstrate how to create the database, insert records and construct the inserted data, allowing access remotely, using internet resources, this same environment can be used for larger and complex projects, serving as a basis for the creation of more robust solutions.

Fig. 8.The database phpMyAdmin login screen, for second layer creation..

Access to create the database structure was developed using the phpMyAdmin graphical interface, after selecting the database and the creation screen for queries, the development environment for the project was created.

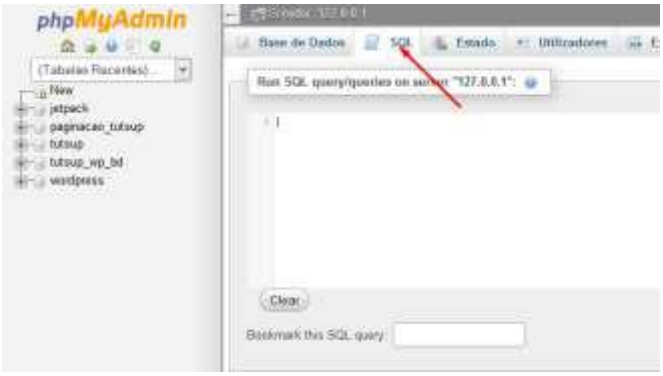

Fig. 9.Query construction with the phpMyAdmin.

```
//Creating the database with user, email and password
encrypted
CREATE TABLE user_regs ( cod_reg int(11) NOT
NULL PRIMARY KEY AUTO_INCREMENT,
user_name varchar(60),
user_email varchar(40) UNIQUE KEY,
user_pass varbinary(256) NOT NULL) ;
//Inserting records with user, email and encrypted
password
INSERT INTO user_regs (user_name, user_email,
user_pass) values ('Antonio','teste@teste.com.br',
aes_encrypt('123', 'uni9'));
//Verifying all records in the database
SELECT * FROM user_regs;
// Testing the password decryption
SELECT user_name, user_email,
aes_decrypt(user_pass,'uni9') FROM user_regs;
```

https://dx.doi.org/10.22161/ijaers.5.11.26 *ISSN: 2349-6495(P) | 2456-1908(O)*

As shown in figure 7, the project developed in the AppInventor, makes the access by sending the data typed on the smartphone screen, as shown in figure 6, the algorithm should first access the web page that has the algorithm developed in the php language, sending the email address and password provided by the user during access.

The algorithm developed in php should access the database, with the appropriate settings provided during the access, soon after, the algorithm verifies if the email and password, exist in the database, soon after these are validated and informed the success or not during the access.

V. CONCLUSIONS

The results obtained with the development of this study, allowed to conclude that the construction of solutions in three layers allows the transfer and reception of data in a remote way, enabling a fast communication, allowing the device which should perform the interface, as in this case the smartphone with the Android operating system, has a very small processing load, because the communication with the second layer is who should make the effort to process the data.

With the tests carried out, it was also possible to validate the infrastructure, analyzing its different aspects and resources, allowing a deeper understanding of its main characteristics, considering the weak and strong points, validating the proposal and the research hypothesis, in the presented model a practical test is used, without the intention of being complex, this for the understanding and validation of the results obtained with the tests.

As a future project is intend to build more robust solutions, which can meet more sophisticated projects, since it is understood that more complex solutions need more resources and tools, depending on the type of need, the project can be adapted, because flexibility is very large in relation to the materials used. Hopefully this all can contribute to the development of new projects of scientific research, in which studies are used on the Internet of Things, for the aid of patients, or people with special needs.

ACKNOWLEDGMENT

Special thanks for all colleagues, students and relatives, which has collaborated with this project.

REFERENCES

[1] A. C. Bento. IoT: NodeMCU 12e X Arduino Uno, Results of an experimental and comparative survey. International Journal of Advance Research in Computer Science and Management Studies, v. 6, p. 46-56, 2018.

[2] A. C. Bento. IoT: Results of an Experimental Survey with Nodemcu, Nextion, DS1307 and NRF24L01+. International Journal of Current Innovation Research, v. 4, p. 969-974-974, 2018.

[3] A. Kargin ; O. Ivaniuk ; G. Galych ; A. Panchenko. Polygon for smart machine application. 2018 IEEE 9th International Conference on Dependable Systems, Services and Technologies (DESSERT). p. 464-468. IEEE Conference.

[4] A. Rajalakshmi ; H. Shahnasser. Internet of Things using Node-Red and alexa. 2017 17th International Symposium on Communications and Information Technologies (ISCIT). p. 1-4. IEEE Conference.

[5] A. Škraba ; A. Kološvari ; D. Kofjač ; R. Stojanović ; Vladimir Stanovov; Eugene Semenkin. Prototype of group heart rate monitoring with NODEMCU ESP8266. 2017 6th Mediterranean Conference on Embedded Computing (MECO). p. 1-4. IEEE Conference.

[6] Arduino. 2018. Official Available at: https://www.arduino.cc

[7] CERP. (2009). IoT – Internet of Thinsgs of European Research Cluster. Internet of things: Strategic Reserach Roadmap, Available at: http://www.internet-of-thingsresearch.eu/pdf/IoT_Cluster_Strategic_Research_Agenda_2009.pdf

[8] D. Minchev ; Atanas Dimitrov. Home automation system based on ESP8266. 2018 20th International Symposium on Electrical Apparatus and Technologies (SIELA). p. 1-4. IEEE Conference.

[9] G. M. B. Oliveira ; D. C. M. Costa ; R. J. B. V. M. Cavalcanti ; J. P. P. Oliveira ; D. R. C. Silva ; M. B. Nogueira ; M. C. Rodrigues. Comparison Between MQTT and WebSocket Protocols for IoT Applications Using ESP8266. 2018 Workshop on Metrology for Industry 4.0 and IoT. p. 236-241. IEEE Conference.

[10] H. Hejazi ; H. Rajab ; T. Cinkler ; L. Lengyel. Survey of platforms for massive IoT. 2018 IEEE International Conference on Future IoT Technologies (Future IoT). p. 1-8. IEEE Conference.

[11] I. Miladinovic ; S. Schefer-Wenzl. NFV enabled IoT architecture for an operating room environment. 2018 IEEE 4th World Forum on Internet of Things (WF-IoT). p. 98-102. IEEE Conference.

[12] I. Singh ; V. Pallagani ; V. Khandelwal ; U. Venkanna. IoT based smart home automation system using sensor node. 2018 4th International Conference on Recent Advances in Information Technology (RAIT). p. 1-5. IEEE Conference.

https://dx.doi.org/10.22161/ijaers.5.11.26 *ISSN: 2349-6495(P) | 2456-1908(O)*

[13] Itead. Studio. Nextion Development Software and Informations. https://nextion.itead.cc/

[14] IteadLibNextion. Libraries and examples for Nextion devices. https://github.com/itead/ITEADLIB_Arduino_Nextion

[15] ITU-T. (2012). Internet of Things Global Standards Initiative. Available at: http://www.itu.int/ITU-T/recommendations/rec.aspx?rec=y.2060.

[16] J. Thyparampil Raj ; J. Sankar. IoT based smart school bus monitoring and notification system. 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC). p. 89-92. IEEE Conference.

[17] L. Özgür ; V. K. Akram ; Moharram Challenger ; Orhan Dağdeviren. An IoT based smart thermostat. 2018 5th International Conference on Electrical and Electronic Engineering (ICEEE). p. 252-256. IEEE Conference.

[18] M. Poongothai ; P. Muthu Subramanian ; A. Rajeswari. Design and implementation of IoT based smart laboratory. 2018 5th International Conference on Industrial Engineering and Applications (ICIEA). p. 169-173. IEEE Conference.

[19] M. Singh ; S. L. Shimi. Implementation of room automation with cloud based monitoring system. 2018 2nd International Conference on Inventive Systems and Control (ICISC). p. 813-817. IEEE Conference.

[20] M. Srinivas ; P. Durgaprasadarao ; V. Naga Prudhvi Raj. Intelligent medicine box for medication management using IoT. 2018 2nd International Conference on Inventive Systems and Control (ICISC). p. 32-34. IEEE Conference.

[21] P. Srivastava ; M. Bajaj ; A. S. Rana. IOT based controlling of hybrid energy system using ESP8266. 2018 IEEMA Engineer Infinite Conference (eTechNxT). p. 1-5. IEEE Conference.

[22] S. Barai ; D. Biswas ; B. Sau. Estimate distance measurement using NodeMCU ESP8266 based on RSSI technique. 2017 IEEE Conference on Antenna Measurements & Applications (CAMA). p. 170 - 173. IEEE Conference.

[23] S. S. Pakalapati ; G. G. Chary ; A. K. Yadaw ; S. Kumar ; H. K. Phulawariya ; R. Kumar. A prosthetic hand control interface using ESP8266 Wi-Fi module and Android application. 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS). p. 1-3. IEEE Conference.

[24] S. Saha ; A. Majumdar. Data centre temperature monitoring with ESP8266 based Wireless Sensor Network and cloud based dashboard with real time alert system. 2017 Devices for Integrated Circuit (DevIC). p. 307-310. IEEE Conference.

[25] W. Hlaing ; S. Thepphaeng ; V. Nontaboot ; N. Tangsunantham ; T. Sangsuwan ; C. Pira. Implementation of WiFi-based single phase smart meter for Internet of Things (IoT). 2017 International Electrical Engineering Congress (iEECON). p. 1-4. IEEE Conference.