Ben-Gurion University of the Negev

Faculty of Engineering Science

School of Electrical and Computer Engineering

Dept. of Electrical Engineering

Finals IOT Project

"Integrated IoT Solution for Enhancing Workplace Efficiency and Security"

Group Number	**8**
Students	**Tal Shvartzberg – 316581537** **talshva@post.bgu.ac.il** **Oren Schor - 316365352** **schoro@post.bgu.ac.il**
Supervisor	**Guy Tel-Zur**
Submission date	**22.03.24**

Table of Contents:

1. Abstract 3
2. Introduction 4
3. Literature Review 5
4. Methodology: 6
5. References 9
6. Appendices 10

1. Abstract

This project presents an integrated Internet of Things (IoT) solution aimed at enhancing workplace efficiency and security within an office environment. Utilizing a variety of IoT technologies, including sensors, smart ID cards, and facial recognition, the project introduces a sophisticated system for managing security entrances, personalizing climate control, and optimizing operational procedures through a centralized cloud-based platform. By collecting information on entry and exit times, computer usage patterns, and individual climate preferences, the system leverages cloud computing's robust data processing capabilities to uncover valuable insights. These insights not only facilitate a more secure and personalized work environment but also empower management with data-driven recommendations to augment employee productivity and satisfaction. The project underscores the important role of cloud computing in transforming workplace dynamics through continuous data analysis, highlighting its impact on security enhancement, productivity increase, and the promotion of data-informed decision-making.

2. Introduction

In the rapidly evolving landscape of workplace management, the integration of technology has become paramount in fostering environments that are not only productive but also congenial and secure. The advent of the Internet of Things (IoT) offers unprecedented opportunities to revolutionize the way office facilities are managed, addressing long-standing challenges in creating spaces that are conducive to both employee well-being and operational efficiency. Despite the advancements, many offices still grapple with outdated systems that hinder workplace dynamics, posing a problem in achieving optimal productivity and security.

The necessity for a comprehensive system that seamlessly manages office facilities while enhancing the worker experience is more pronounced than ever. Traditional methods of office management often fall short in providing a convenient, friendly, and secure environment, leading to many inefficiencies that can impede organizational growth and employee satisfaction. Furthermore, in an era where financial wisdom is as crucial as technological adoption, there is a compelling need to devise solutions that not only improve the quality of the work environment but also contribute to significant cost savings.

This project proposes an integrated IoT solution aimed at transforming the office landscape by focusing on critical aspects such as entrance management and environmental control. By leveraging IoT technology, the project seeks to streamline access control, customize climate settings to individual preferences, and enhance overall workplace security. Although the scope of this project is limited to these aspects, the potential applications of IoT in office management are vast, indicating that the exploration of such technologies is just beginning.

By providing a blueprint for integrating technology into everyday office operations, this project underscores the critical role of IoT in shaping the future of workplace management, where efficiency, security, and employee satisfaction are inextricably linked.

3. Literature Review

Recent advancements in IoT technologies have significantly influenced workplace management systems, aiming to enhance security and employee productivity. The integration of IoT in workplace environments, as highlighted by the emergence of various IoT technologies, including edge AI, IoT-based streaming analytics, and advanced connectivity options like eSIM and Wi-Fi 6, demonstrates the potential for creating more secure, efficient, and user-friendly office spaces [1]. Furthermore, the application of IoT for real-time posture monitoring underscores the technology's role in promoting health and well-being in the workplace by preventing musculoskeletal disorders through posture correction alerts, showcasing IoT's ability to contribute to both operational efficiency and employee health [2].

Additionally, IoT's role in developing contactless systems, as seen in temperature measuring and attendance monitoring to combat COVID-19, illustrates the adaptability and relevance of IoT solutions in addressing immediate and practical workplace challenges [3]. The comparative study on real-time face recognition further exemplifies IoT's application in enhancing workplace security, providing insights into the performance of IoT platforms and cloud infrastructures in executing security tasks efficiently [4].

These studies collectively highlight the multifaceted benefits of integrating IoT technologies in workplace management systems. They not only contribute to creating a more secure and efficient environment but also address employee well-being and health, showcasing IoT's potential to transform workplace experiences comprehensively.

4. Methodology:

While the broader vision of our project encompassed the creation of a smart office environment complete with climate control, data analysis and other advanced features, we chose to focus specifically on implementing the smart authentication door access component. This decision was made to ensure a concentrated effort on enhancing security and efficiency at the workplace through innovative IoT solutions.
Our journey to bring this aspect of the project to life involved a comprehensive methodology that balanced theoretical exploration with practical application, highlighting the significance of targeted innovation in achieving impactful results.

The journey from concept to reality required a deep dive into existing technologies, hands-on experimentation with IoT devices, and the integration of various software protocols. This section outlines the key steps in the process, emphasizing the exploration, learning, and implementation phases.

Exploration and Conceptualization

- Identifying the Need: The initial phase involved understanding the challenges faced by modern workplaces in terms of efficiency and security. By reviewing current literature and existing solutions, we identified gaps where an IoT-based solution could offer significant improvements.

- Technology Scouting: We explored various IoT technologies, including sensors, modules, and platforms, that could be leveraged to build the solution. This involved studying the capabilities of devices like the ESP32-CAM, RFID readers, and Raspberry Pi Pico W, and how they could be utilized in an office environment.

- Code Examples and Libraries: To speed up the development process, we searched for open-source projects and code examples that demonstrated the use of these devices in similar applications. Repositories on platforms like GitHub provided valuable resources for facial recognition, RFID authentication, and device communication.

Learning and Development

- Understanding IoT Protocols: A significant part of the learning process was dedicated to understanding communication protocols essential for IoT applications, such as MQTT and HTTPS. We studied how these protocols facilitate secure and efficient data exchange between devices and servers.

- Software and Hardware Integration: Hands-on experimentation was crucial. We practiced integrating the ESP32-CAM, the Raspberry Pi Pico W and the RFID modules. This phase involved a lot of trial and error, learning how to troubleshoot hardware issues, and optimizing the system for reliable performance.

- Security and Privacy: Learning about data security and privacy was paramount, given the project's focus on workplace security. We explored best practices for encrypting data transfers and ensuring that user data, especially facial recognition information, was handled responsibly.

Implementation and Testing

- Building the Prototype: With a solid understanding of the necessary technologies and protocols, we began assembling the prototype. This involved configuring the ESP32-CAM for facial recognition, setting up the RFID reader for card scanning, and programming the Raspberry Pi Pico W to control the access mechanism.

- Software Development: Parallel to hardware assembly, we developed the software to manage device communication, data processing, and integration with cloud services. This included writing scripts for MQTT messaging, setting up InfluxDB and Grafana for data visualization, and implementing webhooks for Google Drive uploads.

- Real-world Testing: The final phase involved deploying the system in a controlled environment and conducting rigorous testing. This helped identify any practical issues that weren't apparent during the development phase, such as the system's response to different lighting conditions or how it handled multiple simultaneous access attempts.

Reflection and Iteration

After the initial deployment, we reflected on the project's outcomes, gathering feedback from users to identify areas for improvement. This iterative process involved revisiting the code, refining the hardware setup, and enhancing the system's functionality based on real-world performance and user experiences.

Repository and Code Management:

The project's GitHub repository, located at this link, contains all the source code, libraries, and documentation necessary for setting up and running the system. It includes detailed instructions on configuring the hardware components, installing the necessary software libraries, and deploying the system.

Bringing this IoT project to life was a journey of learning and discovery, requiring a blend of technical skills, creativity, and persistence. By leveraging existing code examples, integrating diverse technologies, and navigating the complexities of IoT protocols, we were able to develop a sophisticated solution that addresses the pressing needs of modern workplaces.

5. References

[1] IoT Analytics (2022). "55 Emerging IoT Technologies You Should Have on Your Radar." https://iot-analytics.com/iot-technologies/

[2] La Mura, M., De Gregorio, M., Lamberti, P., & Tucci, V. (2023). IoT System for Real-Time Posture Asymmetry Detection. *Sensors (Basel, Switzerland)*, *23*(10), 4830-. https://doi.org/10.3390/s23104830

[3] Tamilselvan, S., Ramesh, R., Niveda, R., Poonguzhali, P., & Dharani, S. (2021). IoT based Touch-free Attendance System (ITAS). *Journal of Physics: Conference Series*, *1917*(1), 12012-. https://doi.org/10.1088/1742-6596/1917/1/012012

[4] Ahmed, A., Saha, S., Saha, S., Bipul, M. Y., Md Imran, S., Muslim, N., & Islam, S. (2020). Real-time face recognition based on IoT: A comparative study between IoT platforms and cloud infrastructures. *Journal of High-Speed Networks*, *26*(2), 155–168. https://doi.org/10.3233/JHS-200636

6. Appendices

Hardware

- ESP32-CAM module
- RFID reader module (MFRC522)
- Raspberry Pi Pico W
- I2C LCD display
- Servo motor

Software

- Mosquitto MQTT Broker on PC
- Python 3 on PC with paho-mqtt library (pip install paho-mqtt)
- CircuitPython firmware for ESP32-CAM
- MicroPython firmware on Raspberry Pi Pico W
- Libraries for interfacing with I2C LCD and RFID on Pico W
- InfluxDB and Grafana for data visualization