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Early coronavirus disease detection using internet of things smart system

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ABSTRACT

The internet of things (IoT) is quickly evolving, allowing for the connecting of a wide range of smart devices in a variety of applications including industry, military, education, and health. Coronavirus has recently expanded fast across the world, and there are no particular therapies available at this moment. As a result, it is critical to avoid infection and watch signs like fever and shortness of breath. This research work proposes a smart and robust system that assists patients with influenza symptoms in determining whether or not they are infected with the coronavirus disease (COVID-19). In addition to the diagnostic capabilities of the system, the system aids these patients in obtaining medical care quickly by informing medical authorities via Blynk IoT. Moreover, the global positioning system (GPS) module is used to track patient mobility in order to locate contaminated regions and analyze suspected patient behaviors. Finally, this idea might be useful in medical institutions, quarantine units, airports, and other relevant fields.

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1. INTRODUCTION

The increased usage of mobile technologies and smart devices in the healthcare industry has a huge global influence [1]. The internet of things (IoT) enables the integration of physical devices capable of connecting to the internet and gives clinicians real-time health status information. Chronic illnesses such as diabetes, heart disease, and high blood pressure are significant global economic and social issues [2]. It might also serve as a platform for public health organizations to obtain data in order to track the coronavirus disease (COVID-19) epidemic. In comparison to other nations, the number of new cases in the United States is quickly growing [1], [3]. The COVID-19 virus has become a major worldwide health issue since its discovery in Wuhan, China in December 2019 [4]–[7]. The World Health Organization has designated this viral epidemic as the world's sixth public health emergency. COVID-19 is a new kind of coronavirus that has never been seen in people before [6], [8]. COVID-19 can lead to significant sickness in some people, especially the elderly and those with major underlying chronic diseases such as heart disease, respiratory disease, and diabetes [9]–[11]. For the time being, there is no direct medicine for this virus. Fever, chills, dry cough, trouble breathing, fatigue, aches pains, headache, and sore throat are all symptoms of COVID-19 [12]. In COVID-19, higher respiratory signs like a runny nose and sinus congestion are uncommon. The findings of a disease diagnosis are determined by the therapist's experience, knowledge, and interpretation [13].

Knowledge-based systems are frameworks in which a rationale mechanism addresses issues by applying rules established by a person to a knowledge base. Because it utilizes a huge amount of data such as symptoms and patient history, the use of computer-based approaches in medical diagnostics is increasing the quality of medical services. The IoT, artificial intelligence (AI), and machine learning approaches are all helping to disseminate such technologies. A robust IoT-based system was designed in order to assist patients to get medical considerations promptly [14]. The system monitors a suspected patient during the 14 days of quarantine to recognize that the patient is infected by ordinary flu or infected by the COVID-19 virus. Noteworthy that the evaluations are performed based on the IoT model by expert physicians, doctors, and medical centers. IoT is used with diverse metrics in different sectors, such as construction, agriculture, medicine, and remote real-time control. Several experiments have been performed using IoT for healthcare surveillance [15]. Previously, even during the COVID-19 pandemic, it is important to track the eldest communicating COVID-19 patients remotely to verify vital signs over the 14-day quarantine cycle to guarantee that no symptoms of COVID-19 emerge. This article presents any of the benefit programs repeatedly stated for other cases [16]. A structure focusing on medical care, such as hospital emergency services, ambulance, and care services, has been suggested by Lakkis and Elshakankiri [17]. The sensors were utilized by to detect and communicate health data in the suggested system. This information is solely used to track health and respond to emergencies. Furthermore, no specific illness was mentioned in the suggested method. Gupta *et al.* [18] emphasizes the use of IoT to monitor and evaluate the health settings of obese people. The investigation also looked into the storage of medical data. Neyja *et al.* [19] presented a cardiac vascular disease monitoring system. An electrocardiogram (ECG) sensor must be used to provide heart rate data to the hospital. In this system, an algorithm is suggested that is activated in the event of exceptional situations that necessitate an urgent reaction from a medical professional. Ghaffar *et al.* [20] suggested a method for tracking various illnesses. The system was implemented using the Cisco packet tracer tool. The system begins by collecting data using sensors and then processing it with a microcontroller. Second, several judgments regarding diagnosis, medication administration, and emergency response will be made. Although the suggested approach addresses three illnesses, COVID-19 has yet to be evaluated. The earlier suggested methods took into account a variety of illnesses and cases, but monitoring the eldest who came into touch with COVID-19 instances has yet to be examined. Many additional studies have focused on developing diagnosis systems. Moreover, Naser and Mahdi [21] demonstrated an elastomeric, on-demand, and dependable medical diagnostic solution based on IoT and cloud architecture that benefited patients and professionals alike. Patients' heart rates are measured utilizing sensors during symptom-based analysis. The program engages with individuals to gather information about their symptoms initially and then look for a diagnosis afterwards. Finally, noteworthy that none of the previous works have paid attention to how sensors can communicate with the microcontroller, despite the fact that selecting the appropriate microcontroller unit is critical, especially when it comes to reducing the cost and complexity of the design because it can diminish the complexity of detachable kits to reconstruct IoT systems.

In this research, a robust IoT based-system was designed in order to assist patients to get medical considerations promptly. The system monitors a suspected patient during the 14 days of quarantine to recognize that the patient is infected by ordinary flu or infected by COVID-19 virus. Noteworthy that the evaluations are performed based on IoT model by expert physicians, doctors and medical centers. The rest of the article is written out as: In section 1, a general introduction to the origins of the coronavirus and the symptoms that may arise when a person is infected alongside with the most up-to-date illness and disease detection technologies were presented. In addition, section 2 detailed the work methodology and demonstrated the steps required to collect and analyze the data appropriately. Section 3 revealed and discussed the obtained results. The conclusions and future works of the work were presented in section 4.

2. METHOD

For the evaluation of patients with COVID-19 or Flu, the suggested method used a knowledge-based approach. Once the idea on how the system is going to perform get ready through step 1, the components needed to realize the data must be unveiled in step 2 as: An Arduino enterprise produced the node microcontroller unit (NodeMCU), which is a contemporary microcontroller. This component functions as an Arduino with needs that are independent of automatic voltage regulator (AVR) processors, requiring Arduino IDE C++ compilers to compile the entire package. The package is regarded as a full kit owing to the features created by the extrasensory perception (ESP) team, and it is designed to decrease the particular sectors that are necessary to be linked to distinct responsibilities of the performer. The software module that is required to analyze the Arduino C+ headers using microcontroller unit (MCU) language has been dubbed "Core" [22]–[24]. In contrast to the design process that produced the Arduino core under the dominion of the ESP8266 Wi-Fi based on the GitHub ESP8266 core website, the ESP8266 subsystem innovation contributes to the construction of sturdy and comprehensive platforms. This component is considered as a platform that combines the ESP8266 with the NodeMCU. The microcontroller presented in Figure 1 can be controlled by networks 802.11n and 802.11b. This implies that it could function as an access point (AP) and Wi-Fi, or both of them simultaneously [25], [26].

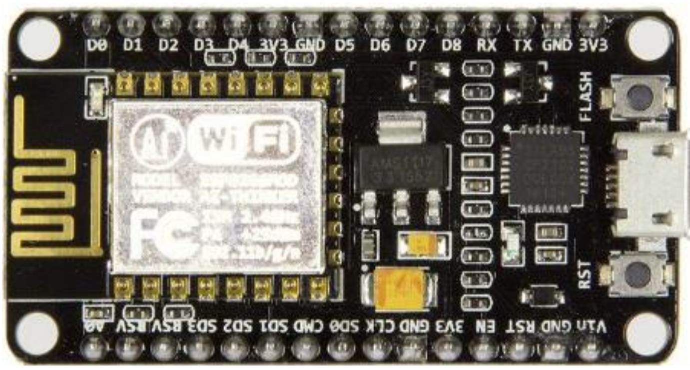


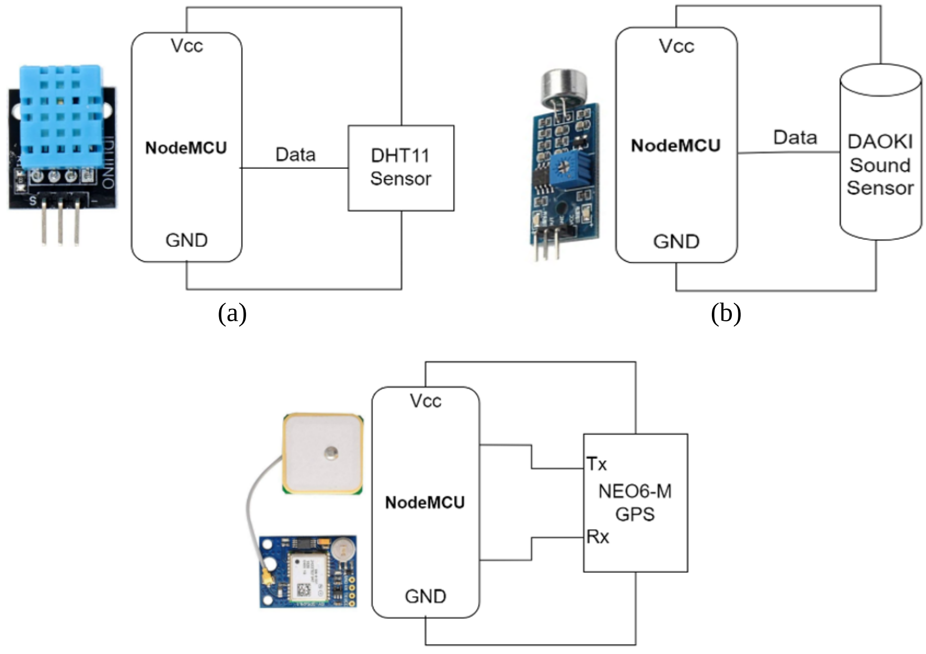
Figure 1. NodeMCU microcontroller

Moreover, it is intended to demonstrate the sensors that are utilized to build the proposed systems in one scene as given in Figure 2. The Dihydrotestosterone-11 (DHT11) temperature humidity sensor measures and records temperature and humidity levels Figure 2(a). The DHT11 sensor, which displays temperature (T) and humidity (H), is complicatedly handled with optical signal output modification [27]. The sensor ensures exceptional sensitivity and outstanding long-term stability with respect to proprietary digital signal processing in the sensing equipment. This module consists of a resistive humidity circuit and an northcentral technical college (NTC) temperature board, both of which are connected to a high-performance 8-bit microprocessor and provide outstanding quality, speed, anti-interference functionality, and cost-effectiveness [24], [28]. Another important component is the noise (cough sound) level measurement in the surrounding environment, where the investigation was performed with high sensitive DAOKI sensor given in Figure 2(b). The LM393YD chip analyzer is used to determine the excess volume threshold. A potentiometer placed on the module is used to set the triggering threshold. A high voltage level emerges on output if the volume threshold is surpassed. The microcontroller can gather and execute the sensor's output signal simultaneously. A sound sensor can be used to construct a variety of collaborative activities [29]. Moreover, the global policy and strategy (GPS) coordinates the signals sent from the base station to space through satellites in order to determine the location of an object on the planet. Through the universal asynchronous receiver/transmitter (UART) connection, the suggested NEO-6M GPS module illustrated in Figure 2(c) can be interconnected and connected with the microcontroller. The module gathers data from a package called National Marine Electronics Association (NMEA) string, which includes universal time coordinated (UTC) time, longitudes, latitudes, and elevations. The global navigation system consists of a constellation of satellites orbiting the globe, which serves as a backdrop for GPS devices. Onboard each satellite is a time clock that displays the exact time. Each satellite continually sends its position and time clock on the 1.575 GHz band as it orbits the globe [30], [31].

Since the GPS receiver is at a precise location on the planet, the signals are entirely responded to by directing the receiver towards the sky [32]. The proposed GPS satisfies (1),

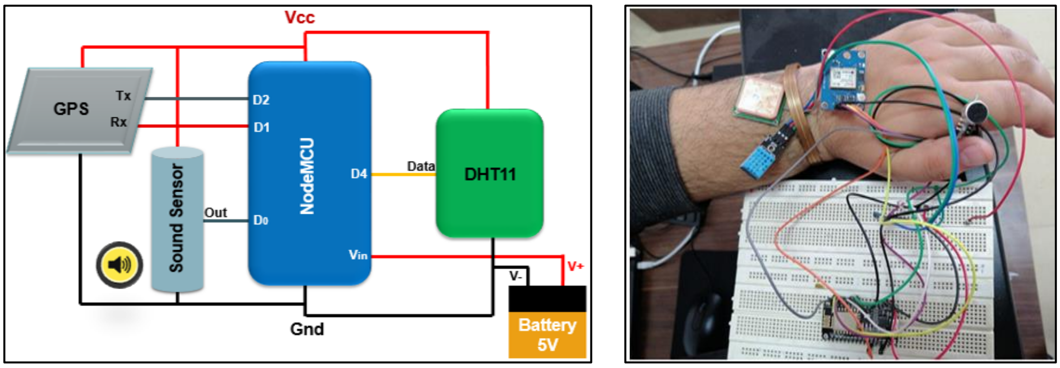
$$R = C \times \Delta t \quad (1)$$

where the GPS can span the range (R) with respect to the speed of light (C) and signal travel time (Δt). This means that the proposed GPS is specific since it deals with certain parameters presented in (1). The overall connections of the proposed components alongside with real patient's evaluation were presented in Figure 3. The communication step (step 3) clarified in Figure 3(a), is the period that the sensors are connected to the NodeMCU board in order to get the output signal from the environment. As mentioned before, this type of microcontroller is embedded by the ESP8266 chip in order to connect the proposed system to the internet in a modern way. Hereby, the IoT system is satisfied appropriately in a modest and compact shape owing to the precious features that were offered by the NodeMCU unit. The overall system covered the parts that were presented above and unveiled in Figure 3(a) as the schematic overall connection considering the exact ports connected to each sensor. As a final point in the communication step, it is intended to show the realistic IoT system test on patient's body as presented in Figure 3(b).



(c)

Figure 2. Sensor types (a) temperature and humidity sensor DHT, (b) sound microphone sensor, and (c) GPS NEO unit connection



(a) (b)

Figure 3. The communication steps (a) overall system module and (b) the realistic view of the proposed system

3. RESULTS AND DISCUSSION

Noteworthy that the rest steps are significant and should be followed henceforward in order to collect the data from the sensors (step 4) then display and discuss the output of each sensor separately (step 5). The data collection process has taken place in a specific location for 50 minutes from (12:05 to 12:55) and the longer time was omitted for clarity. Mainly, the system is started by following the steps shown in the flowchart as shown 1 Figure 4. The system realizes all the data that can be recorded by the sensors and the result is delivered to an Excel sheet through the I/O monitor of the Arduino IDE software and Blynk IoT platform [28], [33].

The proposed system presents the realized data as curves to illustrate the variations in the body's temperature degree, perspiration rates, the motion activity of a patient in (latitude, longitude), and the sound strength of the patient's cough. The aforementioned variables are presented in Figures 5 to 8 respectively. Finally, it is intended to present the overall data uniformly for more comparison motives, which helps to evaluate the situation of a patient in a simple way as shown in Table 1. Noteworthy that the above-mentioned patient's data was received and monitored by the Blynk IoT platform in several conditions as unveiled in Figure 9.

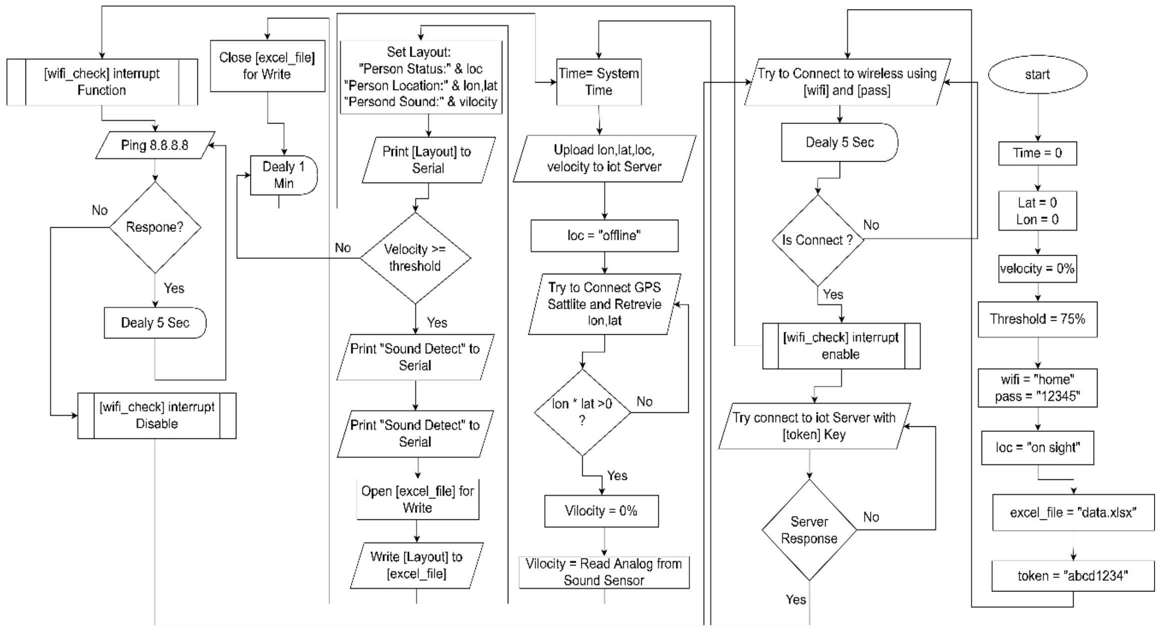


Figure 4. The working mechanism of the system (lat=latitude, lon=longitude, loc=location)

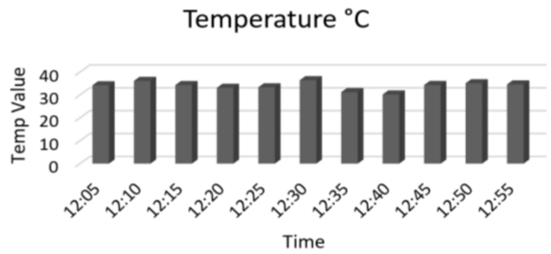


Figure 5. Temperature degree variations in the body

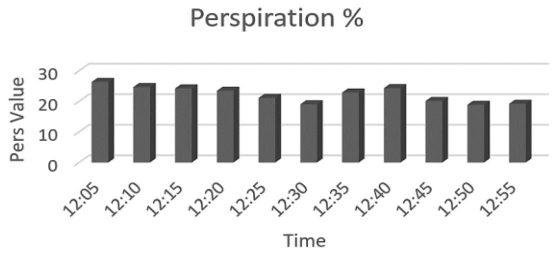


Figure 6. Perspiration rates in the body

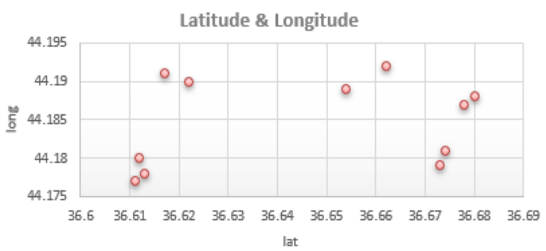


Figure 7. Motion activity of specific patient (lat: latitude and long: longitude)

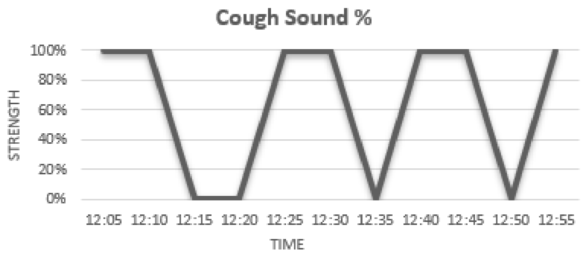


Figure 8. The periodic strength of the cough

Table 1. The overall collected data

Time	Temperature	Perspiration	Latitude	Longitude	Sound
12:05	34.22	26.33	36.678	44.187	34
12:10	36.14	24.67	36.611	44.177	200
12:15	34.33	24.22	36.68	44.188	0
12:20	33.12	23.45	36.613	44.178	0
12:25	33.35	21.12	36.654	44.189	640
12:30	36.45	19.03	36.673	44.179	100
12:35	31.23	22.88	36.622	44.19	0
12:40	30.22	24.32	36.612	44.18	80
12:45	34.36	20.13	36.617	44.191	870
12:50	35.12	18.87	36.674	44.181	0
12:55	34.62	19.18	36.662	44.192	37

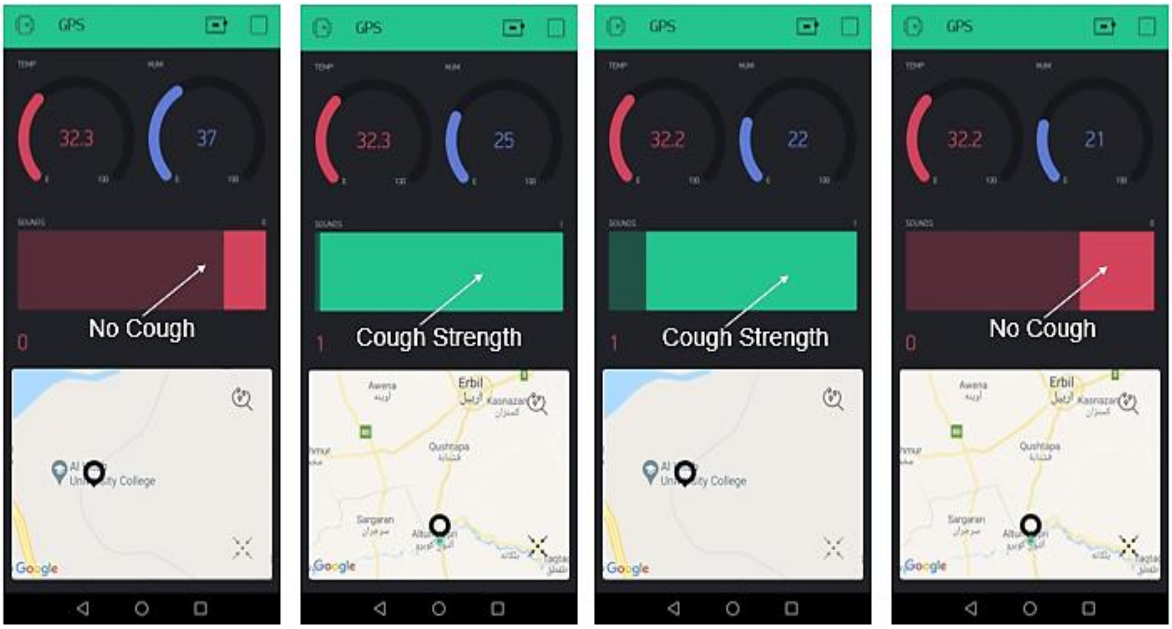


Figure 9. Blynk platform view for patient information monitoring

4. CONCLUSION AND FUTURE WORK

This research paper describes a low-cost, low-profile circuit design approach for tracking a patient's everyday activities. The patients infected with influenza or COVID-19 are identified remotely using this smart system. Furthermore, by alerting medical authorities via IoT communication methodologies, the proposed system assists these people in receiving medical care as soon as possible. It also acts as an early warning system for the identification of coronavirus or flu virus infections, knowing that a GPS module is utilized to track the movement of patients in order to pinpoint infected areas and assess the activities of suspected patients. It is worth mentioning that the proposed system is considered less complex and user-friendly since the design depended mainly on the NodeMCU microcontroller that employs the ESP8266 chip as a single package for Wi-Fi communication. As a suggestion for future work, IOS or Android application could be built for remotely monitoring. Finally, this idea might be a perfect application in medical facilities, quarantine units, airports, and other similar places.

REFERENCES

[1] K. Kumar, N. Kumar, and R. Shah, "Role of IoT to avoid spreading of COVID-19," *International Journal of Intelligent Networks*, vol. 1, pp. 32–35, 2020, doi: 10.1016/j.ijin.2020.05.002.

[2] Y. Dong and Y.-D. Yao, "IoT platform for COVID-19 prevention and control: a survey," *IEEE Access*, vol. 9, pp. 49929–49941, 2021, doi: 10.1109/ACCESS.2021.3068276.

[3] M. da C. Ribeiro-Dantas, G. Alves, R. B. Gomes, L. C. T. Bezerra, L. Lima, and I. Silva, "Dataset for country profile and mobility analysis in the assessment of COVID-19 pandemic," *Data in Brief*, vol. 31, Aug. 2020, doi: 10.1016/j.dib.2020.105698.

[4] C. C. Lai, T. P. Shih, W. C. Ko, H. J. Tang, and P. R. Hsueh, "Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges," *International Journal of Antimicrobial Agents*, vol. 55, no. 3, Mar. 2020, doi: 10.1016/j.ijantimicag.2020.105924.

[5] S. SushilSikchi, S. Sikchi, and M. S. Ali, "Fuzzy expert systems (FES) for medical diagnosis," *International Journal of Computer Applications*, vol. 63, no. 11, pp. 7–16, Feb. 2013, doi: 10.5120/10508-5466.

[6] B. M. Nema, Y. M. Mohialden, N. M. Hussien, and N. A. Hussein, "COVID-19 knowledge-based system for diagnosis in Iraq using IoT environment," *Indonesian Journal of Electrical Engineering and Computer Science (IJECE)*, vol. 21, no. 1, pp. 328–337, Jan. 2021, doi: 10.11591/ijeecs.v21.i1.pp328-337.

[7] WHO, "Coronavirus disease (COVID-19) weekly epidemiological update and weekly operational update," *World Health Organization*. 2019, Accessed: Jan. 10, 2022. [Online]. Available: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

[8] P. Judson, *Knowledge-based expert systems in chemistry: artificial intelligence in decision making*, 2nd ed. Royal Society of Chemistry, 2019.

[9] A. M. Sagir and S. Sathasivam, "A novel adaptive neuro fuzzy inference system based classification model for heart disease prediction," *Pertanika Journal of Science and Technology*, vol. 25, no. 1, pp. 43–56, 2017.

[10] D. Santra, S. K. Basu, J. K. Mandal, and S. Goswami, "Rough set based lattice structure for knowledge representation in medical expert systems: Low back pain management case study," *Expert Systems with Applications*, vol. 145, May 2020, doi: 10.1016/j.eswa.2019.113084.

[11] A. Badnjevic, L. Gurbeta, and E. Custovic, "An expert diagnostic system to automatically identify asthma and chronic obstructive pulmonary disease in clinical settings," *Scientific Reports*, vol. 8, no. 1, Dec. 2018, doi: 10.1038/s41598-018-30116-2.
[12] J. Guo, C. L. Radloff, S. E. Wawrzynski, and K. G. Cloyes, "Mining twitter to explore the emergence of COVID-19 symptoms," *Public Health Nursing*, vol. 37, no. 6, pp. 934–940, Nov. 2020, doi: 10.1111/phn.12809.
[13] K. Eyasu, W. Jimma, and T. Tadesse, "Developing a prototype knowledge-based system for diagnosis and treatment of diabetes using data mining techniques," *Ethiopian Journal of Health Sciences*, vol. 30, no. 1, pp. 115–124, Jan. 2020, doi: 10.4314/ejhs.v30i1.15.
[14] S. Maheshwari, R. R. Sharma, and M. Kumar, "LBP-based information assisted intelligent system for COVID-19 identification," *Computers in Biology and Medicine*, vol. 134, Jul. 2021, doi: 10.1016/j.compbiomed.2021.104453.
[15] M. Otoom, N. Otoum, M. A. Alzubaidi, Y. Etoom, and R. Banihani, "An IoT-based framework for early identification and monitoring of COVID-19 cases," *Biomedical Signal Processing and Control*, vol. 62, Sep. 2020, doi: 10.1016/j.bspc.2020.102149.
[16] M. Al-Shalabi, "COVID-19 symptoms monitoring mechanism using internet of things and wireless sensor networks," *International Journal of Computer Science and Network Security (IJCSNS)*, vol. 20, no. 8, 2020.
[17] S. I. Lakkis and M. Elshakankiri, "IoT based emergency and operational services in medical care systems," in *Internet of Things Business Models, Users, and Networks*, Nov. 2017, pp. 1–5, doi: 10.1109/CTTE.2017.8260983.
[18] D. Gupta, A. Parikh, and R. Swarnalatha, "Integrated healthcare monitoring device for obese adults using internet of things (IoT)," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 10, no. 2, pp. 1239–1247, Apr. 2020, doi: 10.11591/ijece.v10i2.pp1239-1247.
[19] M. Neyja, S. Mumtaz, K. M. S. Huq, S. A. Busari, J. Rodriguez, and Z. Zhou, "An IoT-based E-health monitoring system using ECG signal," in *Global Communications Conference*, Dec. 2017, pp. 1–6, doi: 10.1109/GLOCOM.2017.8255023.
[20] A. A. Ghaffar, S. M. Mostafa, A. Alsaleh, T. Sheltami, and E. M. Shakshuki, "Internet of things based multiple disease monitoring and health improvement system," *Journal of Ambient Intelligence and Humanized Computing*, vol. 11, no. 3, pp. 1021–1029, Mar. 2020, doi: 10.1007/s12652-019-01204-6.
[21] S. S. A. Naser and A. O. Mahdi, "A proposed expert system for foot diseases diagnosis," *Journal of Applied Sciences Research*, vol. 4, no. 12, pp. 160–173, 2016.
[22] A. Mrouf, I. Albatish, M. Mosa, and S. S. Abu Naser, "Knowledge based system for long-term Abdominal pain (stomach pain) diagnosis and treatment," *International Journal of Engineering and Information Systems*, vol. 1, no. 4, pp. 71–88, 2017.
[23] A. Skraba, A. Kolozvari, D. Kofjac, R. Stojanovic, V. Stanovov, and E. Semenkin, "Prototype of group heart rate monitoring with NODEMCU ESP8266," in *6th Mediterranean Conference on Embedded Computing (MECO)*, Jun. 2017, pp. 1–4, doi: 10.1109/MECO.2017.7977151.
[24] S. Mahmood, S. Alani, F. Hasan, and M. Mustafa, "ESP 8266 node MCU based weather monitoring syste," *Proceedings of the Proceedings of the 1st International Multi-Disciplinary Conference Theme: Sustainable Development and Smart Planning*, 2020, doi: 10.4108/eai.28-6-2020.2298609.
[25] A. Ismaeel, O. Rafat, and S. Mahmood, "IoT technology based smart systems control methodology using Net Pi network platform," *Proceedings of the Proceedings of the 1st International Multi-Disciplinary Conference Theme: Sustainable Development and Smart Planning*, 2020, doi: 10.4108/eai.28-6-2020.2297945.
[26] D. Abdulahad, "Design of smart house system based on webserver architecture control," *International Journal of Computer Applications*, vol. 181, no. 8, pp. 43–49, Aug. 2018, doi: 10.5120/ijca2018917624.
[27] S. Nozad, M. Forat, and F. Hasan, "Design of weather monitoring system using Arduino based database implementation," *Journal of Multidisciplinary Engineering Science and Technology (JMEST)*, vol. 4, no. 4, pp. 2458–9403, 2017.
[28] S. Alani, S. N. Mahmood, S. Z. Attaallah, H. S. Mhmood, Z. A. Khudhur, and A. A. Dhannoon, "IoT based implemented comparison analysis of two well-known network platforms for smart home automation," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 11, no. 1, pp. 442–450, Feb. 2021, doi: 10.11591/ijece.v11i1.pp442-450.
[29] C. Harrold, *Practical smart device design and construction*. Berkeley, CA: Apress, 2020.
[30] D. Satria, S. Yana, R. Munadi, and S. Syahreza, "Prototype of google maps-based flood monitoring system using Arduino and GSM module," *International Research Journal of Engineering and Technology*, vol. 4, no. 10, pp. 1044–1047, 2017.
[31] R. Kim, T. Nagayama, H. Jo, and B. F. Spencer Jr., "Preliminary study of low-cost GPS receivers for time synchronization of wireless sensors," in *Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2012*, Apr. 2012, vol. 8345, doi: 10.1117/12.915394.
[32] D. Aziz, S. Algburi, S. Alani, and S. Mahmood, "Design and implementation of GPS based quadcopter control system," *1st International Multi-Disciplinary Conference Theme: Sustainable Development and Smart Planning*, 2020, doi: 10.4108/eai.28-6-2020.2297931.
[33] D. A. Aziz, R. Asgarnezhad, and S. N. Mahmood, "The recent advances in IoT based smart plant irrigation systems: a brief review," in *5th International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)*, Oct. 2021, pp. 97–104, doi: 10.1109/ISMSIT52890.2021.9604699.

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