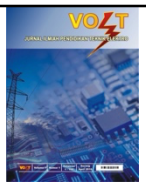
P-ISSN: 2528-5688
E-ISSN: 2528-5696

VOLT

Jurnal Ilmiah Pendidikan Teknik Elektro

Journal homepage: jurnal.untirta.ac.id/index.php/VOLT

Vol. 8, No. 1, April 2023, 1-10



Design a cake scraper tool based on the Internet of Things for the home industry

Mutiara Adinda Wijaya[1]*, Ahmad Taqwa [1], A. Adewasti[1]

[1]Department of Electrical Engineering, Politeknik Negeri Sriwijaya, Palembang 30137, Indonesia
*Corresponding author: mutiaraadinda1056@gmail.com

Received: 1 March 2023. Revised: 1 April 2023. Accepted: 5 April 2023. Available online: 8 April 2023
https://doi.org/10.30870/volt.v8i1.21484

Abstract

Scraper cake tools based on the Internet of Things (IoT) are designed to improve efficiency and control in the cake production process. The use of IoT technology in scraper cake tools is projected to give further benefits in terms of operational data collecting, real-time analysis, and remote control. The MIT application, which can be accessed via an Android-based smartphone, is used to control the Scraper cake tool. This Cake Scraper tool uses a dc motor as a machine rotating drive, making the cake cream smoothing operation easier and more efficient. Users interact with the program by modifying the motor speed as well as the x and y axis sides. The results demonstrated that an IoT-based cake scraper equipment improves cake production efficiency by decreasing human error and increasing consistency in flattening cake cream. The implementation of IoT technology in scraper cake tools also improves the collection of operational data for advanced analysis, production planning, and preventive maintenance.

Keywords: Cake Scraper Tools; efficiency; Internet of Things; MIT; Adafruit;

INTRODUCTION

The implementation of Internet of Things (IoT) technology in diverse sectors has resulted in a substantial revolution in the operational and managerial aspects of systems (Danuri, 2019). The utilization of IoT in the food industry, particularly in baking, holds significant potential for enhancing production efficiency, control, and quality. An essential element in the cake making process is the utilization of a cake scraper tool, which serves the purpose of leveling the cake cream. The Internet of Things is an auspicious scientific

advancement that aims to enhance living by utilizing intelligent sensors and equipment that collaborate via the internet network. (Cahyono, 2016) (Lu, 2017), (Moreno et al., 2014).

IoT is a network that facilitates the collection, analysis, and transmission of digital data acquired from various sensor devices, including RFID, infrared sensors, GPS, scanners, and smart meters (Mayer & Schneegass, 2017). The purpose of sensors in IoT networks is to detect and identify the characteristics of equipment using both wired and wireless communication networks. This allows them to gather precise data and control operations in real time (Hidayatullah & Juliando, 2017).

The objective of this study is to create a cake scraper tool using IoT technology, which incorporates intelligent sensors, internet connectivity, and artificial intelligence. The purpose is to enhance efficiency and control in the cake production process. The IoT-enabled cake scraping tool is anticipated to surmount multiple challenges encountered by traditional instruments and offer a range of supplementary advantages (Mellado & Núñez, 2021), (Nema et al., 2021), (Qurat-Ul-Ain et al., 2018).

With the rise in production and technology, there is a demand for diverse technological solutions that can enhance manufacturing operations and streamline the sales process. The technology has the capacity to alleviate the workload of merchants and accelerate the sales process. Currently, there are still numerous cake merchants who rely on conventional labor for their baking operations, particularly in the cake-making process.

Hence, it is imperative to develop an automated cake scraper manufacturing device to facilitate the operations of sellers in their trade. This device is outfitted with an ESP 32 MCU Node microcontroller functioning as an automated controller. Relay functions as a tool controller in conjunction with the Motor Driver.

METHOD

The materials specified for this tool include: The DC voltage provided by the needed adaptor is 12 and 5 volts. The voltage supplied by the Arduino is 5 volts. Employing two stepper motors to control the vertical and horizontal side bars. Utilizing the L298N motor driver as a motor controller. Utilizing a direct current motor. Utilizing the NodeMCU 32 microcontroller. The output displayed to the user utilizes a liquid crystal display (LCD) with dimensions of 16x2 (Siswandi, 2017).

The cake scraper tool is composed of many components, namely: Arduino, DC motor driver, NodeMCU ESP 32, power supply, stepdown transformer 5A, LED, switch, motor driver (L298N), LCD, jumper wire, cake mat, and stepper motor.

Arduino

Arduino is an open-source electrical kit or circuit board that contains a primary component, specifically a microcontroller chip of the AVR type manufactured by Atmel. Microcontrollers are programmable chips or ICs (Integrated Circuits) that may be programmed using a computer. The objective of embedding a program in a microcontroller is to enable the electronic circuit to receive, analyze, and produce output based on the input received (Samsugi et al., 2018) (Kondaveeti et al., 2021) (Cameron, 2019) (D'Ausilio, 2012).

DC Motor Driver

Direct Current (DC) Motor drivers are utilized for applications that necessitate precise speed control in contrast to alternating current motors. The primary justification for the utilization of DC motors, particularly in contemporary industries, is their ability to readily regulate working speed within a broad range, in conjunction with the various available methods for speed regulation. This DC motor

driver will rotate the DC motor in accordance with signals received from the Arduino (Birdayansyah et al., 2015) (Kim et al., 2006) (H. Wang, 2012) (Samitha Ransara & Madawala, 2015).

NodeMCU ESP 32

The NodeMCU ESP32 is a microcontroller developed by Espressif Systems and serves as the successor to the ESP8266 microprocessor. The ESP32 microcontroller offers several advantages over other microcontrollers, including a greater number of pin outs, more analog pins, larger memory capacity, and the availability of Bluetooth 4.0 low energy and WiFi. These features make it suitable for implementing the Internet of Things with the ESP32 microcontroller (Suriana et al., 2022) (MacHeso et al., 2021) (Niranjana et al., 2022).

Power Supply

A power supply is an electrical circuit that converts alternating current (AC) into direct current (DC). A power supply is a device that serves as a source of electrical power for other devices (G. S. A. Putra et al., 2020) (Jang et al., 2012) (Schefer et al., 2020).

Transformer Stepdown 5 A

The primary purpose of the stepdown transformer is to convert high voltage and low current into low voltage and high current. The primary purpose of the stepdown transformer is to decrease the voltage from the mains and adapt it to the specific requirements of electronic devices (Restu Mukti et al., 2022) (Wu et al., 2016) (L. Wang et al., 2022).

LED

LED (Light Emitting Diode) is a component that has the ability to emit light. RGB LEDs are LED lamps that combine three integrated colors within a single unit (Supegina & Sukindar, 2014) (Dupuis & Krames, 2008) (Salter et al., 2010) (Chang et al., 2012).

Switch

A switch is a user interface utilized for controlling the activation or deactivation of electrical devices (Putri & Mandenni, 2019)

L298N motor driver

The L298N motor driver is widely recognized as the preferred choice for regulating motor speed and direction, particularly in line follower and line tracer robots. The L298N motor driver offers the benefit of high precision in motor control. Furthermore, the L298N motor driver offers the benefit of being effortlessly manageable (Fikriyah & Rohmanu, 2018) (How et al., 2012) (Peerzada et al., 2021) (Azhari et al., 2023).

LCD

LCD is a display medium that utilizes liquid crystals as its primary component. Liquid crystal display (LCD) technology has found applications in a wide range of fields, including electrical devices like televisions, calculators, and computer screens. This post discusses the application of an LCD dot matrix with a character count of 2x16. The LCD serves as a highly functioning viewer that will thereafter be utilized to showcase the operational state of the gadget (Kalengkongan et al., 2018a).

The baking mat

The baking mat is the component of the cake that functions as the foundation or lowermost stratum of the cake. Baking mats are typically composed of many components, which vary based on the specific type of cake being prepared. The primary purpose of the ingredient is to provide rigidity and fortitude to the cake, while also safeguarding against excessive moisture or untidiness on the cake's underside (Selin Dwi, 2022).

Motor Stepper

A stepper motor is an electromechanical device that works by converting electronic pulses into mechanical motion. The stepper motor moves in the order given to the motor.

Stepper motors work on the basis of pulses given to their phase windings in precise sequences. In addition, the pulses must also provide a considerable current in the phase winding. Therefore, for the operation of the stepper motor, it must first design a logic sequencer to determine the sequence of phase winding of the motor and then use a drive (driver) to provide the current required by the phase winding (Purbaya, 2017).

The data collecting methodology employs interviews, field surveys, perusal of manuals or documentation blueprints, and examination of all previously acquired data (Soegijono, 1993). The procedure for creating an IoT-based cake scraper tool using the ESP32 module in an Internet of Things application involves conducting a comprehensive review of relevant literature. This entails searching and gathering data from various sources such as books, theses, scientific journals, and online resources (Samsugi et al., 2018).

Figure 1 illustrates the implementation of the cake scraper system with IoT technology. This device utilizes electrical power for its operation. Upon activation of the tool, the system will enter a state of readiness, awaiting input from user data. Users have the choice of three input options: buttons, Bluetooth, and IoT. To activate the Bluetooth and IoT modes, the user simply needs to press the switch located on the gadget. To activate the user button option, simply press the button and the system will initiate automatic operation.

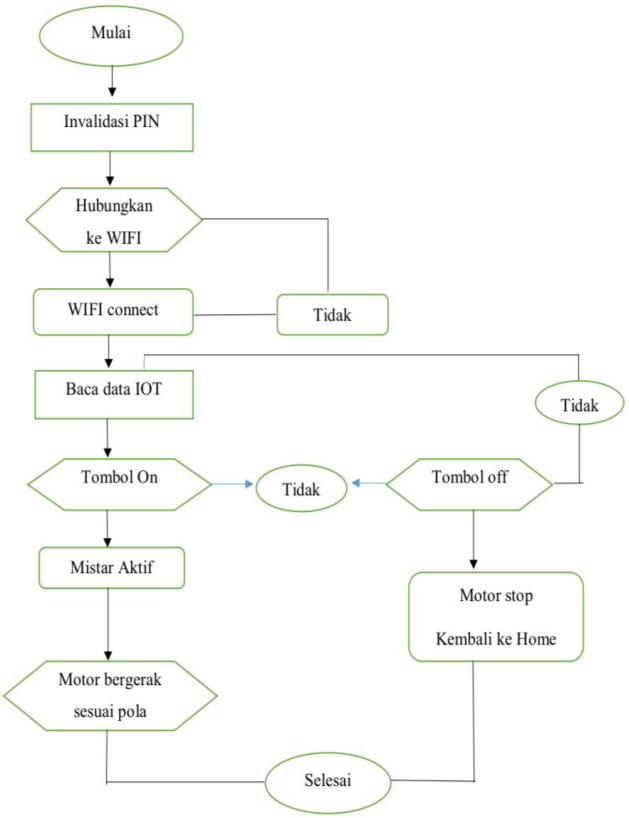


Figure 1. Flowchart of system cake scraper tool

When utilizing Bluetooth mode, the initial phase involves the user launching the pre-existing application, subsequently toggling the switch on both the application and the devices to activate Bluetooth mode, and finally establishing a connection between the Bluetooth-enabled mobile phone and a specific Bluetooth device named "scraper_kue_2023". Upon establishing a connection, the user inputs the desired motor speed, as well as the lengths of the x-axis and y-axis, in order to configure the bar. Once the data has been entered, the user simply needs to press the "send" button. Upon receiving the data, the system will autonomously initiate the motor rotation, causing the x and y axis sides to converge.

The distinction between the utilization of Bluetooth and IoT modes is contingent upon the

presence of internet networks to facilitate the operation. The program is utilized for inputting motor speed data and x and y axis dimensions, which are subsequently transmitted automatically to the adafruit server. Subsequently, the device retrieves the data, triggering the cooking process to commence automatically in Bluetooth mode.

When the button mode is enabled, the user can initiate the system by pressing the button, after which the system will operate automatically. The speed and dimensions of the x and y axes for this mode are configured in Arduino.

Figure 2 displays a block diagram of an Internet of Things (IoT) system that utilizes NodeMCU32 to operate an automated scraper cake tool.

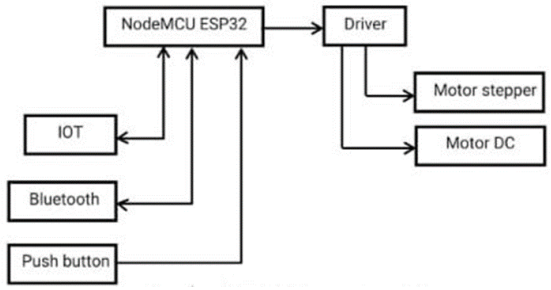


Figure 2. Block diagram illustrating the implementation of an IoT-based automated cake scraper tool utilizing the NodeMCU32 platform.

Input

IoT: an internet-based system that utilises the Android operating system to operate the cake scraper tool (Prihatmoko, 2016).

Bluetooth: functions as an alternate method to activate the automatic feature of the cake scraper.

Push Button: functions as a substitute in situations where IoT and bluetooth fail to operate.

Process

NodeMCU ESP32: functions as a data processor for Android and Internet of Things (IoT) devices, enabling the processing of data to produce the desired output value (Saputra et al., 2019).

Output

Motor Driver: serves as a dc motor regulator to operate the draft cake scraper player (Prabowo, 2010).

DC motor: acts as a tool player (Zamroni & Moediyono, 2010) & placemat.

Stepper Motor: serves as a drive up and down the side of the x and y bar (W. Putra & PLN, 2011).

RESULT AND DISCUSSION

The research findings were derived from system testing, demonstrating the flawless functionality of the cake scraper tool. The cake scraper tools were tested at D'Fortuna Bakery Palembang as a research partner. An initial assessment was conducted by quantifying the velocity and electrical potential of the cake scraper instrument via a dedicated software. The measurement data is displayed in table 1.

Table 1. Measurement of velocity and voltage using the application

No	Velocity	Voltage
1	102	30,3 V
2	130	43 V
3	150	51,6 V
4	168	57,2 V

Table 1 data indicates that the speed of the cake scraper tool directly influences the voltage. Based on this test, it can be inferred that there is a direct relationship between

speed and voltage, where more speed results in larger voltage production.

A second test was conducted to quantify the vertical dimension and Y-axis of the cake scraper tool. The height and Y-axis measurements are displayed in table 2. Based on the measurement results, it may be inferred that the height or depth of a Y measurement does not determine the magnitude and scale of the Y axis.

Table 2. Measurement results of height and Y-axis

No	Height	Y-axis
1	22 cm	0
2	20,9 cm	5
3	19,4 cm	15
4	17,3 cm	30
5	16 cm	39

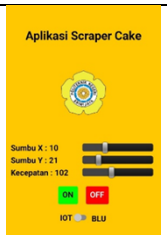
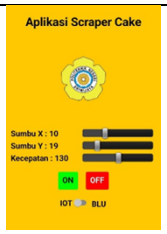
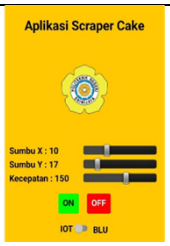
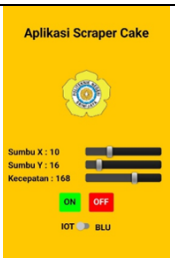
The third test was conducted to quantify the vertical dimension and X-axis of the cake scraper tool. The height and x-axis measurements are displayed in table 3. Based on the findings from this height and x-axis measurement, it can be inferred that there is a positive correlation between the X measurement and the size of the resulting x-axis.

Table 3. Height and x-axis measurements

No	Height	X-axis
1	8,6 cm	0
2	9,7 cm	5
3	10 cm	7
4	10,3 cm	9
5	10,5 cm	11

The fourth test is conducted to evaluate the efficacy of the tool integrated into the Android system. The test results of the android system are displayed in Table 4. According to the data shown in table 4, it can be inferred that all the inputted data is operating correctly and showing successful indicators.

Table 4. Android system testing

Test Description	Expected results	Result testing	Indicator
Navigate to the Landing Page menu	The system was successfully accessed and opened		Success
Input X-axis: 10 Y-axis: 21 Velocity: 102	The system operates optimally.		Success
Input X-axis: 10 Y-axis: 19 Velocity: 130	The system operates optimally.		Success
Input X-axis: 10 Y-axis: 17 Velocity: 150	The system operates optimally.		Success
Input X-axis: 10 Y-axis: 16 Velocity: 168	The system operates optimally.		Success

Based on the analysis of multiple samples and the corresponding outcomes, it can be concluded that this cake scraper tool is capable of functioning effectively. This cake scraper tool is designed to smooth the cake

cream using low and medium speeds. Nevertheless, this cake scraper tool is incapable of handling cakes at a rapid pace. This is due to the dispersion of the cake cream when it is applied at a rapid velocity, resulting in the cake being level. The available cake sizes with this scraper cake tool are 20, 22, and 24 inches in diameter. The reason for the large base on this scraper cake tool is due to its size. This cake scraping tool is not suitable for cakes with a diameter of less than 20 inches.

CONCLUSION

The cake scraper tool exhibits excellent precision in evenly spreading the cake cream. By utilizing an application, the process of flattening the cake cream can be effectively regulated, providing MSME partners with a convenient method for achieving optimal results.

Enhancements should be made to the cake scraper tool to ensure its compatibility with various diameters. Wheels should be attached to the cake scraper tool to facilitate its mobility and relocation. The velocity of the cake scraper tool should be calibrated to enhance efficiency and expedite the process, while ensuring that the cake cream remains intact and does not disperse.

REFERENCES

Azhari, Nasution, T. I., & Azis, P. F. A. (2023). MPU-6050 Wheeled Robot Controlled Hand Gesture Using L298N Driver Based on Arduino. *Journal of Physics: Conference Series*, *2421*(1), 012022. https://doi.org/10.1088/1742-6596/2421/1/012022

Birdayansyah, R., Soedjarwanto, N., & Zebua, O. (2015). Pengendalian Kecepatan Motor DC Menggunakan Perintah Suara Berbasis Mikrokontroler Arduino. *Electrician: Jurnal Rekayasa Dan Teknologi Elektro*, *9*(2), 97–108.

Cahyono, G. H. (2016). Internetofthings(Sejarah,Teknologi Dan Penerapannya). *Forum Teknologi*, *6*(3), 35–36.

Cameron, N. (2019). Arduino Applied. *Arduino Applied*. https://doi.org/10.1007/978-1-4842-3960-5

Chang, M. H., Das, D., Varde, P. V., & Pecht, M. (2012). Light emitting diodes reliability review. *Microelectronics Reliability*, *52*(5), 762–782. https://doi.org/10.1016/J.MICROREL.2011.07.063

D'Ausilio, A. (2012). Arduino: A low-cost multipurpose lab equipment. *Behavior Research Methods*, *44*(2), 305–313. https://doi.org/10.3758/S13428-011-0163-Z/FIGURES/6

Danuri, M. (2019). Perkembangan dan transformasi teknologi digital. *Jurnal Ilmiah Infokam*, *15*(2).

Dupuis, R. D., & Krames, M. R. (2008). History, development, and applications of high-brightness visible light-emitting diodes. *Journal of Lightwave Technology*, *26*(9), 1154–1171. https://doi.org/10.1109/JLT.2008.923628

Fikriyah, L., & Rohmanu, A. (2018). Sistem Kontrol Pendingin Ruangan Menggunakan Arduino Web Server Dan Embedded Fuzzy Logic Di Pt. Inoac Polytechno Indonesia. *Jurnal Informatika SIMANTIK*, *3*(1), 1–23.

Hidayatullah, N. A., & Juliando, D. E. (2017). Desain dan Aplikasi Internet of Thing (IoT) untuk Smart Grid Power Sistem. *VOLT : Jurnal Ilmiah Pendidikan Teknik Elektro*,

2(1), 35. https://doi.org/10.30870/volt.v2i1.1347

How, D. N. T., Baharuddin, M. Z., Mohideen, S. S. K., Sahari, K. S. M., & Anuar, A. (2012). Modular Motor Driver with Torque Control for Gripping Mechanism. *Procedia Engineering*, *41*, 1476–1482. https://doi.org/10.1016/J.PROENG.2012.07.338

Jang, S. R., Ryoo, H. J., Ahn, S. H., Kim, J., & Rim, G. H. (2012). Development and optimization of high-voltage power supply system for industrial magnetron. *IEEE Transactions on Industrial Electronics*, *59*(3), 1453–1461. https://doi.org/10.1109/TIE.2011.2163915

Kalengkongan, T. S., Mamahit, D. J., & Sompie, S. R. U. . (2018a). Rancang Bangun Alat Deteksi Kebisingan Berbasis Arduino Uno. *Jurnal Teknik Elektro Dan Komputer*, *7*(2), 183–188.

Kalengkongan, T. S., Mamahit, D. J., & Sompie, S. R. U. A. (2018b). Rancang Bangun Alat Deteksi Kebisingan Berbasis Arduino Uno. *Jurnal Teknik Elektro Dan Komputer*, *7*(2), 183–188.

Kim, D. K., Lee, K. W., & Kwon, B. Il. (2006). Commutation torque ripple reduction in a position sensorless brushless dc motor drive. *IEEE Transactions on Power Electronics*, *21*(6), 1762–1768. https://doi.org/10.1109/TPEL.2006.882918

Kondaveeti, H. K., Kumaravelu, N. K., Vanambathina, S. D., Mathe, S. E., & Vappangi, S. (2021). A systematic literature review on prototyping with Arduino: Applications, challenges, advantages, and limitations. *Computer Science Review*, *40*, 100364. https://doi.org/10.1016/J.COSREV.2021.100364

Lu, Y. (2017). Industry 4.0: A survey on technologies, applications and open research issues. *Journal of Industrial Information Integration*, *6*, 1–10. https://doi.org/10.1016/J.JII.2017.04.005

MacHeso, P., Chisale, S., Daka, C., Dzupire, N., Mlatho, J., & Mukanyirigira, D. (2021). Design of Standalone Asynchronous ESP32 Web-Server for Temperature and Humidity Monitoring. *2021 7th International Conference on Advanced Computing and Communication Systems, ICACCS 2021*, 635–638. https://doi.org/10.1109/ICACCS51430.2021.9441845

Mayer, S., & Schneegass, S. (2017). *IoT 2017*. 1–2. https://doi.org/10.1145/3131542.3131543

Mellado, J., & Núñez, F. (2021). Design of an IoT-PLC: A containerized programmable logical controller for the industry 4.0. *Journal of Industrial Information Integration*, 100250. https://doi.org/10.1016/J.JII.2021.100250

Moreno, M. V., Úbeda, B., Skarmeta, A. F., & Zamora, M. A. (2014). How can we tackle energy efficiency in iot based smart buildings? *Sensors (Switzerland)*, *14*(6), 9582–9614. https://doi.org/10.3390/s140609582

Nema, B. M., Mohialden, Y. M., Hussien, N. M., & Hussein, N. A. (2021). COVID-19 knowledge-based system for diagnosis in Iraq using IoT environment. *Indonesian Journal of Electrical Engineering and Computer Science*, *21*(1), 328–337. https://doi.org/10.11591/ijeecs.v21.i1.pp328-337

Niranjana, R., Arvind, S., Vignesh, M., & Vishaal, S. (2022). Effectual Home Automation using ESP32 NodeMCU. *International Conference on Automation, Computing and*

Renewable Systems, ICACRS 2022 - Proceedings. https://doi.org/10.1109/ICACRS55517.2022.10028992

Peerzada, P., Larik, W. H., & Mahar, A. A. (2021). DC Motor Speed Control Through Arduino and L298N Motor Driver Using PID Controller. *International Journal of Electrical Engineering & Emerging Technology* , *4*(2), 21–24. https://www.ijeeet.com/index.php/ijeeet/article/view/94

Prabowo, B. A. (2010). Pemodelan Sistem Kontrol Motor DC dengan Temperatur Udara sebagai Pemicu. *INKOM Journal*, *2*(1), 39–43.

Prihatmoko, D. (2016). Penerapan internet of things (IoT) dalam pembelajaran di UNISNU Jepara. *Simetris: Jurnal Teknik Mesin, Elektro Dan Ilmu Komputer*, *7*(2), 567–574.

Purbaya, R. (2017). *Aplikasi Motor Stepper Pada Alat Pencetak Bangun Ruang Tiga Dimensi Untuk Peleburan Filament Pada Motor Extruder*. Politeknik Negeri Sriwijaya.

Putra, G. S. A., Nabila, A., & Pulungan, A. B. (2020). Power Supply Variabel Berbasis Arduino. *JTEIN: Jurnal Teknik Elektro Indonesia*, *1*(2), 139–143. https://doi.org/10.24036/jtein.v1i2.53

Putra, W., & PLN, S. T. T. (2011). Sistem Kendali Motor Stepper Sebagai Penggerak Horizontal dan Vertikal. *Teknik Elektro. Sekolah Tinggi Teknik PLN. Jakarta*.

Putri, G. A. A., & Mandenni, N. M. I. M. (2019). Desain Saklar Otomatis Untuk Kontrol Peralatan Listrik di Bangunan. *Jurnal Ilmiah Merpati (Menara Penelitian Akademika Teknologi Informasi)*, *7*(1).

Qurat-Ul-Ain, Iqbal, S., Khan, S. A., Malik, A. W., Ahmad, I., & Javaid, N. (2018). IoT Operating System Based Fuzzy Inference System for Home Energy Management System in Smart Buildings. *Sensors 2018, Vol. 18, Page 2802*, *18*(9), 2802. https://doi.org/10.3390/S18092802

Restu Mukti, A., Mukmin, C., Randa Kasih, E., Palembang Jalan Jenderal Ahmad Yani No, D., Ulu, S. I., & Selatan, S. (2022). Perancangan Smart Home Menggunakan Konsep Internet of Things (IOT) Berbasis Microcontroller. *Jurnal JUPITER*, *14*(2), 516–522.

Salter, C. L., Stevenson, R. M., Farrer, I., Nicoll, C. A., Ritchie, D. A., & Shields, A. J. (2010). An entangled-light-emitting diode. *Nature 2010 465:7298*, *465*(7298), 594–597. https://doi.org/10.1038/nature09078

Samitha Ransara, H. K., & Madawala, U. K. (2015). A Torque Ripple Compensation Technique for a Low-Cost Brushless DC Motor Drive. *IEEE Transactions on Industrial Electronics*, *62*(10), 6171–6182. https://doi.org/10.1109/TIE.2015.2423664

Samsugi, S., Ardiansyah, A., & Kastutara, D. (2018). Arduino dan Modul Wifi ESP8266 sebagai Media Kendali Jarak Jauh dengan antarmuka Berbasis Android. *Jurnal Teknoinfo*, *12*(1), 23. https://doi.org/10.33365/jti.v12i1.42

Saputra, D. I., Fajrin, I. M., & Zainal, Y. B. (2019). Perancangan sistem pemantau dan pengendali alat rumah tangga menggunakan NodeMCU. *J. Tek. Rekayasa*, *4*(1), 9–16.

Schefer, H., Fauth, L., Kopp, T. H., Mallwitz, R., Friebe, J., & Kurrat, M. (2020). Discussion on Electric Power Supply Systems for All Electric Aircraft. *IEEE Access*, *8*, 84188–84216. https://doi.org/10.1109/ACCESS.2020.2991804

Selin Dwi, H. (2022). *DEKORASI KUE ULANG TAHUN DENGAN TEMA HAWAII*. Poltekpar

NHI Bandung.

Siswandi, A. (2017). Penampil Teks Pada Lcd Karakter 16 X 2 Berbasis Mikrokontroler MA 51 AT89S52. *Jurnal SIGMA*, *8*(3), 205–2010.

Soegijono, M. S. (1993). Wawancara sebagai salah satu metode pengumpulan data. *Media Penelitian Dan Pengembangan Kesehatan*, *3*(1), 157152.

Supegina, F., & Sukindar, D. (2014). Perancangan Robot Pencapit Untuk Penyotir Barang Berdasarkan Warna Led Rgb Dengan Display Lcd Berbasis Arduino Uno. *Jurnal Teknologi Elektro*, *5*(1), 143417.

Suriana, I. W., Setiawan, I. G. A., & Graha, I. M. S. (2022). Rancang Bangun Sistem Pengaman Kotak Dana Punia berbasis Mikrokontroler NodeMCU ESP32 dan Aplikasi Telegram. *Jurnal Ilmiah Telsinas Elektro, Sipil Dan Teknik Informasi*, *4*(2), 75–84. https://doi.org/10.38043/telsinas.v4i2.3198

Wang, H. (2012). Design and Implementation of Brushless DC Motor Drive and Control System. *Procedia Engineering*, *29*, 2219–2224. https://doi.org/10.1016/J.PROENG.2012.01.291

Wang, L., Sun, K., & Burgos, R. (2022). Planar Piezoelectric Transformer-Based High Step-Down Voltage-Ratio DC-DC Converter. *IEEE Transactions on Power Electronics*, *37*(9), 10833–10848. https://doi.org/10.1109/TPEL.2022.3163427

Wu, H., Lu, Y., Chen, L., Xu, P., Xiao, X., & Xing, Y. (2016). High step-up/step-down non-isolated BDC with built-in DC-transformer for energy storage systems. *IET Power Electronics*, *9*(13), 2571–2579. https://doi.org/10.1049/IET-PEL.2015.0841

Zamroni, M., & Moediyono, M. (2010). *Kendali Motor Dc Sebagai Penggerak Mekanik Pada Bracket Lcd Proyektor Dan Layar Dinding Berbasis Mikrokontroler At89s51*. Undip.