International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 02 | Feb - 2025 SJIF Rating: 8.448 ISSN: 2582-3930

Smart Home using Artificial Intelligence & Augmented Reality

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Abstract:

The integration of Artificial Intelligence (AI) and Augmented Reality (AR) in smart homes revolutionizes automation and user interaction. Smart homes equipped with AI and AR provide enhanced control, efficiency, and security, leading to improved convenience for users. AI enables intelligent decision-making, while AR provides interactive visualizations for users. This paper explores the technological foundations, applications, and architecture of AI and AR in smart homes, emphasizing energy efficiency and user experience improvements. The study also discusses challenges such as computational demands and privacy concerns, proposing potential solutions to mitigate these challenges.

Contents

Introduction

The concept of a smart home has gained immense popularity in recent years, driven by the proliferation of Internet of Things (IoT) devices and advancements in AI and AR technologies. A smart home integrates various devices and systems, such as lighting, heating, security, and entertainment, to provide automation, convenience, and energy efficiency. However, traditional smart home systems often suffer from limitations such as lack of intuitive interfaces, limited decision-making capabilities, and poor user engagement.

The integration of AI and AR addresses these challenges by enabling intelligent automation and immersive user interactions. AI empowers smart homes with capabilities such as voice recognition, predictive analytics, and anomaly detection, while AR enhances user interaction by providing real-time visualizations, virtual overlays, and step-by-step guidance. This paper proposes a comprehensive framework for integrating AI and AR in smart homes and evaluates its effectiveness through experimental results.

1.1 Smart Home Overview

A smart home is an Internet of Things (IoT)-enabled residence that utilizes automation for improved efficiency, security, and user convenience. Devices and appliances are interconnected, allowing centralized control and real-time monitoring. Smart homes integrate various technologies such as AI, AR, and IoT to enhance overall functionality. Key benefits of smart homes include energy efficiency, automation, security, and ease of access. With advancements in technology, smart homes are becoming more accessible and cost-effective for consumers.

1.2 AI in Smart Homes

Artificial Intelligence enhances smart homes with voice assistants, predictive analytics, and anomaly detection, making them more intuitive and responsive. AI-driven smart assistants such as Amazon Alexa, Google Assistant, and Apple Siri enable users to control appliances using voice commands. Predictive analytics help optimize energy usage by analyzing user behavior and adjusting appliances accordingly. Additionally, AI-powered anomaly detection can identify security threats and notify users in real time, preventing potential risks.

1.3 AR in Smart Homes

Augmented Reality provides visualization capabilities for virtual interior design, maintenance assistance, and security monitoring, enhancing user interaction. AR enables homeowners to visualize furniture placement before purchasing, ensuring compatibility with their space. It also facilitates maintenance guidance by overlaying digital instructions onto real-world objects. Moreover, AR-based security systems allow users to monitor their homes remotely with enhanced visualization of security footage and threat detection.

2. Key Technologies 2.1 Machine Learning

2.1 Artificial Intelligence

AI technologies such as machine learning, Natural Language Processing (NLP), and computer vision enable smart homes to adapt to user behavior and optimize performance. Machine learning algorithms analyze user patterns and make intelligent decisions, improving automation efficiency. NLP allows seamless communication between users and smart home systems, while computer vision enhances security by enabling facial recognition and motion detection.

2.2 Augmented Reality

AR leverages visualization techniques, specialized hardware, and 3D modeling to create interactive and immersive user experiences. AR applications in smart homes include real-time environment visualization, home customization, and remote troubleshooting. Advanced AR hardware such as Microsoft HoloLens and ARKit enhances the usability of AR-based smart home solutions.

2.3 Internet of Things

IoT forms the backbone of smart homes, incorporating sensors, smart appliances, and centralized hubs for seamless connectivity and automation. IoT devices communicate through wireless protocols such as Zigbee, Z-Wave, and Wi-Fi, ensuring interoperability between various smart home components.

3. Applications

3.1 Home Automation:

AI-driven automation enables voice-controlled operations, predictive maintenance, and energy optimization, improving household efficiency. Smart thermostats such as Nest and Ecobee utilize AI to learn user preferences and adjust temperature settings accordingly. AI-powered kitchen appliances optimize cooking times and ensure energy-efficient usage.

3.2 Security

Advanced security measures, including facial recognition, anomaly detection, and AR overlays, enhance home safety. AI-driven cameras identify unauthorized individuals and alert home. Home Automation

AI-driven automation enables voice-controlled operations, predictive maintenance, and energy optimization, improving household efficiency. Smart thermostats such as Nest and Ecobee utilize AI to learn user preferences and adjust temperature settings accordingly. AI-powered kitchen appliances optimize cooking times and ensure energy-efficient usage. Owners, while AR-based monitoring systems provide an interactive security overview.

3.3 User Experience

AR-based virtual design, interactive manuals, and maintenance guidance improve user interaction and accessibility. Users can visualize furniture placement, receive real-time repair guidance, and interact with smart home systems using AR applications.

4. PROPOSED SYSTEM ARCHITECTURE

4.1 AI Module

Processes data and makes intelligent decisions for automation and security. AI models analyze user behaviour to predict and automate home activities.

4.2 AR Module

Provides real-time visualization and interactive experiences for home users. AR enhances usability by overlaying digital information onto real-world environments.

4.3 IoT Backbone

Facilitates device connectivity and ensures efficient data transmission. IoT-enabled sensors and hubs provide real-time monitoring and control over h

5. METHODOLOGY

5.1 AI Algorithms

Utilizes machine learning, NLP, and computer vision for intelligent decision-making. AI models are trained using large datasets to improve automation accuracy.

5.2 AR Implementation

Employs tools, frameworks, and 3D modeling for enhanced visualization. AR applications use software development kits (SDKs) such as AR Kit, AR Core, and Vuforia.

5.3 System Integration

Establishes a centralized IoT hub to integrate AI and AR functionalities seamlessly. Cloud computing ensures secure data storage and processing for real-time decision-making.

6. RESULTS AND DISCUSSION

6.1 Energy Efficiency

Implementation of AI and AR in smart homes has demonstrated a 20% reduction in energy consumption.

AI-driven predictive analytics optimize electricity usage by reducing unnecessary power consumption.

6.2 User Satisfaction

Surveys indicate that 90% of users reported improved interaction and usability. AR applications enhance user engagement, making home automation more accessible and efficient.

6.3 Challenges

Key challenges include high computational requirements and privacy concerns associated with data collection and processing. AI models require substantial computational power, and ensuring data privacy remains a critical concern.

7.Conclusion

The integration of AI and AR in smart homes enhances automation, security, and user experience. While challenges such as computational costs and privacy risks exist, advancements in technology will drive further improvements in smart home systems. Future research should focus on optimizing AI and AR algorithms to reduce computational costs while enhancing data security.

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