ESP-JETA
ESP Journal of Engineering & Technology Advancements
ISSN: 2583-2646 / Volume 4 Issue 2 April 2024 / Page No: 72-76
Paper Id: JETA-V4I2P111 / Doi: 10.56472/25832646/JETA-V4I2P111

Original Article

Sustain Home: A Renewable Energy-Driven, User-Friendly IoT Based Smart Home System

S.Jeyanthi[1], B. Jeyapadma[2], K. Sakthi Karuppasamy[3], M. Vairamani[4]
[1,2,3,4]*Department of Electrical and Electronics Engineering, Ramco Institute of Technology, Rajapalayam, India.*

Received Date: 18 February 2024 Revised Date: 16 March 2024 Accepted Date: 19 April 2024

Abstract: *In recent years, there has been an increasing interest in utilizing IoT technology to integrate renewable energy sources and enhance user experience. This project introduces an innovative approach to creating a smart home system that merges IoT capabilities with renewable energy sources to establish a sustainable and comfortable living environment. Solar panels are incorporated into the proposed smart house system to mitigate carbon emissions and reduce reliance on conventional grid electricity. Users have the ability to remotely monitor and manage various aspects of their home environment through smartphone applications and IoT-enabled devices and sensors distributed throughout the house. Key components of the system include smart lighting systems for energy-efficient illumination, smart thermostats for temperature regulation, and intelligent appliances that adapt their operation based on energy availability and user preferences. Furthermore, the system integrates sophisticated energy management algorithms to enhance energy efficiency, prioritize renewable energy sources, and minimize overall consumption. A user-friendly interface is crucial for the success of a smart home system. Therefore, voice-activated virtual assistants and user-friendly smartphone apps are being developed to facilitate easy user engagement and customization. Through these interfaces, users can receive alerts and messages, adjust settings to suit their preferences and lifestyle, and monitor energy generation and consumption in real-time. Additionally, the proposed smart home system is designed to be expandable and adaptable, making it easy to incorporate new devices and technologies in the future.*

Keywords: *Internet of Things (IoT), Solar Energy, Home Automation, Energy Management.*

I. INTRODUCTION

This introduces an innovative smart house design that seamlessly integrates IoT technology and renewable energy for sustainable living. By leveraging real-time data insights, our system ensures smooth integration while optimizing energy usage. Solar panels capture sunlight, while wind turbines harness wind energy to power the home efficiently. IoT sensors regulate lighting, heating, and cooling based on tenant preferences and environmental conditions. Excess energy is stored in batteries for future use, ensuring continuous comfort. Residents can use intuitive interfaces to monitor and control their home's energy consumption, fostering environmentally conscious habits. This cutting-edge approach revolutionizes modern living by blending sustainability and comfort in perfect harmony. Welcome to the future of smart housing.

II. LITERATURE SURVEY

The integration of renewable energy sources, particularly solar panels, into smart home systems has garnered significant attention in recent years. By harnessing solar energy, these systems aim to reduce reliance on traditional grid electricity, thereby lowering carbon emissions and promoting sustainability [1]. This approach not only enhances environmental stewardship but also fosters energy independence, contributing to a cleaner and more resilient future.

In parallel, the proliferation of sensors and IoT-enabled devices within smart homes has revolutionized energy management and user experience. These devices continuously collect real-time data on various parameters such as temperature, humidity, light levels, and occupancy, enabling intelligent automation processes [2]. Complex algorithms analyze this data to optimize energy efficiency, improve comfort, and anticipate occupant needs. Such systems empower residents to make informed decisions regarding energy usage patterns, ultimately promoting sustainable behavior [3].

Central to the effectiveness of these smart home systems is the user interface, often in the form of a mobile application. Through intuitive interfaces, users can monitor and control their home environment, adjust settings, receive alerts, and track real-time energy usage and generation [4]. This mobile app provides convenient access to vital information and control over smart home devices, enabling users to optimize comfort, efficiency, and sustainability from anywhere [5].

At the core of these smart home systems lies advanced energy management algorithms. These algorithms analyze real-time data on energy usage and generation, prioritizing renewable sources such as solar power to reduce grid reliance and maximize sustainability [6]. By optimizing energy usage through intelligent algorithms, these systems ensure efficient

operation of appliances and systems, thereby minimizing waste and energy expenditures. Moreover, by scrutinizing usage patterns and employing automation, these systems help users reduce overall energy consumption, encouraging energy-conscious behavior and contributing to a greener living environment [7].

III. PROPOSED WORK

Proposed work on this project aims to expand the system's capabilities and enhance its performance in several key areas. Firstly, there is potential for integrating additional renewable energy sources, such as wind turbines and geothermal energy, to further diversify and optimize energy generation. Secondly, the development of advanced machine learning algorithms will be explored to refine energy consumption patterns and enhance the overall user experience. Finally, there will be a focus on implementing robust security protocols to safeguard user data and ensure the integrity and functionality of the system. These proposed enhancements will contribute to the ongoing evolution of the smart home system, reinforcing its commitment to sustainability, efficiency, and user satisfaction.

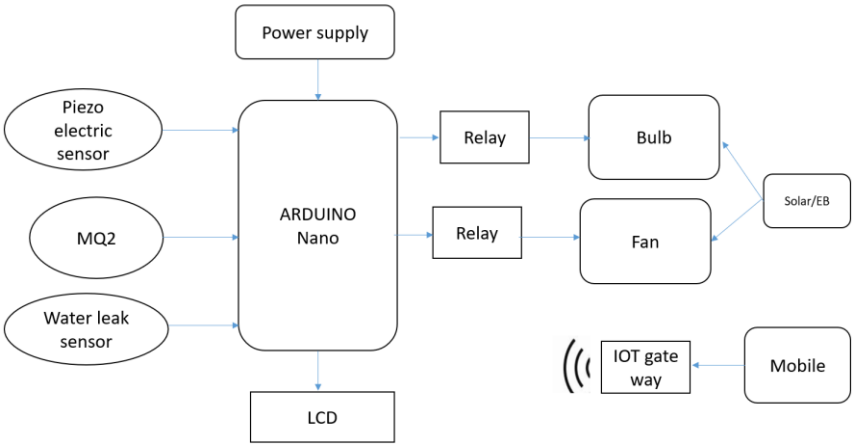

Figure 1: Block Diagram

A. Piezoelectric Sensor

This is the core component of the sensor, usually made of a piezoelectric material such as quartz, PZT (Lead Zirconate Titanate), or PVDF (Polyvinylidene Fluoride). When subjected to mechanical stress or pressure, the piezoelectric element generates an electric charge proportional to the applied force. The piezoelectric element is typically sandwiched between two electrodes. These electrodes facilitate the collection of the electric charge generated by the piezoelectric material.

B. Relay Module

A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the Arduino pins. This relay module has two channels. There are other models with one, four and eight channels. This module should be powered with 5V, which is appropriate to use with an Arduino. There are other relay modules that are powered using 3.3V, which is ideal for ESP32, ESP8266, and other microcontrollers.

C. MQ Sensor

The MQ sensor, a versatile gas sensor widely used in home automation, enhances safety and comfort by detecting various gases like carbon monoxide, methane, and propane. Integrated into smart home systems, these sensors continuously monitor air quality, triggering alerts in the event of gas leaks or hazardous levels of pollutants. Through seamless connectivity with home automation platforms, users receive real-time notifications via mobile apps or smart devices, enabling prompt response and mitigation measures. By providing actionable insights into indoor air quality, MQ sensors contribute to a healthier living environment while safeguarding against potential gas-related risks, ensuring peace of mind for homeowners.

D. Water Leakage Sensor

Water leakage sensors are integral to modern home automation, offering proactive protection against water damage. These sensors are strategically placed in areas prone to leaks, such as kitchens, bathrooms, and basements. Upon detecting moisture, they trigger alerts via connected smart home systems, notifying homeowners through mobile apps or audible alarms. This timely notification empowers homeowners to take swift action, potentially averting costly damage to property and belongings. By seamlessly integrating into existing home automation networks, these sensors provide peace of mind, enabling users to remotely monitor and manage their homes' water safety from anywhere, at any time.

E. Mobile Application

Mobile application Blynk for home automation streamlines control and monitoring of smart devices with intuitive interfaces and customizable widgets. Users can remotely manage lighting, climate control, security systems, and more, all from their smartphones. Offering real-time status updates and notifications, this app empowers homeowners to stay connected to their homes from anywhere. With Blynk-like functionality, it facilitates seamless integration with a wide range of IoT devices, enabling effortless automation and customization according to individual preferences. By providing a user-friendly and versatile platform, this mobile app enhances convenience, efficiency, and peace of mind in modern home automation setups. Figure 1, represents the block diagram.

A seamless user experience is essential for the success of the proposed smart home system. Key features include:

a) Easy-To-Use Interface:

The mobile app offers a simple interface for effortless interaction with the system. With straightforward controls and clear navigation, users can manage various aspects of their smart home, such as adjusting settings, receiving notifications, and monitoring energy usage. This user-friendly interface enhances the overall smart home experience by increasing convenience and accessibility.

b) Customizable Options:

Users can customize settings based on their preferences and lifestyle, tailoring the system to their specific needs. This personalized approach ensures that the smart home seamlessly adapts to individual preferences, enhancing comfort and convenience for all users.

c) Real-Time Monitoring:

Users have real-time access to energy generation and consumption data, providing valuable insights into usage patterns. With this information at their disposal, users can make informed decisions to enhance energy efficiency, minimize waste, and increase sustainability, enabling them to take proactive measures toward a greener, more efficient home.

IV. RESULTS AND DISCUSSION

"Sustain Home" is a pioneering smart home system that combines IoT technology with renewable energy sources to create a sustainable and user-friendly living environment. By incorporating solar panels and wind turbines, the system reduces reliance on the traditional grid, prioritizing renewable energy and lowering carbon emissions.

Central to the system are strategically placed sensors and IoT-enabled devices that continuously collect real-time data on various parameters such as temperature, humidity, and occupancy. This data is analyzed using sophisticated algorithms to optimize energy efficiency and enhance user comfort. Intelligent automation processes adjust heating, cooling, lighting, and other systems based on user preferences and environmental conditions, minimizing energy waste.

The user experience is streamlined through a mobile application, allowing residents to remotely monitor and control their home environment with ease. Real-time energy usage and generation data empower users to make informed decisions, promoting sustainable behavior and reducing overall consumption.

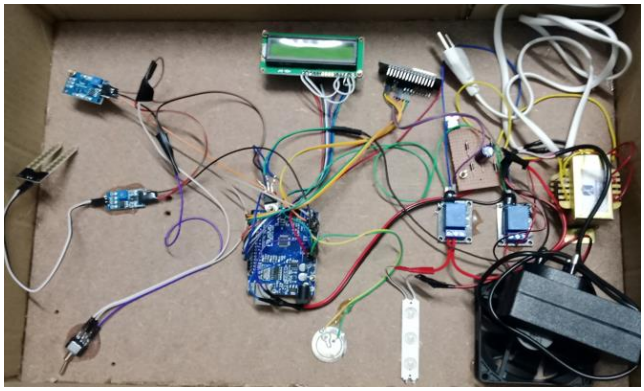

Figure 2: Hardware Setup of the Proposed System

The system is designed to be scalable and compatible, enabling seamless integration of new devices and technologies in the future. Advanced energy management algorithms prioritize renewable energy sources, optimize energy usage, and reduce overall consumption. Figure 2, shows the Hardware setup of the proposed system. This proactive approach not only enhances comfort but also contributes to a greener, more sustainable living environment.

In conclusion, "Sustain Home" represents a paradigm shift in smart home design, prioritizing sustainability and user experience. By blending IoT technology with renewable energy sources, the system sets a new standard for environmentally responsible living in the digital age. Future developments may include integration with additional renewable energy sources, machine learning algorithms to further enhance energy consumption, and implementation of security protocols to safeguard user data and system functionality.

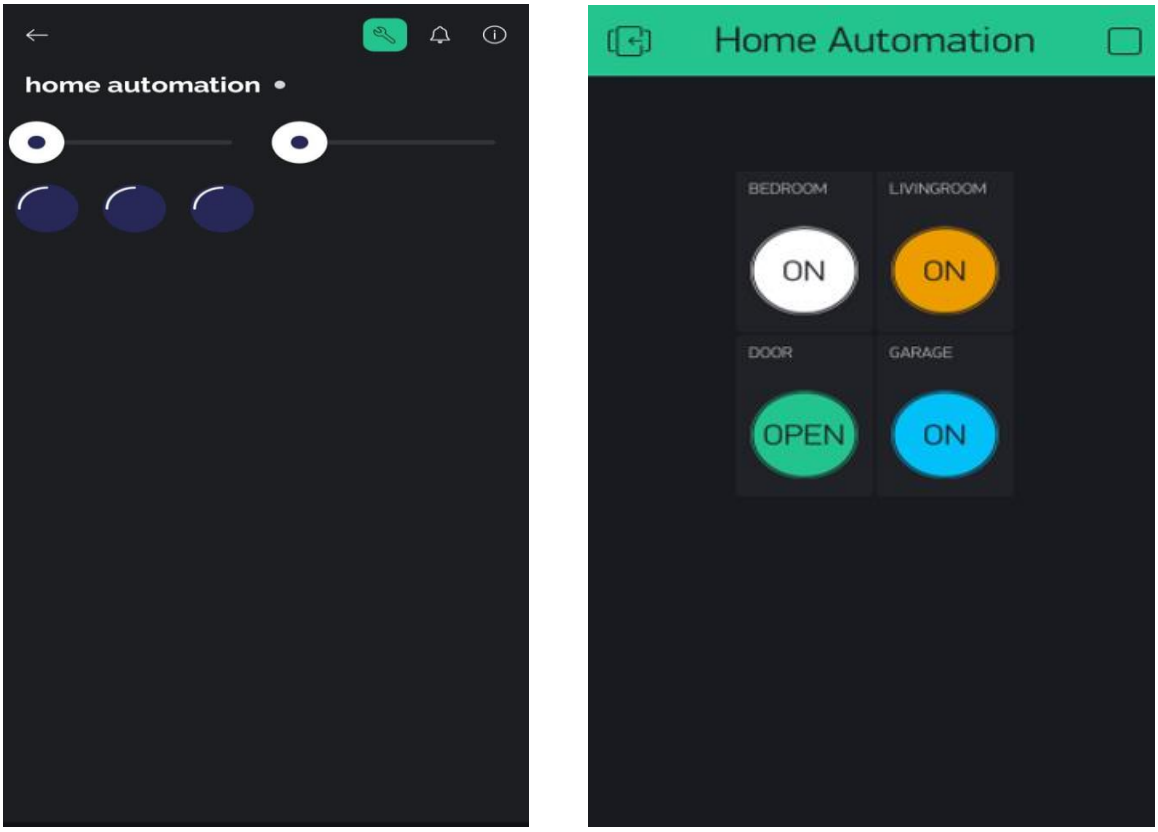

Figure 3: Mobile Application Control

The proposed system is designed to be scalable and compatible, allowing for future expansion and seamless integration of new devices and technologies. This design ensures that the system remains adaptable, enabling it to effortlessly accommodate advancements in smart home technology. Whether incorporating new IoT devices, renewable energy sources, or expanded automation capabilities, the system remains primed for growth. Figure 3, represents the mobile application control. This forward-thinking approach not only future-proofs the smart home but also ensures that it evolves in tandem with technological advancements, consistently delivering cutting-edge capabilities and an unparalleled living experience to its users.

V. CONCLUSION

This pioneering concept redefines smart home design by seamlessly integrating IoT technology with renewable energy, placing sustainability and user experience at the forefront. By harmonizing comfort and eco-consciousness, the system fosters a living environment with minimal environmental impact. Its inherent scalability and interoperability pave the way for ongoing advancements, facilitating continuous improvement and adaptation to evolving user needs and emerging technologies.

Through a holistic approach to design, the system ensures that sustainability and user-centricity are not mutually exclusive but rather complementary aspects. By prioritizing renewable energy sources and leveraging real-time data insights, it optimizes energy usage while enhancing user comfort and convenience. This dynamic equilibrium between environmental responsibility and user satisfaction sets a new standard for modern living, exemplifying the potential of technology to enrich lives while minimizing ecological footprint.

As the smart home landscape evolves, this system stands poised to lead the way, seamlessly integrating new innovations and user preferences. Its commitment to sustainability and innovation not only transforms the way we interact with our homes but also serves as a beacon for environmentally responsible living in the digital era, inspiring future generations to embrace technology as a tool for positive change.

VI. FUTURE SCOPE

Future endeavors for this project entail further exploration into integrating additional renewable energy sources like wind turbines and geothermal energy, broadening the system's sustainability scope. Additionally, the development of machine learning algorithms aims to refine energy consumption patterns and improve user experience, enhancing efficiency and adaptability. Moreover, implementing robust security protocols is paramount to safeguarding user data and ensuring the system's functionality and integrity. These initiatives build upon the foundation set by this study, advancing towards a more sustainable environment where technology not only optimizes energy usage but also prioritizes user security and satisfaction. Through ongoing innovation and refinement, this project continues to contribute to the evolution of smart home systems, aligning with the overarching goal of creating a sustainable and user-centric living environment.

VII. REFERENCES

[1] Saber, M., Nicolas, W., Olivier, L., & Sebastien, M. (2012). *Hemis: Hybrid Multi-agent Architecture for Energy Management and Home Automation. 2012 IEEE Sixth International Conference on Self-Adaptive and Self-Organizing Systems.*

[2] Shabnam, F., Islam, T.-U., Saha, S., & Ishraque, H. (2020). *IoT Based Smart Home Automation and Demand Based Optimum Energy Harvesting and Management Technique. 2020 IEEE Region 10 Symposium (TENSYMP).*

[3] Farid, F., Rehan, M., Faizan, F., & Tahir Qadri, M. (2010). *Home automation and security system via PSTN. 2010 2nd International Conference on Education Technology and Computer.*

[4] Khan, M. F. S., Ahmed, T., Aziz, I., Alam, F. B., Bhuiya, M. S. U., Alam, M. J., ... Mahtab, S. S. (2019). *PLC Based Energy-Efficient Home Automation System with Smart Task Scheduling. 2019 IEEE Sustainable Power and Energy Conference (ISPEC).*

[5] Han, J., Yun, J., Jang, J., & Park, K. (2010). *User-friendly home automation based on 3D virtual world. IEEE Transactions on Consumer Electronics, 56(3), 1843–1847.*

[6] Kim, T., Lee, H., & Chung, Y. (2010). *Advanced universal remote controller for home automation and security. IEEE Transactions on Consumer Electronics, 56(4), 2537–2542.*

[7] Mehrabi, T., Fung, A. S., & Raahemifar, K. (2014). *Optimization of home automation systems based on human motion and behaviour. 2014 IEEE 27th Canadian Conference on Electrical and Computer Engineering (CCECE).*

[8] Asadullah, M., & Ullah, K. (2017). *Smart home automation system using Bluetooth technology. 2017 International Conference on Innovations in Electrical Engineering and Computational Technologies (ICIEECT).*

[9] Ding, J.-R., Sheng, Y.-S., Tu, C.-S., Huang, C.-W., & Su, J.-S. (2010). *The Management of Device Group for Home Automation Network. 2010 Fifth International Conference on Digital Telecommunications.*

[10] Jaihar, J., Lingayat, N., Vijaybhai, P. S., Venkatesh, G., & Upla, K. P. (2020). *Smart Home Automation Using Machine Learning Algorithms. 2020 International Conference for Emerging Technology (INCET).*

[11] Ivanovic, S., Milivojsa, S., Eric, T., & Vidakovic, M. (2017). *Collection and Analysis of System Usage Data in Smart Home Automation Systems. 2017 IEEE 7th International Conference on Consumer Electronics - Berlin (ICCE-Berlin).*

[12] Sayyed Ayesha Baji et al (2019), *Home Automation using IOT Application, International Journal of Research Studies in Science, Engineering and Technology.*