**College of Engineering and Computer Technology**

**APPROVED DESIGN PROJECT for BSCpE Program**

1st Semester SY 2023 - 2024

**Approved Design Project**: EcoSync - Smart Energy Management Control with Occupancy Awareness

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**Abstract**

This research introduces "EcoSync - Smart Energy Management Control with Occupancy Awareness," a system aimed at optimizing energy consumption through intelligent management and occupancy awareness. The study employs a mixed-methods approach, combining quantitative data collection with qualitative insights from user feedback. The proposed EcoSync prototype integrates room-specific occupancy sensors, a user-friendly mobile application, and features such as energy goal setting, nighttime optimization, and user prompts for manual adjustments.

The significance of this work lies in addressing the critical need for efficient energy management, contributing to global energy conservation goals. The research's impact extends by providing an innovative solution to the challenge of energy wastage and aligning with advancements in computer engineering. The outcomes aim to contribute valuable insights and advancements to the broader community interested in smart energy management systems.

**Introduction**

The increasing emphasis on sustainable energy practices has spurred interest in intelligent energy management strategies. This project introduces "EcoSync - Smart Energy Management Control with Occupancy Awareness," a system designed to optimize energy usage through a combination of occupancy awareness and intelligent management. By integrating an advanced occupancy sensor with intelligent energy control, EcoSync aims to enhance energy efficiency while prioritizing user conveniency.

The system is complemented by a user-friendly mobile application, providing an intuitive interface for monitoring and controlling energy consumption. This initiative draws insights from Varakantham, P., Gupta, H. O., & Ghosh, S. (2017), contributing to the discourse on smart grids and intelligent energy management strategies. In doing so, we aim to advance sustainable energy practices and technological innovation.

**Design Project Objectives**

The aim of this project is to establish and implement "EcoSync - Smart Energy Management Control with Occupancy Awareness," an intelligent system designed for managing energy consumption. The primary focus is on optimizing energy use in residential and commercial spaces by incorporating occupancy awareness and intelligent energy control. Through the creation of a user-friendly mobile application and the integration of room-specific occupancy detection, along with energy-saving features, the goal is to minimize unnecessary energy usage, promote sustainable practices, and align with the global initiative for energy conservation. The EcoSync system strives to enhance overall energy efficiency while ensuring user comfort and convenience.

1. **Design and Implement Energy Management System:**
   * Develop an energy management system that optimizes consumption based on occupancy awareness.
2. **User-Friendly Mobile Application:**
   * Design and implement a mobile application for remote control and monitoring of the smart energy management system.
3. **Integration of Occupancy Sensor:**
   * Implement room-specific occupancy detection to enhance energy efficiency.
4. **Energy Consumption Analytics and Reporting:**
   * Provide users with comprehensive reports, trends, and insights into their energy usage patterns over time.

**Respondents**

For this study, the participation of residents or occupants in both residential and commercial spaces where the EcoSync system is deployed is essential. The experiences and feedback from these participants will play a critical role in evaluating the effectiveness and usability of the EcoSync prototype. Employing a purposive sampling method, a sample size of 20 participants has been chosen based on the specific criteria relevant to the study. This approach ensures that the selected participants offer diverse perspectives, reflecting various occupancy patterns in different settings. The decision for a sample size of 20 is guided by the relevance of participants to the study rather than statistical considerations, emphasizing a balanced approach that allows for meaningful insights while considering the practical constraints of a student project. This adjusted sample size is designed to yield valuable feedback on the EcoSync prototype, striking a practical balance between research objectives and resource limitations.

**Methodology**

The development of the EcoSync prototype will follow an Agile Model methodology, which emphasizes flexibility, collaboration, and iterative progress. This approach is well-suited for dynamic projects that involve evolving requirements, such as the integration of hardware, software, and real-world testing in diverse occupancy scenarios. The Agile Model will allow for continuous feedback and adjustments throughout the development process.

1. **Project Planning and Sprint Definition:**
   * Define project goals, scope, and objectives.
   * Break down the project into manageable features and functionalities.
   * Collaboratively plan and prioritize features for each sprint.
2. **Hardware Integration:**
   * Identify and procure necessary hardware components for the occupancy sensor and energy control system.
   * Develop a modular approach for hardware integration to facilitate scalability and future upgrades.
   * Conduct regular sprint reviews to assess hardware integration progress.
3. **Software Development:**
   * Develop the backend system for intelligent energy management, focusing on optimizing consumption based on occupancy patterns.
   * Concurrently, design and implement the user-friendly mobile application for remote control and monitoring.
   * Use an iterative approach to refine features based on ongoing feedback.
4. **Occupancy Detection Implementation:**
   * Integrate room-specific occupancy sensors into the system.
   * Fine-tune the occupancy detection algorithm to ensure accuracy and reliability.
   * Test the occupancy detection system in various room configurations.

Prototyping

Developmental Stage

1. **Prototype Testing in Real-world Scenarios:**
   * Conduct real-world testing in residential and commercial settings to simulate diverse occupancy scenarios.
   * Gather quantitative data on energy consumption through the prototype.
   * Collect qualitative insights through user surveys and interviews to assess user experiences.
2. **Iterative Development and User Feedback:**
   * Regularly review progress and user feedback at the end of each sprint.
   * Implement necessary adjustments and improvements based on feedback.
   * Continue refining features and addressing any issues identified during testing.
3. **Nighttime Optimization Implementation:**
   * Develop and integrate the nighttime optimization feature to deactivate the occupancy detector during nighttime.
   * Ensure that the system effectively adapts to different nighttime scenarios.
4. **User Interaction and Notification System:**
   * Implement a notification system to prompt user interaction when an unoccupied room is detected.
   * Develop user-friendly interfaces for manual adjustments and response to notifications.
   * Fine-tune the timing and logic of notifications based on user preferences.
5. **Final Prototype Validation:**
   * Conduct a comprehensive validation of the final EcoSync prototype.
   * Evaluate the overall system performance, energy efficiency, and user satisfaction.
   * Address any remaining issues and finalize the prototype for deployment.

*Approved during the Design Project Title Presentation on December 7 and 11, 2023.*

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