Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 259-263, 4, 2024

Araştırma Makalesi

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 259-263, 4, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

Development Of Sensor Network System For Digital Transformation Transfer Laboratory

Gökçe İye*, Merih Palandöken [2]

[1]*Department of Electrical and Electronics Engineering, Faculty of Engineering and Architecture, Izmir Katip Celebi University, Turkey*
[2]*Department of Electrical and Electronics Engineering, Faculty of Engineering and Architecture, Izmir Katip Celebi University, Turkey*

(gokceiye280@gmail.com)

(Received:15 May 2024, Accepted: 25 May 2024)

(3rd International Conference on Engineering, Natural and Social Sciences ICENSOS 2024, May 16-17, 2024)

ATIF/REFERENCE: İye, G. & Palandöken, M. (2024). Development Of Sensor Network System For Digital Transformation Transfer Laboratory. *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(4), 259-263.

Abstract – Along with technological innovations, the internet of things, artificial intelligence and big data, as a result of all these, the "digital age" or "digitalization" processes we have discussed have entered our lives. These concepts emerged in the Industry 4.0 period, which represents the fourth phase of the industrial revolution and is still experienced today. Internet of things (IoT) refers to all systems that can transfer data over a network. In the world of the Internet of Things, the role of human-to-human commands and even human-computer interaction is minimized. The paper aims to provide both cost and high efficiency by using IoT and MQTT. The application was designed with object-oriented programming languages such as Python and C#. In the Digital Transformation Transfer Laboratory, data recorded and transferred through sensors are analyzed. The focus of the paper is on processing data from DHT11 and HC-SR04 sensors, analyzing this data intelligently and monitoring it in different applications. The use of sensor networks provides timely access and convenience in accessing information. With the development of the systems to be designed in the paper, it is aimed to control the smart system in an easier and more visual way and to develop a sensor network system for a Digital Transformation Transfer Laboratory suitable for Industry 4.0 requirements with high original value. In this context, the paper aims to develop a sensor network system for the Digital Transformation Transfer Laboratory that complies with the high value requirements of Industry 4.0 and makes the control of the smart system easier and more visually accessible.

Keywords – IoT, MQTT, Industry 4.0, Sensor, Digital Transformation

I. INTRODUCTION

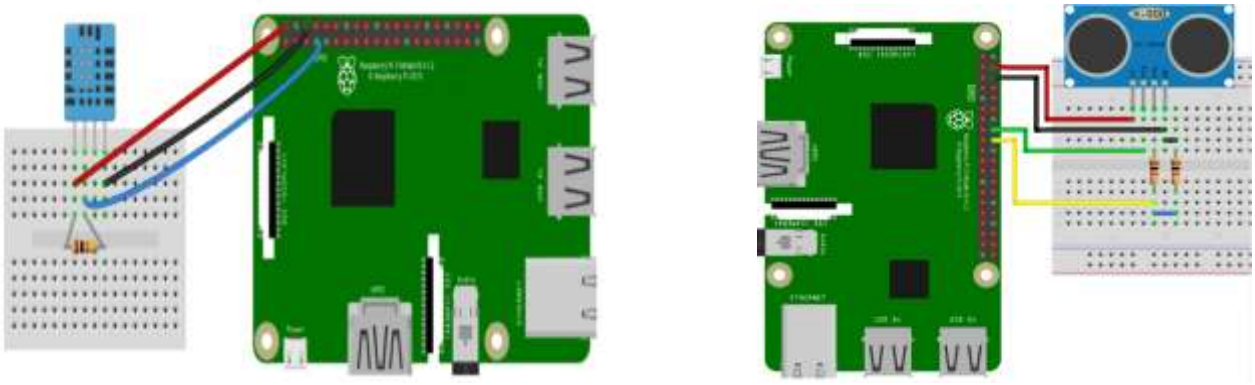
The development of novel digital technologies connected to the Internet of Things, along with advancements in artificial intelligence and automation, is enabling a new wave of manufacturing innovation [1]. Industry 4.0, Internet of Things (IoT), big data, Artificial Intelligence (AI) and cloud computing. These are a few of the other buzzwords that are found everywhere, whether in general newspapers, company websites, articles or scientific journals. The terms represent a set of concepts and methods that have the ability to radically change the industry. For this reason, many authors have

discussed the origins of Industry 4.0, its impact, what its future effects may be, and its applicability in many different publications. The phrase Industry 4.0 was coined in Germany to describe the emerging digitalization of both production systems and manufacturing, concentrated in the industrial sector, but the United States has labeled it Smart Manufacturing [2]. The IoT has several elements: sensors to obtain the data, data processors to analyze the data, and finally, actuators that respond to the information by moving and controlling machinery [3]. It is stated that what provides the power of IoT is the ability of objects to communicate. Communication between IoT devices is not just for data collection; in most cases, this communication is designed to perform specific tasks that interact in physical space, improving the efficiency of tasks that were previously done manually. [3]. Industry 4.0 facilitates system monitoring and fault diagnosis, enables systems and their components to gain self-awareness, ensures that the system is sustainable with environmentally friendly and resource-saving behaviors, increases flexibility in production and improves business models. Industry 4.0 is based on 6 principles which are interoperability, virtualization, autonomous administration, Real-time capability, service orientation. In this paper, these terms, which are actively used in the field of technology, such as IoT and Industry 4.0, have been tried to be made applicable by creating sensor networks for future use.

II. MATERIALS AND METHOD

A. Hardware Design

Raspberry Pi enables exploring the Internet of Things. It is a low-cost, credit card-sized computer that plugs into a computer monitor. It is a capable small device that allows learning to program in languages such as Python[5]. Sensor nodes collect various physical information; temperature, pressure, motion of an object, etc. enables him to be caught. In addition, it can also enable the physical characteristics of the environment to be matched with quantitative measurements [6]. The sensors used transmit data instantly via ESP8266.The data collected in the monitoring environment is generally processed at 3 levels.
1. Events in the environment to be monitored are detected by sensor nodes. Each sensor node processes the data it obtains separately.,
2.At the second level, each node detects and sends the processed data to its neighbors.
3. The top layer in sensor network communication is sending the processed data to the center called the base.



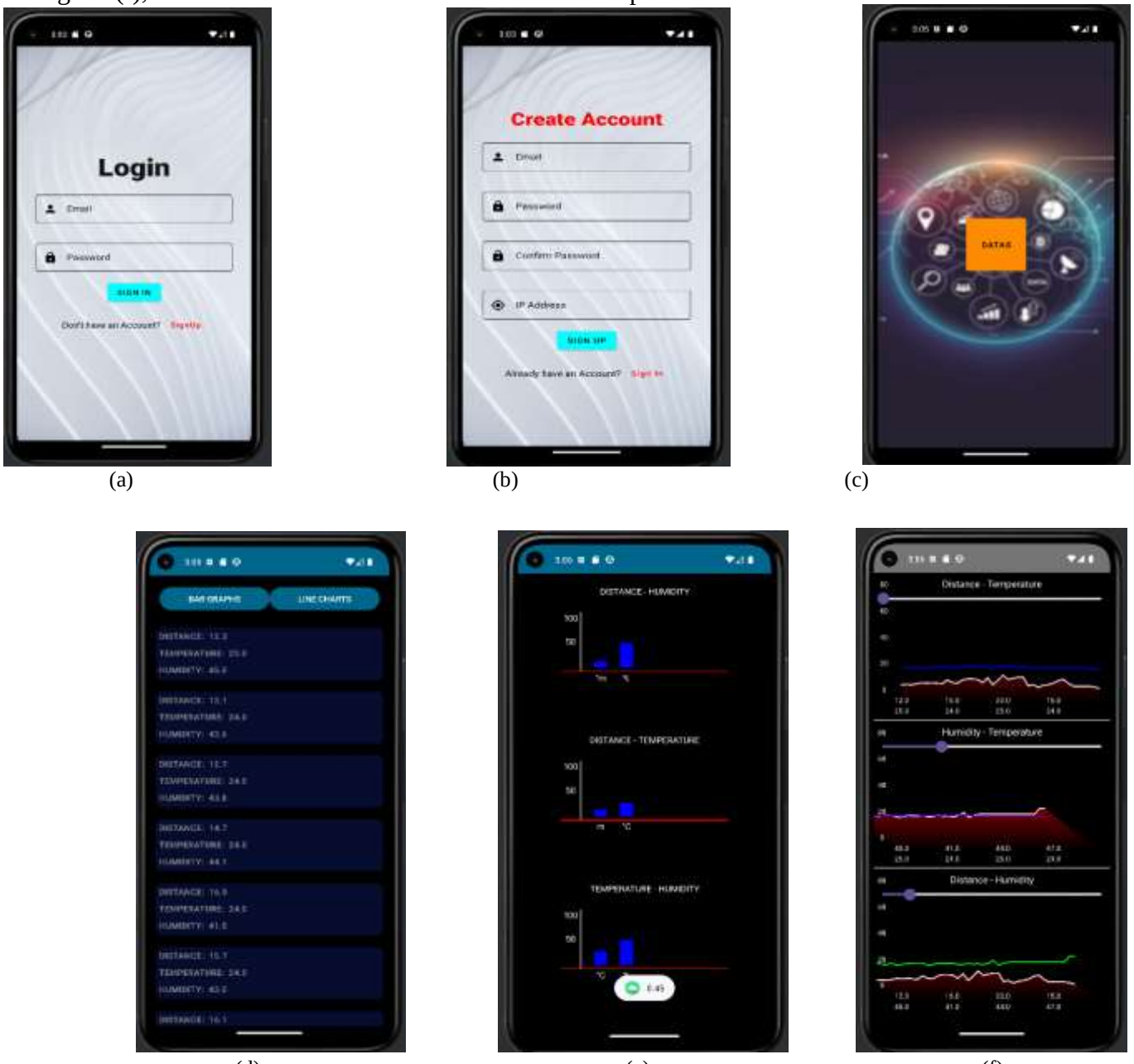
(a) (b)

Figure 1. Raspberry Pi Connection (a) with DHT11 sensor (b) with HC-SR04 sensor

B. Interface Design

The interface design is designed to make the system easier to understand and use by the user. Object-oriented programming languages such as Kotlin and Python were used in this interface design. After the sensors were connected within the Raspberry Pi, their instantaneous data was first sent to Firebas. Then, an application was designed in Android Studio program to instantly track the data coming from the

sensors. First there is the login page, shown in Figure (a). Then, our sign up page for the first registration is shown in Figure (b). After logging in, the page named 'Datas' is shown in Figure (c). After clicking on Datas, we are presented with the data, as shown in Figure (d). Two different chart types await us on this page. In bar charts, the data depends on time. As shown in Figure (e), the data is shown as a percentage after clicking on it in the chart. In the Line Chart, the data are graphed relative to each other, and as seen in Figure (f), an animated tool has been added to view past and future data when the data increases.

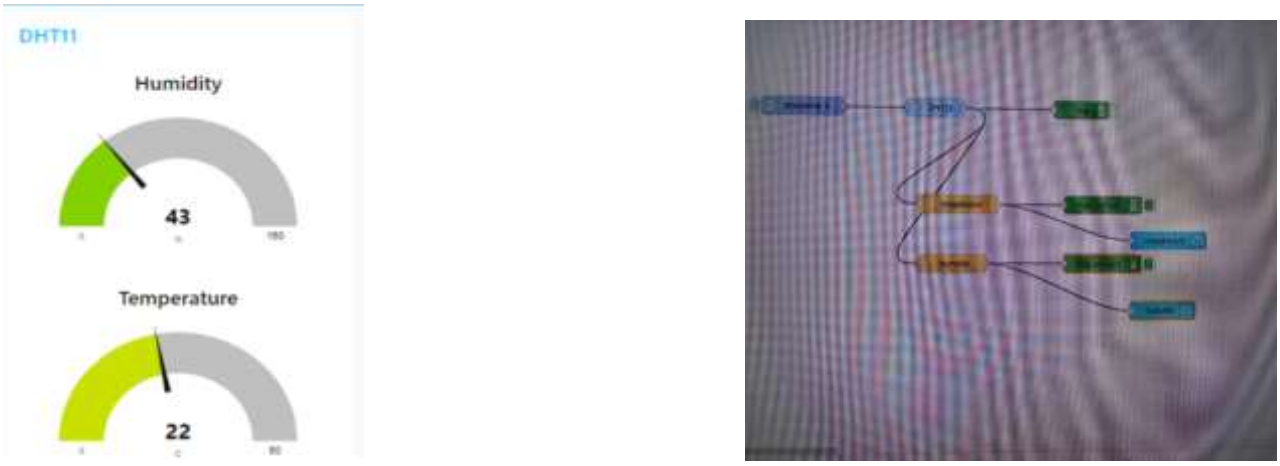


(a) (b) (c)

(d) (e) (f)

Figure 2. Android Studio Application (a) login page, (b) sign up page, (c) Menu page, (d) Data page, (e) Bar graphs, (f) Line charts

In addition, after creating sensor connections in the Node-RED program, which also supports the MQTT protocol, and wireless communication was established between the program and the sensors, Dashboards were added to the Node-RED program and the data was observed instantly, as shown in Figure (a),(b). The data here can also be exported. After creating compatibility in the Breadboard and the system by adding different sensors, it can be developed with different commands.



(a) (b)

Figure 3.Node-RED Application (a) Dashboards (b) Connection of the circuit

III. RESULTS

This paper delivered significant results by leveraging IoT and MQTT technologies for improved efficiency and cost effectiveness. Thanks to the integration of Python and C# programming languages, the Digital Transformation Transfer Laboratory successfully analyzed sensor data, providing intelligent data processing and monitoring in various applications. Sensor networks facilitated timely access to information in accordance with Industry 4.0 requirements. The development of user-friendly, visual control systems has been a turning point in increasing operational ease. Overall, the paper achieved its goal of establishing a high-value sensor network system that will contribute to the ongoing digital transformation journey.

IV. DISCUSSION

In the era of digitization, characterized by technological advances such as the Internet of Things (IoT), artificial intelligence (AI) and big data, the emergence of Industry 4.0 has significantly changed various aspects of their lives. This paper, which aims to exploit the potential of IoT and MQTT technologies, shows the continuous development towards Industry 4.0. An application suitable for the needs of the Digital Transformation Laboratory was developed using object-oriented programming languages such as Python and C#.. This program carefully analyzes data collected by sensors in the laboratory, facilitating intelligent understanding and real-time monitoring in various applications. One of the most important achievements of this paper is the seamless integration of sensor networks, which enables quick access to important information. This not only increases work efficiency, but also paves the way for innovative solutions in intelligent system control. Using technologies like the Raspberry Pi, we have built a strong foundation for future scalability, enabling a wide range of data to be collected as conditions change.

V. CONCLUSION

Leveraging the power of IoT, MQTT and advanced sensor networks, we have successfully developed a state-of-the-art solution tailored to the needs of the Digital Transformation Transfer Lab. Thanks to careful analysis and intelligent interpretation of sensor data, our application allows real-time

monitoring and insight into various applications. This not only increases operational efficiency, but also lays the foundation for future scalability and innovation. In addition, this paper emphasizes the importance of integrating new technologies into traditional industrial processes. By applying object-oriented programming languages and platforms such as the Raspberry Pi, we have demonstrated the possibilities of creating valuable solutions compatible with Industry 4.0.

REFERENCES

[1] David R. Sjödin, Vinit Parida, Markus Leksell & Aleksandar Petrovic (2018) Smart Factory Implementation and Process Innovation, Research-Technology Management, 61:5, 22-31, DOI: 10.1080/08956308.2018.1471277.

[2] Philipp Osterrieder, Lukas Budde, Thomas Friedli,The smart factory as a key construct of industry 4.0: A systematic literature review,International Journal of Production Economics,Volume 221,2020,107476,ISSN 0925-5273, https://doi.org/10.1016/j.ijpe.2019.08.011 .

[3] The Internet of Things: Foundational ethical issues, Fritz Allhoff, Adam Henschke, https://doi.org/10.1016/j.iot.2018.08.005 .

[4] F. Allhoff, G Nicholas, Evans, and Adam Henschke, The Routledge Handbook of Ethics and War: Just War Theory in the Twenty-First Century, Routledge, London (2013).

[5] R. Karunamoorthi, Mohit Tiwari, Tripti Tiwari, Radha Kuruva, Arvind K. Sharma, M. Jemimah Carmichael, T.C. Manjunath, Design and development of IoT based home computerization using Raspberry pi, Materials Today: Proceedings, 2020, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.10.673 .

[6] A. A. Osuwa, E. B. Ekhoragbon and L. T. Fat, "Application of artificial intelligence in Internet of Things," 2017 9th International Conference on Computational Intelligence and Communication Networks (CICN), 2017, pp. 169-173, doi: 10.1109/CICN.2017.8319379.

[7] R. Karunamoorthi, Mohit Tiwari, Tripti Tiwari, Radha Kuruva, Arvind K. Sharma, M. Jemimah Carmichael, T.C. Manjunath, Design and development of IoT based home computerization using Raspberry pi, Materials Today: Proceedings, 2020, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.10.673

[8] El Naqa I., Murphy M.J. (2015) What Is Machine Learning?. In: El Naqa I., Li R., Murphy M. (eds) Machine Learning in Radiation Oncology. Springer, Cham, https://doi.org/10.1007/978-3-319-18305-3_1

[9] Frederik Wedel, Steffen Marx, Application of machine learning methods on real bridge monitoring data, Engineering Structures, Volume 250, 2022, 113365, ISSN 0141-0296, https://doi.org/10.1016/j.engstruct.2021.113365

[10] L. Paradis and Q. Han, “A survey of fault management in wireless sen-sor networks,” Journal of Network and Systems Management, vol. 15,no. 2, pp. 171–190, 2007