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Implementation of smoke detector system in household kitchen based on HTTP protocol with DHT22 and MQ135 sensor integrated with WhatsApp chatbot

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ABSTRACT

This research develops an Internet of Things (IoT)-based smoke detection system using MQ135 and DHT22 sensors integrated with WhatsApp chatbot via HTTP protocol. The system is designed to provide real-time notifications related to air quality, including gas concentration, temperature, and humidity. The test results show accurate and stable sensor performance in detecting environmental parameters. Evaluation is done through Quality of Service (QoS) analysis based on delay, jitter, packet loss, and throughput parameters. The test shows a fairly high network stability with 0% packet loss and an average throughput of 2045.53 Kbps, which falls into the Excellent and Good categories. However, the average delay of 2173.65 ms and jitter of 254.11 ms were classified as Poor, indicating the need for improvement in the responsiveness aspect. This research is expected to contribute to the integration of air quality monitoring systems with practical and easily accessible instant messaging services. The system offers an innovative solution for real-time smoke detection and early warning. Limitations of this study include limited data size and room for improvement in the interpretability and scalability of the system for wider IoT implementation.

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Introduction

The development of Internet of Things (IoT) technology has opened opportunities for many fields, including environmental monitoring such as air quality. IoT was originally an idea used for improvements in the business processes of the manufacturing industry, where this technology can be connected to the internet (Sari et al., 2024). Along with the development that occurs in IoT, it makes a wide application of human needs, including air quality. Poor air quality is one of the most serious global problems, so monitoring and early warning are needed to prevent and mitigate bad things that happen(Dimitroulopoulou et al., 2023).

In its application, IoT technology cannot stand alone. IoT technology requires a channel or bridge that can help it connect to the internet network, or often called a protocol that allows smooth communication (Elhadi et al., 2022). One of the protocols that can be used is HTTP, this protocol is a basic

protocol for data exchange on the internet which is basically a request-response method, which means that the client sends a request to the server, and then the server will respond to the data requested by the client(Muraleedharan & Janet, 2021),(Safitrah et al., 2024).
In previous studies such as research from Dimas, Bagus, Saputra, Rahmi, Nur, Hidayati, Suhardi, Suhard entitled "Early Detection and Automatic Fire Extinguishing System at Home Based on IoT Using NodeMCU ESP32" (Saputra, D. B., Hidayati, R., & Suhardi, 2024) discusses the creation of early fire detectors and automatic extinguishers that monitor gas flames and temperature. Research with the title "Design of smoke detector based on mq-135 sensor and esp32 microcontroller as early fire detection" prepared by Satria, Dhimas, Ghoza, Ulinnuha, Latifa, Insani, Abdi, Nation (Dhimas Ghoza et al., 2024). Discusses the development of an IoT-based smoke detector for fire detection which aims to increase safety and minimize the risk of fire. In addition, real-time smoke, temperature and humidity monitoring features using the blynk application and instant message notifications via WhatsApp add to the efficiency of rapid-fire prevention responses.

Furthermore, research from Soon-Jae, Kweon, Jeong-Ho, Park, Chong-Ook, Park, Hyung, Joun, Yoo, Sohmyung, Ha entitled "Wireless Kitchen Fire Prevention System Using Electrochemical Carbon Dioxide Gas Sensor for Smart Home" (Kweon et al., 2022). The paper contains a discussion of a fire prevention system in the kitchen that utilizes electrochemical CO2 sensors for monitoring the use of gas stoves to warn users of the risk of fire.

However, these studies do not discuss the use of the HTTP protocol as a link between IoT devices. In fact, the role of the protocol is quite important to facilitate efficient, reliable, and secure data exchange between devices(Jadhav, 2024). The HTTP protocol allows data from IoT devices to be sent to a server for processing, but the delivery of data to users requires an interactive interface that can receive notifications directly. One solution is integration with WhatsApp chatbot. Although various studies have been conducted, there are still few that explicitly explore the concrete implementation of HTTP-WhatsApp integration for real-time air quality notification. This approach has great potential in improving the effectiveness of environmental data communication through fast, responsive, and easily accessible alerts. This gap is the main focus of this research to present an IoT-based system that has not been widely explored in optimizing air quality monitoring.

WhatsApp is a fairly popular application that is often used with data on 2 billion monthly active users (Social, n.d.). This application is not only for individual users, but can be used for business users, government and chatbots (Sammir et al., 2023). WhatsApp chatbot can be utilized as a sender of alert messages to the intended user(S et al., 2023). The integration of the HTTP protocol with WhatsApp in sending alert messages from IoT devices certainly provides an innovation in the utilization of IoT technology. This system can be an effective solution in providing early warnings and helping everyone to mitigate the adverse effects of poor air quality. In addition, this research can also be a reference for IoT research integrated with other popular messaging platforms.

Research Method

The research stages that will be carried out in this study can be seen in Figure 1. The picture is an explanation of the stages that will be done.

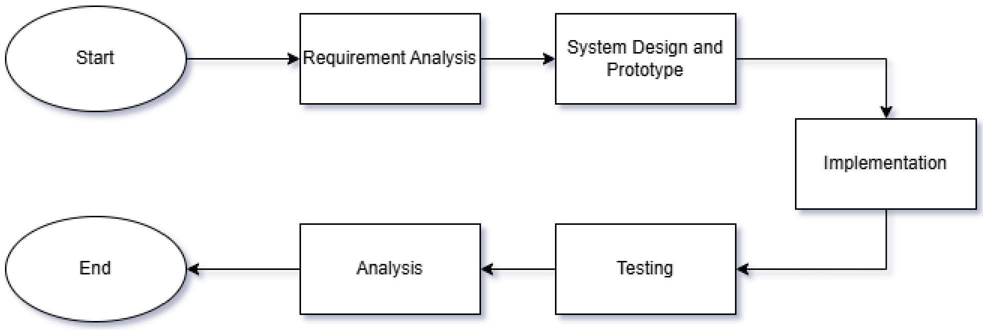

Figure 1 explanation of the stages

This research adopts a hardware engineering approach based on prototyping, supported by experimental testing and quantitative analysis. The system is built through prototype development using sensors and microcontrollers, followed by implementation and evaluation. In the final stage, system performance was assessed using quantitative Quality of Service (QoS) measurements, with parameters such as delay, jitter, packet loss, and throughput. This combination of prototyping and QoS evaluation ensures functional validation and system performance.

2.1 Requirements Analysis

The first stage is to analyze what is needed in the development of this research. These needs include anything that needs to exist before the implementation stage. The needs that are needed include:

1. ESP32 microcontroller
   The ESP32 microcontroller was chosen because in addition to its low cost, it also has many additional features such as adequate connectivity, low power and ease of use making it suitable for integration into various IoT platforms(Sineglazov & Khotsyanovsky, 2022).
2. MQ135 Sensor
   It is a sensor that is often used for air quality monitoring. This sensor can be used to detect various types of gases such as ammonia (NH_3), carbon dioxide (CO_2), and nitrogen dioxide (NO_2)(Rizal Tabriez Tsaqiefudin et al., 2024).
3. DHT22 Sensor
   Sensors that are used as efficient temperature and humidity gauges due to their low tolerance of reading errors(Mubarak et al., 2022).
4. WhatsApp Chatbot
   WhatsApp chatbot is an automated messaging system that emerged as an ideal solution that can be used in various sectors(Ramaditiya et al., 2021).
5. Schematic design of the system
   The system scheme in question is how this system will work, run and operate later to meet the objectives to be achieved.
6. Prototype Design
   The prototype design here is the creation of a schematic description of the hardware that will be made later, so that it has an initial picture of how the existing sensor and microcontroller equipment will be implemented later.

2.2 System Design and Prototype

System design is a stage that focuses on how the system will be made. This design includes making a scheme of how this system will run later(Nistrina & Lestari, 2024). In this case, it means how this system can work and send warning notification data to the WhatsApp chatbot when the smoke detector has read a value that exceeds the specified limit. The system design scheme that will be made is depicted in Figure 2:

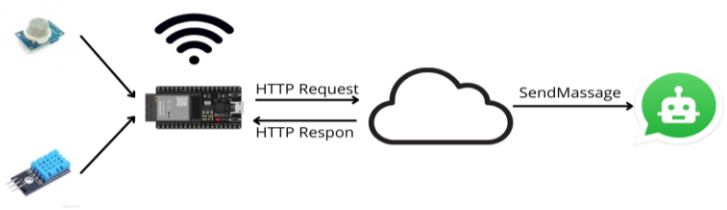

Figure 2 system design scheme

In addition, at this stage the hardware prototype scheme to be developed is also being made. This aims to facilitate the implementation that will be carried out at a later stage. prototype itself is a scheme made to support a research or experiment and evaluate the objectives of the research (Lee, 2020). The prototype that will be made in this study will follow the scheme from Figure 3:

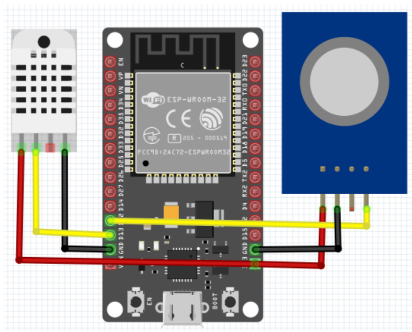

Figure 3 scheme prototype

The scheme is a reference in making a smoke detector prototype from the MQ135 sensor, DHT22 sensor and ESP32 microcontroller.

2.3 Implementation

The implementation phase realizes the main focus of the system design and prototype(Ramírez-zelaya et al., 2023). Based on the scheme, the smoke detector will read the data from the sensors, and when it reaches a certain threshold, the microcontroller sends the data via HTTP protocol to the WhatsApp chatbot. In the prototype, the DHT22 sensor data pin is connected to pin D13, and the MQ135 to pin D12 on the ESP32 microcontroller. All sensors are assembled and connected to the ESP32 using solder. After that, the DHT22 and MQ135 sensors were configured to be read by the ESP32 through the Arduino IDE software, which was developed to program the Arduino board using the C and C++ languages (Hwang et al., 2024). In addition to sensor readings, the configuration also includes threshold settings for sending alert messages from the ESP32 to the WhatsApp chatbot using the HTTP protocol.

2.4 Testing

The testing stage is a stage to evaluate the performance of the system as a whole whether the system works as expected or not. In addition, the testing stage will also use the QoS (Quality of Service) method which is a method that helps in measuring the performance of a network so as to ensure an efficient communication (Anom et al., 2024). The QoS method consists of parameters that will be measured based on(Simargolang & Widarma, 2022)(Dyan Ramadhan & Iskandar, 2023):

a. Delay/Latency
   The time it takes for data to reach its destination.
b. Packet Loss
   A parameter that indicates the number or total number of packets lost in transmission.
c. Throughput
   Is the total number of packets that successfully arrive at the destination.

d. Jitter
Shows the level of variation in the delay of data in a network.

2.5 Analysis

The analysis is carried out to determine the quality of the system obtained based on data taken from the QoS method. After data from the QoS method is collected, the data will be analyzed to determine its quality based on existing parameters using the TIPHON standard. The parameter sizes of the analysis that will be carried out are as follows (Basri & Yuliadi, 2023)(Hasbi & Saputra, 2021):

a. Delay/Latency

Table 1 Index delay/latency

Category	Delay Rate	Index
Very good	< 150 ms	4
Good	150 s/d 300 ms	3
Medium	300 s/d 450 ms	2
Bad	>450 ms	1

The delay can be known with the following formula:

$$Delay = \frac{Total\ \ Delay}{Total\ Packets\ Received} \text{...}(1)$$

b. Packet Loss

Table 2 Index packet loss

Category	Packet Loss	Index
Very good	0%	4
Good	3%	3
Medium	15%	2
Bad	25 %	1

We can know the amount of packet loss in a network with the following formula:

$$Packet\ Loss = (\frac{data\ send\ -packet\ data\ send}{Packet\ data\ received}) x100\% \text{ ....}(2)$$

c. Throughput

Table 3 Index throughput

Category	Throughput rate	Index
Very good	>2100 kbps	4
Good	1201-2100 kbps	3
Medium	701 – 1200 kbps	2
Bad	338 – 700 kbps	1
Very bad	0 – 337 kbps	0

To find out the value of a Throughput, the following formula can be used:

$$Throghput = \frac{Total\ data\ sent}{Data\ send\ time} \text{ ....}(3)$$

d. Jitter

Table 4 Index jitter

Category	Throughput rate	Index
Very good	0 ms	4
Good	1-74 ms	3

Medium	75-124 ms	2
Bad	>125 ms	1

In knowing the total amount of jitter can be known by the following formula:

$$Jitter = \frac{Total\ \ Delay}{Total\ Packets\ Received} \quad \ldots\ldots(4)$$

Meanwhile, to find out the amount or total variance of a delay can be calculated by the following formula:

$$Total\ Varians\ Delay\ = (Delay\ 2 - Delay\ 1) + \ldots + (Delay\ n - Delay(n-1)) \quad \ldots\ldots(5)$$

The TIPHON standard or Telecommunications and Internet Protocol Harmonization Over Network, is a standard created by the ESTI institute which then divides QoS levels into very good, good, medium, bad and very bad(Aziza et al., 2023). The value or percentage of QoS according to TIPHON is as follows(Chen et al., 2023):

Table 5 Index percentage QoS

Category	Persentase %	Index
Very good	95 – 100	3.8-4
Good	75 – 94	3-3.7
Medium	50 – 74	2-2.9
Bad	25 – 49	1-1.9
Very bad	0 - 24	0-0.9

Results and Discussions

3.1 Sensor Testing

The test was carried out in the kitchen area close to the stove with a test time of 1 hour. In this test, 2 sensors were used, namely the MQ135 sensor and the DHT22 sensor.

3.1.1 MQ135 sensor testing

The sensor test on the MQ135 runs well where the sensor reading delay is set for 1 minute before the next reading. The test data can be seen in Figure 4 :

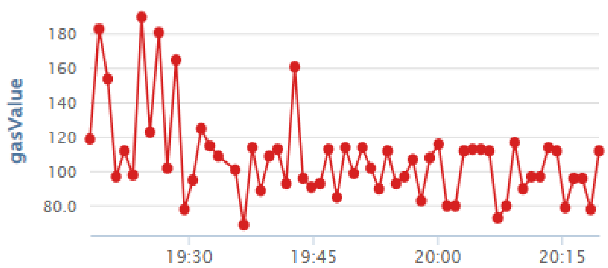

Figure 4 MQ135 sensor test result data

The image displays the gas value read by the Mq135 sensor. in the reading, the average reading is obtained at 107.6 with a total of 60 data and ppm reading units. In the test, the highest gas value was obtained at 190 ppm and the lowest at 69 ppm.

3.1.2 DHT22 sensor testing

The DHT22 sensor measures the temperature and humidity in the kitchen area. The DHT22 sensor used can measure temperature and humidity well with the duration of each measurement session, which is 1 minute. The measured temperature data is shown in Figure 5:

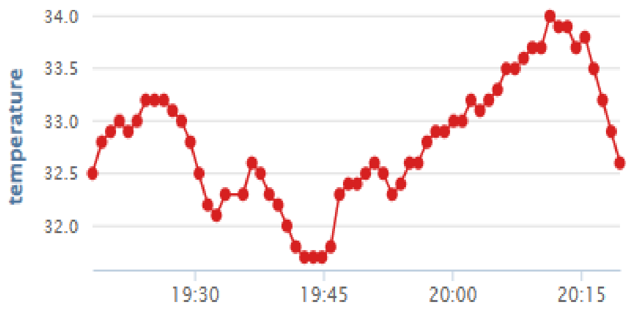

Figure 5 Temperature test result data DHT22 sensor

In the measurement for temperature, the reading data is obtained with an average temperature of 33°C with units of degrees Celsius with the highest temperature at 34°C and the lowest at 32 °C. Furthermore, the humidity measurement can be seen in Figure 6:

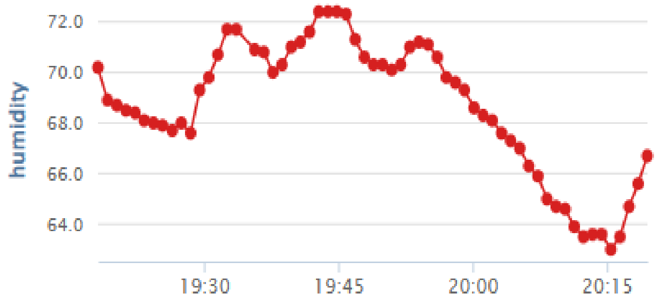

Figure 6 test result data Humidity DHT22 sensor

The humidity measurement obtained an average reading of 68.54 with units of %. The highest humidity was 72.4% and the lowest was 63%.

3.2 HTTP Protocol Testing

In the testing phase, the program is set up so that it can send alert messages to the WhatsApp chatbot via the HTTP protocol. The testing process was carried out 10 times when sending messages with the aim of measuring service quality using the QoS (Quality of Service) method.

3.2.1 Delay/Latency

Delay or Latency is a unit of time required for a message to reach the recipient after being sent by the sender. In this case, Delay is measured to determine the time it takes for the message to reach the WhatsApp chatbot from the iot device. The data results from the tests that have been carried out can be seen from the following table:

Table 6 Dellay testing data

Testing	Delay (ms)	Testing	Delay (ms)
1	2284,00	6	2144,33
2	2096,50	7	2255,14
3	2032,67	8	2208,00
4	2128,50	9	2220,22
5	2182,20	10	2184,90

The average delay of the 10 tests that have been carried out is 2173.65 (ms). The lowest delay in the test was 2032.67 (ms) in the 3rd test and the highest delay was 2284.00 (ms) in the 1st test.

3.2.2 Packet Loss

Packet loss calculates the number of data packets that are lost or do not reach their destination during transmission from sender to receiver. Testing was carried out 10 times to evaluate the stability of the network in sending messages, the results of packet loss testing are obtained in the following table

Table 7 Packet loss testing data

Testing	Packet Loss (%)	Testing	Packet Loss
1	0,00	6	0,00
2	0,00	7	0,00
3	0,00	8	0,00
4	0,00	9	0,00
5	0,00	10	0,00

From the 10 tests that have been carried out, the packet loss rate reached 0% in all tests, which identifies that there is no packet loss detected during message delivery.

3.2.3 Throughput

Throughput refers to the amount of data successfully sent in a certain unit of time which in this test is measured in kilobits per second (Kbps). The throughput calculation results obtained from testing for 10 times are presented in the following table:

Table 8 Throughput testing data

Testing	Throughput	Testing	Throughput
1	3112,00	6	1953,60
2	2069,33	7	1776,62
3	2326,00	8	1904,00
4	1773,71	9	1888,50
5	1775,11	10	1888,5

From the data, it is known that the average throughput is 2045.53 Kbps. The smallest throughput was recorded in the 4th test with a value of 1773.71 Kbps, while the largest throughput occurred in the 1st test with a throughput value of 3112.00 Kbps.

3.2.4 Jitter

Jitter is a variation in data delivery delay between packets during transmission. This parameter is important to evaluate the consistency of data delivery time. The jitter results obtained from 10 trials are presented in the following table:

Table 9 Jitter testing data

Testing	Jitter	Testing	Jitter
1	0,00	6	225,17
2	187,50	7	330,86
3	126,66	8	419,75
4	222,50	9	422,00
5	181,80	10	424,90

Based on the results of 10 tests, the average jitter is 254.11 ms. The smallest jitter was recorded in the 1st test with a value of 0.00 ms, while the largest jitter occurred in the 10th test with a value of 424.90 ms.

3.3 Data Delivery Result

The test results show that sending data via the HTTP protocol to the WhatsApp chatbot was successful. This can be proven by the output in the form of a message received on the WhatsApp application which can be seen in Figure 7:

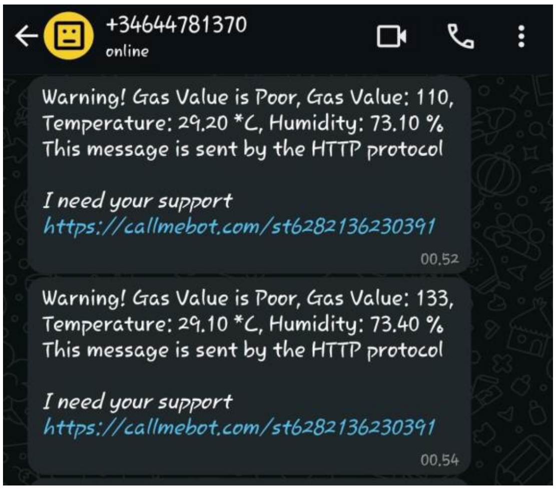

Figure 7 Whatsapp chatbot notification

The results of testing 10 times carried out with the scenario gas value poor at 100, and gas value danger 150 get good results with an indication where each message is successfully received and sent to the WhatsApp chatbot.

Discussion

Sensor Performance and Reading Accuracy

In testing the performance of the MQ135 sensor, the results show the sensor's ability to detect gas concentrations with an average reading of 107.6 ppm for 60 measurements, with the highest value of 190 ppm and the lowest value of 69 ppm. This indicates that the MQ135 sensor can provide consistent measurement results in a kitchen environment. The DHT22 sensor, which is used to measure temperature and humidity, recorded an average temperature of 33°C with a measurement range between 32°C and 34°C. For humidity, the average reading was 68.54% with the lowest value being 63% and the highest being 72.4%. These results prove that the DHT22 sensor works well for monitoring environmental conditions. Both sensors showed suitable accuracy for this IoT-based smoke detection application, although it should be noted that the measurement results can be affected by environmental conditions such as air ventilation and activity in the kitchen.

Quality of Service (QoS) Analysis

QoS testing is performed to evaluate the quality of network services used in the system. Some of the parameters analyzed are:

Table 10 QoS analysis

No	Parameters	Analysis Results
1.	Delay/Latency	The test results show an average delay of 2173.65 ms with the lowest delay of 2032.67 ms and the highest of 2284.00 ms. Based on TIPHON standards, the index obtained based on the average is 1 this value is included in the bad category. This shows that data transmission performance still needs to be improved to meet better quality standards.
2.	Packet Loss	No packet loss was found (0%) in all tests. This indicates that the network used is very stable and reliable in data transmission.
3.	Throughput	The average throughput was 2045.53 Kbps, with a high of 3112.00 Kbps and a low of 1773.71 Kbps. Based on the TIPHON classification, this throughput is in the good category with an average index of 3.19. The system can send data with good efficiency.
4.	Jitter	The average jitter is 254.11 ms, with the smallest value of 0 ms and the largest value of 424.90 s. Based on TIPHON standards this jitter falls into the Bad category with an average Index of only 1.2. Although high jitter values can affect the consistency of data delivery times, these results do not directly affect the success of the system in sending notifications.

The QoS analysis results show that the system has adequate network performance to support data transmission in a stable and efficient manner. However, the delay and jitter aspects require improvement to ensure more optimal responsiveness and consistency of delivery time. Overall, the system can perform its function well in supporting IoT applications.

Compared to Dhimas Ghoza et al. (2024) who used the Blynk platform for environmental monitoring notifications, this study offers a more open and controlled integration through HTTP protocol and WhatsApp chatbot. Although the real-time alert system was successfully implemented, the study did not include an in-depth QoS evaluation, especially regarding delay, jitter, and throughput. Similarly, the study by Kweon et al. (2022) focused on fire prevention, but did not discuss the efficiency of communication protocols. This research involves TIPHON-based QoS testing that provides a quantitative evaluation of network performance, as well as identifying areas for improvement such as delay and jitter. Thus, the system is not only functionally innovative, but also has the advantage of measurable technical evaluation.

Conclusions

This research successfully developed an IoT-based smoke detection system using MQ135 and DHT22 sensors integrated with WhatsApp chatbot via HTTP protocol. The test results show that the MQ135 and DHT22 sensors provide accurate and stable performance in detecting gas concentration, temperature, and humidity. Quality of Service (QoS) analysis shows that the network used has high stability with 0% packet loss and an average throughput of 2045.53 Kbps which falls into the Very Good and Good categories, although the average delay of 2173.65 ms and Jitter of 254.11 ms are in the Bad category requiring improvement to increase responsiveness. Overall, this system can provide an effective solution in detecting smoke and providing real-time notifications, with the potential for further development to improve network performance. Scientifically, this research contributes to the development of an IoT-based air quality monitoring system through the integration of HTTP protocol and WhatsApp chatbot and is equipped with QoS analysis based on TIPHON standards. Practically, this system can be applied in household kitchens or public facilities as an early warning mechanism. In the future, development can be directed towards automatic threshold adjustment, expansion of sensor nodes, and optimization of network protocols to improve the speed and consistency of notification delivery.

References

Anom, H., Aji, S., & Prasetyo, A. C. (2024). *Evaluasi Kinerja Jaringan WiFi Mahasiswa : Analisis Throughput , Delay , Jitter , dan Packet loss*. *8*(1), 23–27.

Aziza, R. N., Jaya Adilman, Djunaidi, K., Sudirman, M. Y. D., & Yusra, M. D. (2023). COMPARATIVE STUDY OF CLOUD COMPUTING NETWORK SERVICES BASED ON QoS ANALYSIS USING TIPHON STANDARD. *Jurnal Teknik Informatika (Jutif)*, *4*(5), 1201–1209. https://doi.org/10.52436/1.jutif.2023.4.5.1411

Basri, A., & Yuliadi, B. (2023). Wireless Network Bandwidth Quality Measurement Using Qos Standard Tiphon. *PIKSEL : Penelitian Ilmu Komputer Sistem Embedded and Logic*, *11*(2), 283–292. https://doi.org/10.33558/piksel.v11i2.7109

Chen, J., Mao, C., & Song, W. W. (2023). QoS prediction for web services in cloud environments based on swarm intelligence search. *Knowledge-Based Systems*, *259*, 110081. https://doi.org/https://doi.org/10.1016/j.knosys.2022.110081

Dhimas Ghoza, S., Latifa, U., & Abdi Bangsa, I. (2024). Perancangan Smoke Detector Berbasis Sensor Mq-135 Dan Mikrokontroler Esp32 Sebagai Deteksi Dini Kebakaran. *JATI (Jurnal Mahasiswa Teknik Informatika)*, *8*(3), 4344–4350. https://doi.org/10.36040/jati.v8i3.9881

Dimitroulopoulou, S., Dudzińska, M. R., Gunnarsen, L., Hägerhed, L., Maula, H., Singh, R., Toyinbo, O., & Haverinen-Shaughnessy, U. (2023). Indoor air quality guidelines from across the world: An appraisal considering energy saving, health, productivity, and comfort. *Environment*

International, *178*(July). https://doi.org/10.1016/j.envint.2023.108127

Dyan Ramadhan, A., & Iskandar, I. (2023). Evaluasi Peforma Jaringan Internet Menggunakan Metode QoS. *Klik: Kajian Ilmiah Informatika Dan Komputer*, *3*(6), 996–1004. https://doi.org/10.30865/klik.v3i6.892

Elhadi, S., Chhiba, L., Sael, N., & Marzak, A. (2022). Guide to choosing internet of things protocols. *Indonesian Journal of Electrical Engineering and Computer Science*, *27*(3), 1557–1565. https://doi.org/10.11591/ijeecs.v27.i3.pp1567-1575

Hasbi, M., & Saputra, N. R. (2021). Analisis Quality of Service (Qos) Jaringan Internet Kantor Pusat King Bukopin Dengan Menggunakan Wireshark. *Universitas Muhammadiyah Jakarta*, *12*(1), 1–7. https://jurnal.umj.ac.id/index.php/just-it/article/view/13596

Hwang, I., Kong, T., & Park, J. (2024). Graphical Arduino IDE system with wiring layout and flowchart functions for physical computing education. *Computer Applications in Engineering Education*, *32*. https://doi.org/10.1002/cae.22783

Jadhav, A. M. (2024). Communication Protocols for IoT Applications. *International Journal for Research in Applied Science and Engineering Technology*, *12*(4), 5875–5877. https://doi.org/10.22214/ijraset.2024.61338

Kweon, S. J., Park, J. H., Park, C. O., Yoo, H. J., & Ha, S. (2022). Wireless Kitchen Fire Prevention System Using Electrochemical Carbon Dioxide Gas Sensor for Smart Home. *Sensors*, *22*(11), 1–16. https://doi.org/10.3390/s22113965

Lee, B. Y. H. (2020). Prototyping: The Dual Actions. *Prototyping: The Dual Actions*. https://doi.org/10.31182/cubic.2020.3.024

Mubarak, H., Rizal, M., Iqbal, I., Waris, A., Tahir Sapsal, M., & Suelfikhar, I. (2022). Design of a Greenhouse Room Temperature and Humidity Control System Using a DHT 22 Sensor. *Jurnal Agritechno*, *15*(02), 160–165. https://doi.org/10.20956/at.vi.943

Muraleedharan, N., & Janet, B. (2021). A deep learning based HTTP slow DoS classification approach using flow data. *ICT Express*, *7*(2), 210–214. https://doi.org/10.1016/j.icte.2020.08.005

Nistrina, K., & Lestari, T. A. (2024). Desain Inovatif Sistem Informasi Profil Hotel Damanaka Pangalengan Berbasis Website Menggunakan UML dan Figma. *JurnalSistemInformasi, J-SIKA*, *6*, 8–17.

Ramaditiya, A., Rahmatia, S., Munawar, A., & Samijayani, O. N. (2021). Implementation chatbot whatsapp using python programming for broadcast and reply message automatically. *Proceeding - 2021 International Symposium on Electronics and Smart Devices: Intelligent Systems for Present and Future Challenges, ISESD 2021*, 0–3. https://doi.org/10.1109/ISESD53023.2021.9501523

Ramírez-zelaya, J., Rosado, B., Jiménez, V., Gárate, J., Peci, L. M., Gil, A. De, Pérez-peña, A., & Berrocoso, M. (2023). *Design and Implementation of a Prototype Seismogeodetic System for Tectonic Monitoring*. 1–22.

Rizal Tabriez Tsaqiefudin, Edi Kurniawan, & Diana Alia. (2024). Perancangan Sistem Pendeteksi Polusi Udara Di Dalam Kamar Mesin Secara Wireless Menggunakan Sensor MQ135 Dan TGS2106 Berbasis Lora Ra-02. *Jurnal Kendali Teknik Dan Sains*, *2*(3), 34–49. https://doi.org/10.59581/jkts-widyakarya.v2i3.3250

S, P., Balakrishnan, N., T R, K., B, A. J., & S, D. (2023). Design and Development of AI-Powered Healthcare WhatsApp Chatbot. *2023 2nd International Conference on Vision Towards Emerging Trends in Communication and Networking Technologies (ViTECoN)*, 1–6. https://doi.org/10.1109/ViTECoN58111.2023.10157423

Safitrah, T., Sinaga, A. B. G., Alghifari, M., & Neyman, S. N. (2024). Pengaruh Serangan Slow HTTP DoS terhadap Layanan Web: Studi Eksperimental dengan Slowhttptest. *Journal of Technology and System Information*, *1*(4), 11. https://doi.org/10.47134/jtsi.v1i4.2663

Sammir, H., Hamdi, K., & Harto, B. (2023). Whatsapp Chatbot Autoresponder Berbasis Pencarian Artikel. *Prosiding Seminar Nasional Sistem Informasi Dan Teknologi (SISFOTEK)*, 254–258.

Saputra, D. B., Hidayati, R., & Suhardi, S. (2024). Sistem Deteksi Dini dan Pemadaman Kebakaran Otomatis di Rumah Berbasis IoT Menggunakan NodeMCU ESP32. *Sistem Deteksi Dini Dan Pemadaman Kebakaran Otomatis Di Rumah Berbasis IoT Menggunakan NodeMCU ESP32*, *5*, 581–589.

Sari, I. P., Novita, A., Al-Khowarizmi, A.-K., Ramadhani, F., & Satria, A. (2024). Pemanfaatan Internet of

Things (IoT) pada Bidang Pertanian Menggunakan Arduino UnoR3. *Blend Sains Jurnal Teknik*, *2*(4), 337–343. https://doi.org/10.56211/blendsains.v2i4.505

Simargolang, M. Y., & Widarma, A. (2022). Quality of Service (QoS) for Network Performance Analysis Wireless Area Network (WLAN). *CESS (Journal of Computer Engineering, System and Science)*, *7*(1), 162. https://doi.org/10.24114/cess.v7i1.29758

Sineglazov, V., & Khotsyanovsky, V. (2022). Camera Image Processing on ESP32 Microcontroller with Help of Convolutional Neural Network. *Electronics and Control Systems*, *2*(72), 26–31. https://doi.org/10.18372/1990-5548.72.16939

Social, H. add W. A. (n.d.). *GLOBAL SOCIAL MEDIA STATISTICS*. Datareportal.Com. https://datareportal.com/social-media-users