ETCOR Educational Research Center Inc.
SEC Reg. No. 2024020137294-00
Sta. Ana, Pampanga, Philippines
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Automated Remote Monitoring and Control of Power and Temperature applying IoT

John Angelo B. Rivera, MSIT*[1], Dr. Neil P. Balba[2]
[1] Lyceum of the Philippines University - Batangas, 4200 Capitol Site, Batangas City
[2] Lyceum of the Philippines University – Laguna
*Corresponding Author e-mail: *johnangelo.borromeo.rivera@gmail.com*

Received: 09 April 2025 **Revised**: 10 May 2025 **Accepted**: 12 May 2025

Available Online: 14 May 2025

Volume IV (2025), Issue 2, P-ISSN – 2984-7567; E-ISSN - 2945-3577

https://doi.org/10.63498/etcor316

Abstract

Aim: This paper explores the facilitation of simplified administration, seamless access, and continuous monitoring for organizations through the strategic migration of a significant portion of their systems to the cloud, leveraging technological advancements. It aims to develop and implement an Internet of Things (IoT)-based solution for monitoring and controlling temperature and power systems of on-premise servers, especially relevant in hybrid and remote work environments.
Methodology: This study employed systematic data collection and analysis approaches to address the complexities of administering and maintaining on-premise servers. A prototype was developed using a prototyped life cycle model, incorporating IoT sensors to collect key performance indicators such as server temperature and backup battery voltage. These sensors were integrated with Gizduino-based technology, with the data compiled and transmitted to a web server for real-time monitoring and control.
Results: This research demonstrates the practical implementation of a remote monitoring and control system for on-premise servers. It provides a valuable solution for organizations navigating the complexities of hybrid work environments, particularly those still reliant on physical server infrastructure. The study highlights the potential of IoT applications to enhance system reliability and administrative efficiency.
Conclusion: There is a statistically significant interaction between motivation and learning style preferences on students' numeracy skills.

Keywords: *Gizduino, IoT, Temperature Sensor, Voltage Sensor*

INTRODUCTION

The development and evolution of servers have been foundational to modern computing and business operations (De Donno, et al., 2019). From their roots in queueing theory and early ARPANET classifications to the groundbreaking innovations of Tim Berners-Lee with the first web server in 1990, servers have advanced from basic data handlers to highly efficient, space-saving systems such as rack, blade, and software-defined servers. These innovations, like HP's Moonshot and the concept of virtualization, have enabled businesses to scale their digital infrastructure while improving performance, reducing power consumption, and optimizing space. Today's data centers emphasize not only performance but also energy efficiency, with regulatory bodies and technological standards pushing for greener solutions amid soaring global data demand.

Meanwhile, the Philippine Business Process Outsourcing (BPO) industry has emerged as a critical economic pillar (Thompson, 2022), driven by global demand, especially from the U.S. and other countries like Australia and those in Europe. The sector has demonstrated resilience and adaptability (Sallaz, 2019), notably thriving during the COVID-19 pandemic due to the shift to remote work. Alongside BPOs, the freelance economy has surged, with over

ETCOR Educational Research Center Inc.
SEC Reg. No. 2024020137294-00
Sta. Ana, Pampanga, Philippines
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

1.5 million Filipinos engaging in digital platforms. Supporting these IT-intensive industries is a robust infrastructure of data centers, where temperature control, energy efficiency, and reliable uninterruptible power supplies (UPS) are vital. Effective monitoring systems have become indispensable in managing remote sites and ensuring operational continuity, further underlining the centrality of IT infrastructure to the country's digital economy.

The primary aim of this project was to enhance the management of on-premises servers, particularly for Bold Business PH in its remote office in Taguig City, and for similar businesses relying on localized server infrastructure. By integrating Internet of Things (IoT) devices, the project significantly reduced the need for manual oversight and physical intervention. It enabled real-time monitoring of server temperature and UPS battery levels while automating the operation of essential equipment such as the air conditioning system and power sources. Through intelligent, real-time decision-making based on environmental data, the system ensured energy-efficient cooling and protected servers from temperature-related risks.

The project also introduced a web-based interface for seamless monitoring and a GSM-enabled notification system. This allowed Systems Administrators to access live data and receive SMS alerts whenever the microcontroller executed specific tasks, such as switching appliances on or off based on pre-set thresholds. The automation not only improved response times but also ensured continuous server performance and reliability. Overall, the implementation marked a significant shift toward smarter server management, highlighting the transformative potential of IoT in maintaining optimal operational conditions with minimal human intervention.

Objectives

The main objective of the study is to design and implement an IoT device to automate process and monitor the temperature of the server and battery level of UPS for Bold Business.

Specifically, this study is aimed at:

1. Using a temperature sensor to monitor the temperature of the server if it's getting hot or not;
2. Using a Vcc DC voltage sensor to detect and check the level of the UPS battery;
3. Using relays to automate processes like turning on and off appliances like Air conditioning System;
4. Using a GSM shield to send notification to the recipient (Systems Administrators) for the process omitted by the IoT device;
5. Create a webserver to check the temperature of the server and battery level of the UPS and control appliances by simply clicking buttons on the web. The web can be accessed by implementing tunnel connections or by using applying DNS.
6. Test the functionality, accuracy and acceptability of the system.

METHODS

Research Design

The research endeavors to achieve its objectives through the utilization of both descriptive and developmental research methodologies. The descriptive approach is evident in the researchers' execution of surveys to amass data. Furthermore, the evaluation of the designed system's acceptability encompasses comprehensive functionality, accuracy, and reliability tests. To enhance the system's development and design, supplementary insights were garnered through interviews.

The study also assumes a prototyping development trajectory, given the culmination of a prototype that seamlessly interlinks distinct subsystems. This prototyping approach affirms the creation of an integrated model as the ultimate output of the research endeavor.

Data and Process Modeling

The progression of the system's development necessitates a collaborative approach, involving the utilization of a structured tool or model that serves as a guiding framework to effectively accomplish the study's objectives. These chosen tools and models furnish a systematic set of methodologies, offering a sequential and methodical approach to address the requisites at each stage of the model's progression. Through meticulous assessment and analysis spanning from data collection to the solution's realization, the Prototyping Development Model emerged as the preferred choice to yield the desired results. This model offers a well-defined sequence of phases, thereby facilitating the systematic creation of the intended product.

The Prototyping Model embodies a dynamic and client- centric approach within the realm of software development, fostering active collaboration and iterative enhancement to ensure the ultimate delivery of a product that not only meets but surpasses customer expectations

Sequential Phases in Prototyping Development

The development of the prototype for the Automated Remote Monitoring and Control of Power and Temperature system followed a structured sequence of phases, beginning with requirement analysis. This initial phase involved collecting relevant data through interviews, surveys, observations, and literature reviews to inform a robust system design. The research team assessed necessary hardware and software components to ensure alignment with both the project's objectives and industry standards. Collaboration with IT professionals and key stakeholders played a crucial role in refining the system requirements and fostering a design that met both technical and operational needs.

Following the analysis, the project moved through the stages of design, building, and evaluation. A prototype was created based on analyzed requirements, using selected tools and models. The system was then tested multiple times by IT experts to ensure functionality, focusing on components such as relay operations, SMS notifications, GSM shield reception, and web server access. A refinement phase followed, where continuous testing and revisions were made until all specifications were met. The process concluded with the development of a fully functional system that successfully automated the monitoring and control of server room temperature and power using IoT technology.

Project Design and Development Process

The Project Design and Development Process involved a meticulous selection of both hardware and software to ensure alignment with the system's functional requirements. Arduino IDE Version 1.0.6 served as the main programming platform, enabling real-time automation and monitoring of the system. Gizduino was used as the core microcontroller due to its flexibility and compatibility with various sensors and modules. Hardware components such as temperature and DC voltage sensors, GSM and LAN shields, relays, and power adapters were integrated into the prototype to implement the Internet of Things (IoT)-based Automated Remote Monitoring and Control of Power and Temperature. A structured checklist guided IT professionals in evaluating the system's performance, ensuring all components worked harmoniously. Additionally, purposive sampling was used to select qualified participants—IT experts, stakeholders, and business managers—for the prototype's usability and acceptability testing.

The system architecture comprised several interconnected modules performing automated functions such as temperature regulation and voltage monitoring. Visual diagrams and schematic representations illustrated the layout and connection of components including the main prototype, temperature sensor, and DC voltage sensor. Process flowcharts for temperature detection and DC level monitoring showed how sensor readings triggered specific actions like activating relays or sending notifications to administrators via GSM. The system also featured a Web server for real-time remote monitoring. Lastly, a Gantt chart depicted the comprehensive project timeline covering planning, design, development, testing, and deployment phases, providing a structured framework for project execution and progress tracking.

RESULTS and DISCUSSION

This chapter presents the outcomes of unit testing and system evaluation carried out to validate the performance and reliability of the developed hardware-software system prototype.

The unit testing phase focused on seven primary hardware components: Gizduino 324 + ATmega, temperature sensor, DC voltage sensor, SIM800L module, Ethernet shield, relay module, and magnetic contactor. Each component underwent multiple testing iterations, all of which produced favorable results. These outcomes confirmed that the individual components performed as expected under defined conditions, demonstrating operational reliability and consistency.

The Gizduino microcontroller board was tested through LED indicators for basic functionality, yielding successful results across five trials. The temperature sensor was validated by immersion in hot water, consistently registering readings above 40°C. For the DC voltage sensor, tests involved measuring a 3.7V battery's output, which the sensor accurately captured. The SIM800L GSM module demonstrated its network readiness through successful

ETCOR Educational Research Center Inc.
SEC Reg. No. 2024020137294-00
Sta. Ana, Pampanga, Philippines
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181
RUN RESEARCHERS RUN

signal detection, indicated by LED blinking. Similarly, the Ethernet shield was verified through the illumination of Power and FULLD LEDs. Both the relay module and magnetic contactor responded correctly to control signals, whether triggered via programmed intervals or web-based commands.

Subsequent to unit testing, a comprehensive system evaluation was performed involving IT professionals, stakeholders, and managers from Bold Business and other companies. This phase aimed to assess the integrated system's functionality in real-world scenarios, particularly through its web-based interface for controlling air conditioning (AC) and UPS battery charging (Majhi & Mohanty, 2024; Nagarale, Set al., 2024). The evaluation confirmed the system's ability to execute control commands reliably, reflect accurate status updates on the interface, and deliver timely SMS notifications to administrators.

One key result of the evaluation was the successful demonstration of the system's manual control functionality via the web interface. Users could turn the UPS charging on and off remotely, with the interface reflecting real-time status updates—"CHARGING" when on and "NOT CHARGING" when off. In all test trials, SMS alerts were delivered successfully to the administrator, confirming that the system's communication and responsiveness met the expected standards. These trials exhibited a 100% success rate across ten iterations, reinforcing the dependability of manual UPS control (Kim, et al., 2021; Song, et al., 2023).

In parallel, the automated air conditioning control feature was tested using temperature thresholds. The AC system automatically activated when temperatures reached 33°C or above, with the web interface displaying an "ON" status and sending a corresponding SMS alert. Conversely, when the temperature dropped to 14°C or lower, the AC turned off and a similar alert was issued. These automated controls functioned flawlessly throughout the test series, highlighting the accuracy and responsiveness of the system's temperature-based automation logic.

The prototype also incorporated automated control of UPS battery charging based on preset voltage levels. The system was configured to stop charging when the battery reached 10V and resume charging when it dropped below 3V. Testing validated that the microcontroller correctly identified these voltage levels, activated or deactivated the relay accordingly, updated the web interface, and issued SMS notifications. Each test confirmed the proper functioning of the voltage monitoring and response mechanisms, proving the effectiveness of the prototype's energy management strategy.

Altogether, the prototype consistently demonstrated accurate performance across both manual and automated functionalities. It seamlessly integrated sensor inputs, actuator responses, user interface feedback, and communication protocols. The synchronization between user commands, system response, and administrative alerts was evident in all test results, showing the system's suitability for real-time monitoring and remote control applications in environments requiring power and environmental management (Yang, et al., 2019; Al Mamun & Yuce, 2019; Hayat, et al., 2019).

The testing phase substantiated the prototype's overall functionality, precision, and reliability. The alignment between expected and actual results across all test cases affirmed the robustness of the design. With its proven performance, the system stands ready for real-world deployment, offering a practical solution for server rooms and other setups that demand intelligent automation and remote system control.

Conclusions

The prototype was designed to meet the requirements of the Systems Administrators at Bold Business, allowing them to effectively monitor and maintain servers located in remote offices while working from home. This innovative solution includes the following essential components: a temperature sensor for detecting server temperatures, a DC Voltage Sensor for monitoring the battery level of the Backup UPS, and a GSM module for seamless notification transmission and device control based on predefined functions.

The central center of the system is a website that serves as the primary monitoring station for the servers and Backup Battery. Administrators are granted the ability to remotely manage multiple aspects, such as turning on or off the Air Conditioning System and enabling or deactivating the Backup Battery charge.

The developed device has been subjected to extensive testing, validating its efficacy through a consistent match between expected and actual outputs. This robust consistency demonstrates the precision of the system, as

ETCOR Educational Research Center Inc.
SEC Reg. No. 2024020137294-00
Sta. Ana, Pampanga, Philippines
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

the test results closely correspond to the supplied base-values. In addition, a series of successful tests attest to its dependability, validating its consistent performance and adherence to predefined standards..

Recommendations

The researchers firmly suggest that the developed prototype be implemented and utilized by the Systems Administrators at Bold Business. In addition, it is recommended to introduce this prototype to other enterprises that currently operate in a work-from-home environment. Doing so will ensure that these organizations can effectively maintain and monitor their systems and servers by utilizing the capabilities of this system, including temperature monitoring of servers and real-time tracking of Backup Battery levels.

Additionally, it is essential to emphasize the prototype's ongoing evolution and development. Prioritize consistent upgrades and enhancements to meet the evolving requirements of businesses, especially in the context of equipment maintenance, such as server upkeep.

Future researchers are urged to investigate opportunities for expanding the prototype's capabilities and functionalities. For instance, incorporating a feature that adjusts the lighting in server rooms so that it is off during the day and on at night could increase its utility. In addition, researchers should consider integrating the prototype with an advanced Wi-Fi module that supports the 5GHz frequency and has a greater wireless network range. This enhancement would eradicate the need for Ethernet/LAN cables, thereby enhancing the flexibility and effectiveness of remote monitoring and control operations.

REFERENCES

Al Mamun, M. A., & Yuce, M. R. (2019). Sensors and systems for wearable environmental monitoring toward IoT-enabled applications: A review. *IEEE Sensors Journal*, *19*(18), 7771-7788.

De Donno, M., Tange, K., & Dragoni, N. (2019). Foundations and evolution of modern computing paradigms: Cloud, iot, edge, and fog. *IEEE access*, *7*, 150936-150948.

Hayat, H., Griffiths, T., Brennan, D., Lewis, R. P., Barclay, M., Weirman, C., ... & Searle, J. R. (2019). The state-of-the-art of sensors and environmental monitoring technologies in buildings. *Sensors*, *19*(17), 3648.

Kim, G., Humble, J., Debois, P., Willis, J., & Forsgren, N. (2021). *The DevOps handbook: How to create world-class agility, reliability, & security in technology organizations*. It Revolution.

Majhi, A. A. K., & Mohanty, S. (2024). A Comprehensive Review on Internet of Things Applications in Power Systems. *IEEE Internet of Things Journal*.

Nagarale, S. R., Bora, V., Sonaskar, S., & Khawashi, K. (2024, August). Enhancing cold storage infrastructure efficiency through IoT, image processing and solar panel. In *AIP Conference Proceedings* (Vol. 3139, No. 1). AIP Publishing.

Sallaz, J. J. (2019). *Lives on the line: how the Philippines became the world's call center capital*. Oxford University Press.

Song, Y., Romero, A., Müller, M., Koltun, V., & Scaramuzza, D. (2023). Reaching the limit in autonomous racing: Optimal control versus reinforcement learning. *Science Robotics*, *8*(82), eadg1462.

Thompson, M. (2022). Business process outsourcing industry in the Philippines.

Yang, C. T., Chen, S. T., Den, W., Wang, Y. T., & Kristiani, E. (2019). Implementation of an intelligent indoor environmental monitoring and management system in cloud. *Future Generation Computer Systems*, *96*, 731-749.