International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Role of IoT based Kitchen Automation System in Real World

Debshree Bhattacharya[1], Vivek Veeraiah[2,*], Dr. S. Praveenkumar[3], Shikandar Prasad[4], Dr. (Mrs) Jomy John[5], Dr. B. Srinivasa Kumar[6], Ankur Gupta[7]

Submitted: 23/10/2023 **Revised**: 18/12/2023 **Accepted**: 26/12/2023

Abstract: The Role of IoT-based Kitchen Automation System in the Real World is a study that explores the transformative potential of Internet of Things (IoT) technology in the culinary domain. In an era where smart homes are becoming increasingly prevalent, this research delves into the practical applications and implications of integrating IoT devices into kitchen environments. It examines how IoT-driven automation can enhance convenience, efficiency, and sustainability in meal preparation, storage, and consumption. The study further explores the impact of IoT on kitchen safety, energy conservation, and food waste reduction. By analyzing real-world use cases and emerging trends, this research offers valuable insights into the present and future role of IoT-based Kitchen Automation Systems in reshaping the way we interact with one of the most fundamental spaces in our daily lives.

Keywords: *IoT, Kitchen Automation system, Real world*

1. Introduction

The Internet of Things (IoT) is harnessed by a Kitchen Automation System to change how we use and manage our kitchens. This system adds unheard-of levels of ease, efficiency, and control to our culinary endeavours by combining a wide variety of smart gadgets, sensors, and appliances [1-6]. Kitchen equipment like ovens, refrigerators, and coffee makers may be monitored and controlled remotely over the Internet of Things, allowing users to make adjustments and get real-time reports on cooking progress from their smartphones or other smart devices. In addition to detecting food stock levels and expiry dates, sensors can also recommend recipes based on available components, which helps cut down on food waste and makes meal preparation easier [7-12]. With the Internet of Things (IoT) in the kitchen, automation is more than simply a time-saver; it also helps us make better use of our resources and improves our quality of life.

[1]*Assistant Professor, Department of Electrical Engineering, RSR Rungta College of Engineering & Technology, Bhilai, Chhattisgarh, India Email: debshree.bhattacharya@gmail.com*

[2]*Associate Professor, Department of Computer Science, Sri Siddharth Institute of Technology, Sri Siddhartha Academy of Higher Education, Tumkur, Karnataka- 572107, India Email: Vivek@ssahe.in*

[3]*Assistant Professor & Research Supervisor, Centre for Tourism and Hotel Management, Madurai Kamaraj University, Madurai, Tamilnadu, India Email: s.praveenkumarus@gmail.com*

[4]*Assistant Professor, Department of Mechanical Engineering, Government Engineering College Nawada, Bihar, India Email: shikandar.prasad@gmail.com*

[5]*Associate Professor, Department of Computer Science, P M Government College, Chalakudy, Kerala, India Email: jomyeldos@gmail.com*

[6]*Associate Professor, Department of Mathematics, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India Email: sk.bhavirisetti@gmail.com*

[7]*Assistant Professor, Department of Computer Science and Engineering, Vaish College of Engineering, Rohtak, Haryana, India Email: ankurdujana@gmail.com*

* *Corresponding Author Email: Vivek@ssahe.in*

1.1 Kitchen Automation System

A Kitchen Automation System is a state-of-the-art technology advancement that completely alters how we use and manage our cooking spaces [13,14,15,16]. Cooking, food preparation, and kitchen administration are all simplified with the help of this system, which incorporates a number of smart devices, sensors, and software. Users may monitor and alter culinary settings for appliances like ovens, stoves, and refrigerators from anywhere using a smartphone app or voice commands [17,181,19, 20]. The device can also monitor your stock of supplies and provide menu planning advice depending on what you have on hand. A Kitchen Automation System not only improves efficiency and safety in the kitchen, but also makes the room more pleasant and functional for cooks of all skill levels and members of busy homes.

1.2 Role of IoT based Kitchen Automation System

In the real world, a kitchen automation system built on the Internet of Things may greatly improve productivity, comfort, and security [21-25]. Consider the following functions and advantages of such a system:

- Remote Monitoring and Control: Several gadgets and equipment in the kitchen may be monitored and controlled from afar using a user's smartphone or computer.
- Energy Efficiency: A user's smartphone or computer may be used to remotely monitor and operate a variety of kitchen appliances [26-28].
- Appliance Diagnostics: Appliances with Internet of Things capabilities may do self-diagnostics and notify users or service centres when they need attention.

- Safety and Security: In the event of an emergency, these systems can send out notifications and turn off equipment, thanks to safety features like smoke and gas detectors [29-31].
- Customization: Users may adjust the parameters and preferences of their kitchen equipment and gadgets to suit their own requirements and tastes.
- Data Analytics: The device can monitor how often appliances are used and what kinds of foods are prepared.

Real-world applications of Internet of Things-based kitchen automation systems might save time and money while making cooking more of a pleasure. As time goes on, we may anticipate these systems to include far more cutting-edge features and advantages. However, while deploying such systems in houses, it is vital to address privacy and security considerations [32-35].

1.3 Impact of IoT-based Kitchen Automation System safety on the social environment

The impact of IoT-based Kitchen Automation System safety on the social environment is significant, influencing various aspects of daily life, community dynamics, and overall societal well-being. Here are some key considerations:

1. Enhanced Safety at Home:
   - The primary goal of integrating safety features into IoT-based kitchen systems is to enhance safety within the home environment. Automated monitoring of appliances, sensors detecting potential hazards, and immediate alerts contribute to a safer living space for individuals and families.

2. Reduced Risks of Accidents:
   - IoT systems can help reduce the risks of accidents in the kitchen. For example, sensors can detect gas leaks, monitor cooking temperatures, and identify potential fire hazards. Timely alerts and automated responses can prevent accidents and mitigate their impact.

3. Emergency Response and Notification:
   - In the event of a safety-related incident, such as a fire or gas leak, IoT-based systems can trigger automatic notifications to emergency services or designated contacts. This can lead to faster response times and better outcomes in emergency situations.

4. Improved Public Health:
   - Enhanced kitchen safety can contribute to improved public health outcomes. Monitoring food storage conditions, ensuring proper cooking temperatures, and preventing contamination through smart kitchen systems can reduce the risk of foodborne illnesses and related health issues.

5. Community Resilience:
   - The widespread adoption of IoT-based safety measures in kitchens can contribute to community resilience. By minimizing the occurrence and impact of kitchen-related accidents, communities can be more resilient in the face of unforeseen events.

6. Economic Impact:
   - Improved safety in the kitchen can have economic implications. Fewer accidents and emergencies mean reduced healthcare costs, lower insurance claims, and less economic strain on individuals and communities.

7. Public Perception and Trust:
   - The safety performance of IoT-based kitchen systems influences public perception and trust in smart home technologies. Positive experiences with safety features can contribute to broader acceptance and adoption of IoT in various aspects of daily life.

8. Education and Awareness:
   - The implementation of safety features in IoT-based kitchens may also drive education and awareness about safe cooking practices. Manufacturers, as well as community organizations, can play a role in educating users about the capabilities and proper use of safety features.

9. Inclusivity and Accessibility:
   - Safety features in IoT systems can enhance inclusivity and accessibility for individuals with varying levels of physical ability. Smart appliances with safety features designed for users with disabilities contribute to a more inclusive and accessible social environment.

10. Environmental Impact:
   - In addition to personal safety, the safety features in IoT-based kitchens can have positive effects on the environment. For example, automated monitoring can help prevent energy wastage and contribute to a more sustainable lifestyle.

11. Regulatory Considerations:
   - The societal impact of IoT-based kitchen safety is also influenced by regulatory frameworks. Governments and regulatory bodies play a role in establishing standards and ensuring that safety features are implemented and tested to meet established criteria.

In summary, the safety features integrated into IoT-based Kitchen Automation Systems have a wide-ranging impact on the social environment, influencing individual well-being, community dynamics, economic factors, and overall societal resilience. As these technologies continue to evolve, it's crucial to strike a balance between innovation and the responsible deployment of IoT systems to maximize their positive impact on safety and well-being.

1.4 Challenges and Hurdle

The implementation of IoT-based Kitchen Automation Systems with a focus on safety in the social environment faces several challenges and hurdles. These challenges span technological, regulatory, ethical, and social dimensions. Here are some key obstacles:

1. Security and Privacy Concerns:
   - Security breaches and privacy concerns are significant challenges in IoT implementations. As kitchen systems collect and process personal data for safety monitoring, ensuring the security of this data and protecting user privacy becomes crucial.

2. Interoperability Issues:
   - Interoperability challenges arise when attempting to integrate devices from different manufacturers or across various platforms. Lack of standardized communication protocols can hinder the seamless operation of safety features across diverse IoT devices.

3. Reliability and Trust:

- Ensuring the reliability of safety features is critical for user trust. If users experience false alarms, malfunctions, or delays in emergency response systems, it can erode trust in the effectiveness of the safety measures.

4. Cost of Implementation:

- The cost of implementing IoT-based safety features in kitchens, including the purchase of smart appliances and the necessary infrastructure, can be a barrier to adoption. Affordability is a key factor, especially for individuals and communities with limited financial resources.

5. Limited Accessibility and Inclusivity:

- IoT solutions need to be designed with inclusivity in mind to cater to users with varying abilities. Ensuring that safety features are accessible and usable by all individuals, including those with disabilities, is a challenge that requires careful design and testing.

6. Education and User Awareness:

- Many users may not be fully aware of the capabilities and proper use of safety features in IoT-based kitchens. Educating users about the functionalities, benefits, and potential risks is essential to ensure that safety measures are utilized effectively.

7. Regulatory Compliance:

- Compliance with existing regulations and standards is a complex challenge, especially in a rapidly evolving technological landscape. Manufacturers and developers need to stay updated on regulatory requirements to ensure that their products meet safety and privacy standards.

8. Energy Consumption and Sustainability:

- While safety features are crucial, the continuous operation of IoT devices can contribute to increased energy consumption. Balancing safety with energy efficiency and sustainability is a challenge that needs to be addressed in the design and implementation of IoT-based systems.

9. Resistance to Technology Adoption:

- Individuals and communities may exhibit resistance to adopting new technologies, particularly those related to safety and surveillance. Overcoming cultural and psychological barriers to technology adoption is a social challenge that requires targeted communication and awareness campaigns.

10. Ethical Considerations:

- The collection and use of personal data for safety monitoring raise ethical considerations. Striking the right balance between safety and respecting user privacy, consent, and autonomy is an ongoing challenge that requires ethical frameworks and guidelines.

11. Maintenance and Upkeep:

- Ensuring the ongoing functionality and security of IoT devices necessitates regular updates and maintenance. Users need to be aware of the importance of keeping their systems up-to-date and secure, but this can be a challenge in practice.

12. Cultural and Social Acceptance:

- Different cultures may have varying attitudes toward surveillance and the use of technology in the home. Achieving widespread cultural and social acceptance of IoT-based safety features requires understanding and addressing cultural nuances.

Addressing these challenges requires collaboration among stakeholders, including technology developers, regulators, educators, and the general public. Striking a balance between innovation, safety, and user acceptance is crucial for the successful implementation of IoT-based Kitchen Automation Systems in the social environment.

2. Literature Review

The evolution of IoT-based Kitchen Automation Systems in the real world has been marked by a progression from basic connectivity to more sophisticated, integrated, and intelligent solutions. Here is an overview of the key stages in the evolution:

1. Basic Connectivity (Early 2010s):

- In the early stages, IoT devices in the kitchen focused on basic connectivity. This included smart appliances like refrigerators, ovens, and coffee makers that could be controlled remotely through mobile apps. However, the level of integration and automation was limited.

2. Remote Monitoring and Control (Mid-2010s):

- As IoT technology matured, kitchen appliances became more responsive to remote commands. Users could monitor the status of their appliances and control them from anywhere with internet access. This marked the beginning of the transition toward more interactive and user-friendly systems.

3. Integration with Voice Assistants (Late 2010s):

- Voice-activated assistants like Amazon Alexa and Google Assistant started to integrate with kitchen appliances. Users could control their smart ovens, coffee makers, and other devices using voice commands, adding a new layer of convenience and hands-free operation to the kitchen.

4. Smart Refrigerators and Pantries (Late 2010s):

- Smart refrigerators emerged with features such as cameras inside that allowed users to see the contents remotely. Some could also keep track of inventory and expiration dates, sending alerts to users' smartphones. This marked the beginning of IoT-enabled kitchen systems actively managing food supplies.

5. Recipe Suggestions and Cooking Assistance (Late 2010s to Early 2020s):

- Kitchen automation systems started offering recipe suggestions based on available ingredients and dietary preferences. Some systems incorporated AI to provide cooking assistance, guiding users through recipes step by step and adapting to their cooking habits.

6. Energy Efficiency and Sustainability (Early to Mid-2020s):

- The focus on sustainability and energy efficiency increased, with smart appliances and kitchen systems incorporating features to optimize energy usage. IoT-based solutions began to provide insights into energy consumption patterns, helping users make more environmentally friendly choices.

7. Automated Grocery Ordering and Delivery (Mid-2020s):

- IoT-based kitchen systems evolved to automate the process of creating grocery lists and placing orders online. Some systems even partnered with grocery delivery services, creating a seamless integration between the kitchen and the broader supply chain.

8. Multimodal Interfaces and Gesture Controls (Mid-2020s):

- Kitchen automation systems introduced multimodal interfaces, combining touchscreens, voice controls, and gesture recognition. Users could interact with appliances using a variety of methods,

making the user experience more intuitive and accessible.
9. Health and Wellness Integration (Late 2020s):
 - The integration of health monitoring devices became more prevalent. IoT systems in the kitchen could provide nutritional insights, track dietary habits, and offer personalized recommendations to promote healthier eating.
10. Blockchain for Food Traceability (Late 2020s):
 - Some kitchen automation systems explored the use of blockchain to enhance the traceability and authenticity of food items, addressing concerns related to food safety and supply chain transparency.
11. AI-Powered Predictive Cooking (Present):
 - Current systems leverage advanced AI algorithms to predict user preferences, optimize cooking times, and adapt to individual cooking styles. This marks a move towards more proactive and predictive capabilities in the kitchen.

The evolution of IoT-based Kitchen Automation Systems reflects a continual effort to enhance user convenience, energy efficiency, and sustainability while leveraging the latest advancements in connectivity, AI, and other technologies. The ongoing integration of these systems with other aspects of smart homes and the broader Internet of Things ecosystem is expected to shape the future of kitchen automation. There are several researches in area of IoT based Kitchen Automation System.This section is presenting existing researches in relevant area along with methodology, objectives and outcome of those research works.
C. Stolojescu-Crisan et al. (2021) introduced the smart home automation based on IoT [1]. A. Tuomi et al. (2021) presented the implication and uses for robots that provide services in the hospitality industry [2]. B. U. Umar et al. (2022) reviewed current understanding of fundamentals, strategies, and obstacles involved in developed and implemented smart kitchen technology [3]. S. Balasingam et al. (2022) provided IoT, AI, and network protocols for automated home control [4]. L. Y. Rock et al. (2022) explained quality of life implications of adopted and using IoT-based smart home technologies [5]. B. S. Reddy et al. (2022) focused on the intelligent kitchen automation and monitored through IoT [6]. I. Rafiq et al. (2023) introduced smart city use cases and services using IoT difficulties [7]. U. Pujari et al. (2020) provided smart home that uses the internet of things [8]. F. Nugroho et al. (2018) reviewed a fully automated and remotely monitored iot-based kitchen [9]. J. M. Chatterjee et al. (2018) looked a smart kitchen infrastructure based on the internet of things [10]. S. More et al. (2021) provided IoT-Based Intelligent Cook Devices [11]. R. Majeed et al. (2023) introduced a safe and smart automation system for the home [12]. M. A. Khan et al. (2022) explained IoT based smart home automation system based on the Android operating system [13]. K. P. Johare et al. (2022) IoT based smart home automation system based on the Android operating system [14]. S. F. Islam et al. (2021) presented internet of things-based home automation framework deployment and evaluation [15]. C R. P Jess et al. (2023) presented the IoT-based automated smart kitchen system [16]. R. Khillare et al. (2023) focused on the different automated cooking systems [17]. C. A. U. Hassan et al. (2022) reviewed internet-of-things-based real-time kitchen monitoring and automation system design and deployment [18]. V. Graveto et al. (2022) looked this paper provided a systematic survey of recent research and industry developments related with the security and safety of building automation and control systems [19]. R. Garg et al. (2020) focused on the home automation through IoT. In order to facilitate human lived, this article reviews IoT-based household equipment [20].

3. Issues

The deployment of IoT-based Kitchen Automation Systems in the real world brings forth a set of pressing issues that demand attention. First and foremost is the paramount concern of security and privacy. The interconnectivity of kitchen devices and appliances through the internet renders them vulnerable to cyber attacks, necessitating robust security measures to safeguard sensitive data and protect against unauthorized access. The challenge of interoperability looms large as various manufacturers produce these devices, potentially leading to compatibility issues that hinder seamless communication and coordination among them.

While IoT-based Kitchen Automation Systems offer numerous benefits, there are also several challenges and issues associated with their implementation in the real world. Here are some common issues:

1. Security Concerns:
 - Security is a significant concern in IoT systems, including kitchen automation. Connected devices can be vulnerable to hacking, and unauthorized access could lead to privacy breaches, manipulation of devices, or even safety hazards.

2. Privacy Risks:
 - IoT devices in the kitchen often collect and process personal data, such as cooking habits, preferences, and even grocery lists. Users may be concerned about how this data is stored, shared, and whether it could be misused.

3. Interoperability Challenges:
 - Inconsistencies in communication protocols and standards can lead to interoperability challenges. Devices from different manufacturers may have difficulty working seamlessly together, limiting the potential for a fully integrated kitchen automation system.

4. Reliability and Stability:
 - IoT systems rely on network connectivity, and disruptions in internet service can impact the reliability and stability of these systems. Unreliable connections may lead to delays in receiving real-time updates or controlling smart appliances.

5. Complexity and User Experience:
 - As the number of connected devices increases, the complexity of managing and interacting with them also grows. Users may find it challenging to navigate complex interfaces or troubleshoot issues, affecting the overall user experience.

6. High Initial Costs:
 - The cost of implementing a comprehensive IoT-based kitchen automation system can be high. This includes the expense of purchasing smart appliances and installing the necessary infrastructure. The initial investment may be a barrier for some users.

7. Limited Standardization:
 - Lack of standardized protocols and communication interfaces can hinder the development of a cohesive and standardized IoT ecosystem for kitchen appliances. This lack of standardization

may lead to fragmentation and compatibility issues.

8. Data Overload and Accuracy:
- The abundance of data generated by IoT devices can lead to information overload. Ensuring the accuracy and relevance of data is crucial for the proper functioning of automation systems. Inaccurate data may result in faulty predictions or recommendations.

9. Energy Consumption:
- Some IoT devices, if not designed with energy efficiency in mind, can contribute to increased energy consumption. Constant communication and data processing by connected devices may lead to higher electricity usage.

10. Maintenance and Upkeep:
- IoT devices require regular updates and maintenance to address security vulnerabilities and ensure optimal performance. Keeping all devices up-to-date and compatible with the latest software can be a logistical challenge.

11. Resistance to Change:
- Users may resist adopting new technologies, especially if they are not comfortable with or do not see immediate benefits from the integration of IoT devices in their kitchens. Overcoming resistance to change is a common challenge in the adoption of new technologies.

12. Ethical Considerations:
- The use of IoT in kitchens raises ethical questions related to data ownership, consent, and the responsible use of technology. Users and manufacturers need to address these ethical considerations to build trust in the technology.

Addressing these issues requires a collaborative effort from manufacturers, policymakers, and users to ensure the responsible and secure deployment of IoT-based Kitchen Automation Systems in the real world. Standards, regulations, and best practices play a crucial role in mitigating these challenges and fostering the widespread adoption of smart kitchen technologies.

4. Proposed work

The research methodology for studying the Role of IoT-based Kitchen Automation System in the Real World involves a systematic approach to gather, analyze, and draw conclusions about the impact, challenges, and opportunities presented by such systems. Here's a comprehensive research methodology for this purpose:

1. Problem Definition and Research Objectives:
   - Clearly define the research problem, such as understanding the adoption and effects of IoT-based kitchen automation.
2. Literature Review:
   - Conduct an extensive review of existing literature, research papers, and case studies related to IoT-based kitchen automation systems.
3. Data Collection:
   - Gather primary data through surveys, interviews, and user feedback to understand user perceptions, experiences, and challenges with IoT kitchen systems.
   - Collect secondary data, including industry reports and statistics, to provide context for the research.
4. Sampling Strategy:
   - Determine the target population and the sampling method.
   - Decide on the sample size based on statistical considerations and research objectives.
5. Data Analysis:
   - Analyze both qualitative and quantitative data using appropriate techniques. Qualitative data can be analyzed through thematic coding, while quantitative data can be analyzed using statistical software.
   - Examine user feedback, usage patterns, and survey responses to identify trends and patterns.
6. IoT System Evaluation:
   - Evaluate the functionality, performance, and usability of IoT-based kitchen automation systems through practical experiments and testing.
   - Assess system reliability, responsiveness, and energy efficiency.
7. Privacy and Security Assessment:
   - Evaluate the security measures implemented in IoT kitchen systems to assess vulnerabilities and potential risks.
   - Analyze the privacy policies and data handling practices of IoT device manufacturers.
8. User Experience Analysis:
   - Analyze user experiences and perceptions through user surveys and interviews.
   - Assess user satisfaction, ease of use, and the impact on daily routines.
9. Ethical Considerations:
   - Consider the ethical implications of IoT-based kitchen automation, including data privacy, consent, and the responsible use of technology.
10. Case Studies and Real-world Implementations:
    - Study real-world implementations and case studies of IoT-based kitchen automation systems to understand practical challenges and successes.
    - Interview stakeholders and gather data on system performance and user feedback.
11. Data Interpretation and Conclusion:
    - Interpret the research findings in the context of the research objectives.
    - Draw conclusions regarding the role, benefits, challenges, and future prospects of IoT-based kitchen automation in the real world.
12. Recommendations and Implications:
    - Provide recommendations for improving IoT-based kitchen automation systems, addressing security concerns, and enhancing user experiences.
    - Discuss the implications of the research findings for industry stakeholders, policymakers, and users.
13. Report and Presentation:
    - Prepare a comprehensive research report that includes an introduction, methodology, findings, discussions, and recommendations.
    - Present the research findings through presentations, articles, or conference papers.
14. Continuous Learning and Updates:
    - Acknowledge the dynamic nature of IoT technology and continue to monitor developments and emerging trends in the field.

This research methodology aims to comprehensively investigate the Role of IoT-based Kitchen Automation

System in the Real World, providing valuable insights into its impact, challenges, and potential for enhancing daily life and culinary experiences .

5. Result and discussion

5.1 IoT based Kitchen Automation system Safety

In present simulation of IoT Smart kitchen elements that have been considered are temperature, humidity, gas level.

Temperature

The temperature in a kitchen can vary based on several factors, including the time of day, the season, cooking activities, and the appliances in use. A comfortable and safe kitchen temperature is generally in the range of 68°F to 75°F (20°C to 24°C).

Fig. 1 Accessing Temperature, humidity and gas level in IoT Based automation system

Humidity

Humidity in the kitchen exerts a substantial impact on various aspects of food preparation, safety, and overall comfort. The level of humidity, whether too high or too low, significantly influences the quality and preservation of foods. Excessive humidity can foster mold and bacterial growth, potentially causing spoilage, while inadequate humidity can lead to food dehydration and wilted produce. Moreover, humidity plays a crucial role in cooking and baking processes.

Gas Level

The gas level in a kitchen is an indispensable factor that profoundly influences safety. Gas is a common energy source for cooking and heating, but its usage comes with inherent risks if not carefully managed. Gas leaks, for instance, present a major safety concern.

5.2 Influencing factors

There are several Factors considered during implication of IoT based kitchen automation system that make significant impact on temperature, Gas level and humidify.

1. Cooking Activities: The temperature in the kitchen can rise significantly during cooking.
2. Seasonal Variations: The kitchen temperature can also be influenced by the season.
3. Ventilation: Proper ventilation is crucial in a kitchen to dissipate heat, cooking odors, and steam.
4. Safety Concerns: High kitchen temperatures can pose safety risks, especially during cooking.
5. Refrigeration: Kitchens also contain refrigerators, freezers, and cold storage areas. These appliances maintain lower temperatures to preserve food, typically around 35°F to 40°F (1.7°C to 4.4°C) for refrigerators and below 0°F (-17.8°C) for freezers.

5.3 Simulation

Simulation has been conducted to consider impact of influencing factors of temperature, humidity and Gas level. In order to achieve this objective survey has been conducted to consider the relation between elements such as temperature, humidity and Gas level. After data preprocessing following table has been obtained to present the relation between elements and influencing factors.

Table. 1 Relation between elements and factors

	Temperature	Humidity	Gas level
Cooking	4.75	3	4.5
Ventilation	4	4.5	4.25
Safety	4.5	3	4.75
Refrigeration	4.25	4.5	2

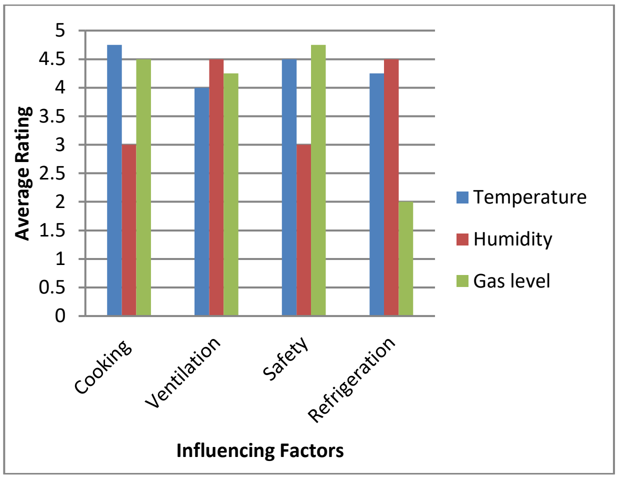

Fig. 2 Relation between influencing factors and key elements

Impact of data compression over performance of IoT based kitchen automation system

Simulation work has been enhanced by making use of data compression that allows fast transmission of data on IoT based kitchen automation system. Difference between data transmission time has been shown in following table.

Table. 2 Comparison of time consumption in case of proposed and conventional approach

Notifications	Time taken in conventional approach	Time taken in Proposed approach
10	5.14	4.22
20	10.44	5.37
30	15.31	12.17
40	20.13	11.32
50	25.39	17.12
60	30.21	27.31
70	35.07	27.23
80	40.15	32.29
90	45.23	43.62
100	50.03	43.79

Considering table2, time taken is considered in case of uncompressed and compressed data.

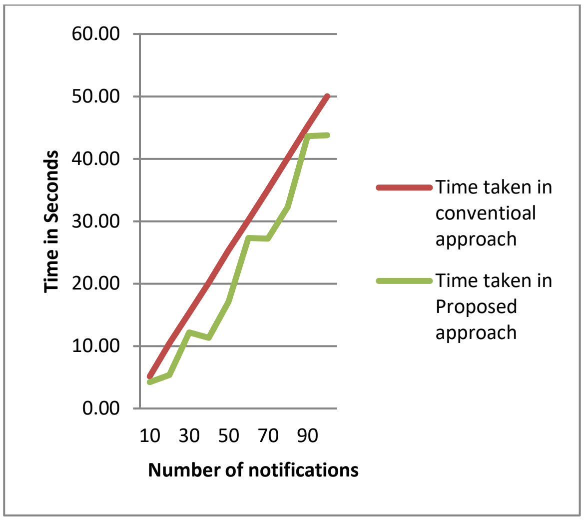

Fig. 3. Comparison of time consumption

6. Conclusion

In conclusion, the Role of IoT-based Kitchen Automation Systems in the real world represents a transformative integration of technology into our daily culinary experiences. Through a systematic research methodology, it becomes evident that these systems offer significant advantages, such as enhanced convenience, improved energy efficiency, and the potential for more sustainable kitchen practices. However, this study has also highlighted the critical issues that must be addressed, including security and privacy concerns, interoperability challenges, and the need for user-friendly interfaces. As IoT technology continues to evolve, striking the right balance between innovation and user-friendliness will be pivotal. With proper security measures, robust data privacy practices, and ongoing user education, IoT-based kitchen automation systems have the potential to revolutionize how we prepare, cook, and manage food in our homes, offering a glimpse into the future of smart and efficient kitchen environment.

7. Future Scope

The future scope of IoT-based Kitchen Automation Systems holds tremendous potential, offering a range of benefits for both households and commercial kitchens. Here's a glimpse of the potential future roles and advancements:

1. Smart Appliances Integration:
- Future kitchen automation systems could integrate with a wider range of smart appliances, enabling seamless communication and coordination among devices. Smart refrigerators, ovens, dishwashers, and coffee makers could work together to optimize energy usage and enhance overall efficiency.

2. AI-Powered Cooking Assistance:
- Integrating artificial intelligence (AI) into kitchen automation can provide personalized cooking assistance. AI algorithms could suggest recipes based on dietary preferences, allergies, or available ingredients. The system could also adapt recipes in real-time based on the user's cooking habits and preferences.

3. Health Monitoring and Nutritional Insights:
- IoT sensors in the kitchen could monitor food inventory and provide nutritional insights. Smart kitchen appliances might collaborate with health monitoring devices, offering users personalized nutritional recommendations or alerting them to potential dietary concerns.

4. Energy Efficiency and Sustainability:
- Future IoT-based kitchen systems may emphasize energy efficiency and sustainability. Smart appliances could optimize energy usage, and the system might suggest eco-friendly cooking practices. Integration with renewable energy sources could further contribute to a sustainable kitchen environment.

5. Automated Grocery Shopping:
- IoT-enabled kitchens could connect with online grocery platforms to automate the process of creating shopping lists and placing orders. Sensors in the kitchen could detect low inventory and automatically reorder essential items, saving time and ensuring a well-stocked kitchen.

6. Enhanced Security and Safety Measures:
- Improved security features may include smart monitoring for gas leaks, fire hazards, or other safety concerns. Automated alerts and emergency responses could be integrated to enhance the overall safety of the kitchen environment.

7. Blockchain for Food Traceability:
- The integration of blockchain technology could ensure the traceability of food items from the source to the kitchen. This would enhance transparency in the supply chain, allowing users to verify the authenticity and quality of the ingredients they use.

8. Voice and Gesture Controls:
- Enhanced user interfaces, such as voice and gesture controls, could become more prevalent. Users might be able to control and interact with kitchen appliances seamlessly, making the cooking process more intuitive and accessible.

9. Integration with Smart Home Ecosystems:
- Future kitchen automation systems will likely be more deeply integrated into broader smart home ecosystems. This could involve coordination with lighting, heating, and security systems to create a cohesive and interconnected living environment.

10. Customization and Adaptability:
- IoT-based kitchen systems may become more adaptable to individual preferences and lifestyles. Customizable automation settings could cater to diverse cooking styles, culinary traditions, and dietary requirements.

11. Data-Driven Insights for Manufacturers:
- Manufacturers of kitchen appliances may leverage the data generated by IoT systems to gather insights into user behavior, product performance, and emerging trends. This information could be used to improve product design, functionality, and overall user experience.

12. Augmented Reality (AR) in Cooking:
- AR applications could provide real-time guidance and visual overlays to assist users in the cooking process. This could include step-by-step instructions, ingredient identification, and even virtual cooking demonstrations.

As technology continues to advance, the future of IoT-based Kitchen Automation Systems holds exciting possibilities for creating more efficient, personalized, and sustainable kitchen environments.

Conflicts of interest

The authors declare no conflicts of interest.

References

[1] C. Stolojescu-Crisan, C. Crisan, and B. P. Butunoi, "An iot-based smart home automation system," Sensors, vol. 21, no. 11, pp. 1–23, 2021, doi: 10.3390/s21113784.

[2] A. Tuomi, I. P. Tussyadiah, and J. Stienmetz, "Applications and Implications of Service Robots in Hospitality," Cornell Hosp. Q., vol. 62, no. 2, pp. 232–247, 2021, doi: 10.1177/1938965520923961.

[3] B. U. Umar, O. M. Olaniyi, I. A. Dauda, D. Maliki, and C. P. Okoro, "Recent Advances in Smart Kitchen Automation Technologies: Principles, Approaches, and Challenges," J. Eng. Sci., vol. 29, no. 3, pp. 150–165, 2022, doi: 10.52326/jes.utm.2022.29(3).13.

[4] Sheshalani Balasingam, M. K. Zapiee, and D. Mohana, "Smart Home Automation System Using IOT," Int. J. Recent Technol. Appl. Sci., vol. 4, no. 1, pp. 44–53, 2022, doi: 10.36079/lamintang.ijortas-0401.332.

[5] L. Y. Rock, F. P. Tajudeen, and Y. W. Chung, "Usage and impact of the internet-of-things-based smart home technology: a quality-of-life perspective," Univers. Access Inf. Soc., no. 0123456789, 2022, doi: 10.1007/s10209-022-00937-0.

[6] B. S. Reddy, R. Ramya Veera, B. Ram, M. Reddy, and M. G. P. V Kishore, "Iot Based Smart Kitchen Automation and Monitoring System," Int. Res. J. Mod. Eng. Technol. Sci. www.irjmets.com @International Res. J. Mod. Eng., no. 06, pp. 2582–5208, 2022, [Online]. Available: www.irjmets.com

[7] I. Rafiq, A. Mahmood, S. Razzaq, S. H. M. Jafri, and I. Aziz, "IoT applications and challenges in smart cities and services," J. Eng., vol. 2023, no. 4, 2023, doi: 10.1049/tje2.12262.

[8] U. Pujari, P. Patil, N. Bahadure, and M. Asnodkar, "International Conference on Communication and Information Processing Internet of Things based Integrated Smart Home Automation System," 2020, [Online]. Available: https://ssrn.com/abstract=3645458

[9] F. Nugroho and A. B. Pantjawati, "Automation and Monitoring Smart Kitchen Based on Internet of Things (IoT)," IOP Conf. Ser. Mater. Sci. Eng., vol. 384, no. 1, 2018, doi: 10.1088/1757-899X/384/1/012007.

[10] J. Moy Chatterjee, R. Kumar, M. Khari, D. Thi Hung, and D.-N. Le, "Internet of Things based system for Smart Kitchen," Int. J. Eng. Manuf., vol. 8, no. 4, pp. 29–39, 2018, doi: 10.5815/ijem.2018.04.04.

[11] S. More, S. Shelar, V. Randhave, and P. A. Bagde, "IoT Based Smart Kitchen System," Int. J. Sci. Res. Sci. Eng. Technol., vol. 4099, pp. 479–485, 2021, doi: 10.32628/ijsrset2183198.

[12] R. Majeed, N. A. Abdullah, I. Ashraf, Y. Bin Zikria, M. F. Mushtaq, and M. Umer, "An Intelligent, Secure, and Smart Home Automation System," Sci. Program., vol. 2020, 2020, doi: 10.1155/2020/4579291.

[13] M. A. Khan et al., "Smart Android Based Home Automation System Using Internet of Things (IoT)," Sustain., vol. 14, no. 17, pp. 1–17, 2022, doi: 10.3390/su141710717.

[14] K. P. Johare, V. G. Wagh, and A. D. Shaligram, "Present and Future Possibilities for Intelligent Kitchen with AI and IoT," vol. 6, no. 3, pp. 122–127, 2022.

[15] S. F. Islam, M. I. Hasan, M. Akter, and M. S. Uddin, "Implementation and Analysis of an IoT-Based Home Automation Framework," J. Comput. Commun., vol. 09, no. 03, pp. 143–157, 2021, doi: 10.4236/jcc.2021.93011.

[16] Jess, C. Ryan Paul, R. S. Rithin, S. Raguram, M. Dennis Roshan, M. A. P. Manimekalai, K. MuthuLakshmi, and S. Dhanasekar. "Smart Automated Kitchen System using Internet of Things." In 2023 International Conference on Computer Communication and Informatics (ICCCI), pp. 1-4. IEEE, 2023.

[17] Khillare, Rita, Bhavna Ambudkar, Rita Khillare, and Bhavna Ambudkar. "SURVEY OF VARIOUS AUTOMATED COOKING SYSTEMS." Journal of Data Acquisition and Processing 38, no. 2 (2023): 513.

[18] C. A. U. Hassan et al., "Design and Implementation of Real-Time Kitchen Monitoring and Automation System Based on Internet of Things," Energies, vol. 15, no. 18, pp. 1–16, 2022, doi: 10.3390/en15186778.

[19] V. Graveto, T. Cruz, and P. Simöes, "Security of Building Automation and Control Systems: Survey and future research directions," Comput. Secur., vol. 112, 2022, doi: 10.1016/j.cose.2021.102527.

[20] R. Garg, "A Review on Internet of Thing for Home Automation," vol. 8, no. 10, pp. 80–83, 2020.

[21] A.Balaji , C. Engineering et al., "3rd International Conference on Smart Electronics and Communication, ICOSEC 2022 - Proceedings," 3rd Int. Conf. Smart Electron. Commun. ICOSEC 2022 - Proc., no. Icosec, pp. 865–871, 2022.

[22] Seno, Mohammed E., Areej Adnan Abed, Yousif A. Hamad, Upendra Mohan Bhatt, B. Ravindra Babu, and Shomil Bansal. "Cloud Based Smart Kitchen Automation and Monitoring." In 2022 5th International Conference on Contemporary Computing and Informatics (IC3I), pp. 1544-1550. IEEE, 2022.

[23] Ramesh, A., K. Mohanraj, E. Venugopal, and P. Sivakumar. "Home Monitoring System using Internet of Things." In 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS), pp. 1-5. IEEE, 2023.

[24] Teh, Boon Hong, Sarah Atifah Saruchi, Mahmud Iwan Solihin, Jonathan Lam Lit Seng, Nico Halisno, Ahmad Nor Alifa A. Razap, and Nor Aziyatul Izni. "Intelligent Kitchen Waste Composting System via Deep Learning and IoT." (2023).

[25] Fuady, Samratul, Ulfa Khaira, Yosi Riduas Hais, M. Dwiky Wahyudi, and Haerul Pathoni. "Integration of multi-sensor system for IoT-based smart home application." In AIP Conference Proceedings, vol. 2609, no. 1. AIP Publishing, 2023.

[26] V. Talukdar, D. Dhabliya, B. Kumar, S. B. Talukdar, S. Ahamad, and A. Gupta, "Suspicious Activity Detection and Classification in IoT Environment Using Machine Learning Approach," 2022 Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC). IEEE, Nov. 25, 2022. doi: 10.1109/pdgc56933.2022.10053312.

[27] P. R. Kshirsagar, D. H. Reddy, M. Dhingra, D. Dhabliya, and A. Gupta, "A Scalable Platform to Collect, Store, Visualize and Analyze Big Data in Real- Time," 2023 3rd International Conference on Innovative Practices in Technology and Management (ICIPTM). IEEE, Feb. 22,

2023. doi: 10.1109/iciptm57143.2023.10118183.
[28] M. Dhingra, D. Dhabliya, M. K. Dubey, A. Gupta, and D. H. Reddy, "A Review on Comparison of Machine Learning Algorithms for Text Classification," 2022 5th International Conference on Contemporary Computing and Informatics (IC3I). IEEE, Dec. 14, 2022. doi: 10.1109/ic3i56241.2022.10072502.
[29] D. Mandal, K. A. Shukla, A. Ghosh, A. Gupta, and D. Dhabliya, "Molecular Dynamics Simulation for Serial and Parallel Computation Using Leaf Frog Algorithm," 2022 Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC). IEEE, Nov. 25, 2022. doi: 10.1109/pdgc56933.2022.10053161.
[30] P. R. Kshirsagar, D. H. Reddy, M. Dhingra, D. Dhabliya, and A. Gupta, "A Review on Application of Deep Learning in Natural Language Processing," 2022 5th International Conference on Contemporary Computing and Informatics (IC3I). IEEE, Dec. 14, 2022. doi: 10.1109/ic3i56241.2022.10073309.
[31] P. R. Kshirsagar, D. H. Reddy, M. Dhingra, D. Dhabliya, and A. Gupta, "Detection of Liver Disease Using Machine Learning Approach," 2022 5th International Conference on Contemporary Computing and Informatics (IC3I). IEEE, Dec. 14, 2022. doi: 10.1109/ic3i56241.2022.10073425.
[32] V. V. Chellam, S. Praveenkumar, S. B. Talukdar, V. Talukdar, S. K. Jain, and A. Gupta, "Development of a Blockchain-based Platform to Simplify the Sharing of Patient Data," 2023 3rd International Conference on Innovative Practices in Technology and Management (ICIPTM). IEEE, Feb. 22, 2023. doi: 10.1109/iciptm57143.2023.10118194.
[33] P. Lalitha Kumari et al., "Methodology for Classifying Objects in High-Resolution Optical Images Using Deep Learning Techniques," Lecture Notes in Electrical Engineering. Springer Nature Singapore, pp. 619–629, 2023. doi: 10.1007/978-981-19-8865-3_55.
[34] N. Sindhwani et al., "Comparative Analysis of Optimization Algorithms for Antenna Selection in MIMO Systems," Lecture Notes in Electrical Engineering. Springer Nature Singapore, pp. 607–617, 2023. doi: 10.1007/978-981-19-8865-3_54.
[35] V. Jain, S. M. Beram, V. Talukdar, T. Patil, D. Dhabliya, and A. Gupta, "Accuracy Enhancement in Machine Learning During Blockchain Based Transaction Classification," 2022 Seventh International Conference on Parallel, Distributed and Grid Computing (PDGC). IEEE, Nov. 25, 2022. doi: 10.1109/pdgc56933.2022.10053213.