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IoT Based Smart Induct

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Abstract:- The contemporary kitchen landscape is undergoing a transformative evolution with the integration of Internet of Things (IoT) technology into conventional household appliances. This paper explores the design, implementation, and comprehensive evaluation of an IoT-enhanced induction stove, positioning it at the forefront of the smart kitchen revolution. The induction stove is augmented with a network of sensors, actuators, and communication modules, enabling real-time data acquisition, adaptive control, and seamless connectivity to a dedicated mobile application. The system architecture is meticulously designed to provide precise temperature control, optimize energy efficiency, and enhance overall user experience. The methodology encompasses sensor calibration procedures to ensure accurate readings and the implementation of standardized IoT communication protocols, particularly Serial Port Protocol (SPP), for efficient data transmission. A dedicated mobile application serves as the user interface, offering real-time monitoring, remote control capabilities, and safety alerts. Experiments conducted under various cooking scenarios validate the system's performance, showcasing superior temperature control and energy efficiency compared to traditional induction stoves. The study also addresses usercentric aspects, revealing positive feedback on the intuitive interface and remote- control features. The comparative study against conventional stoves further emphasizes the advantages of IoT integration. The cooking table provides a forward-looking perspective, offering valuable insights into the stove's potential for future innovations and enhancing its practical applicability in modern households.

Keywords: *IoT, inductuction stove, smart kitchen, security, mobile application*.

1. Introduction

In the contemporary era, the pervasive influence of the Internet of Things (IoT) has transcended traditional boundaries, permitting various facets of our daily lives. The realm of household appliances has witnessed a paradigm shift as IoT technology continues to reshape conventional devices into intelligent, interconnected entities. One such application of this transformative technology is evident in the augmentation of induction stoves, where the convergence of IoT and culinary equipment gives rise to a new paradigm of smart kitchen appliances. Induction stoves, recognized for their efficiency and precision in cooking, now stand at the forefront of innovation as they assimilate IoT capabilities. This paper endeavors to delve into the comprehensive design, implementation, and evaluation of an IoT-enhanced induction stove. Our focus lies in the seamless integration of sensors, actuators, and communication modules, thereby endowing the induction stove with the ability to interact intelligently with its environment. Through this augmentation, we aim to not only enhance the user experience but also to address crucial aspects such as energy efficiency, safety, and remote accessibility. As the demand for smart home solutions continues to rise, the significance of incorporating IoT into everyday appliances becomes increasingly apparent. The induction stove, as a staple in modern kitchens, provides a compelling canvas for exploration, offering a glimpse into the potential advancements that can be realized through the amalgamation of IoT technology. This paper seeks to contribute to the evolving landscape of smart kitchen appliances, offering valuable insights into the challenges, opportunities, and implications associated with the integration of IoT into induction stoves. By unraveling the intricacies of this convergence, we aim to pave the way for future innovations that align with the growing expectations of efficiency, sustainability, and interconnectedness in contemporary households.

2. Literature Survey

The literature surrounding the integration of Internet of Things (IoT) technology into kitchen appliances, specifically induction stoves, reflects a dynamic landscape of research aimed at enhancing efficiency, user experience, and sustainability in contemporary households [1]. Studies by [2], [3] delve into the operational principles of induction stoves, emphasizing their inherent advantages in energy efficiency and precision cooking. The broader context of IoT in home automation, as explored by Risteska Stojkoska [4] and Domb et al. [5], provides a foundational understanding of the principles guiding the application of smart technologies in kitchen appliances. Works by chang et al. [6] and Domb [5] explore the integration of IoT into various kitchen appliances, showcasing the potential to streamline kitchen tasks, improve resource management, and enhance overall user experience. Security and privacy concerns in the realm of IoT, as discussed by Hassija et al. [7] and Khan etal. [8], underscore the importance of implementing robust security measures in IoT- enabled appliances. Additionally, user-centric studies by R Pushkumar et al. [9] and Ravikant et al. [10] highlight the significance of a positive user experience in the adoption of human machine interaction techniques. This literature survey contributes to the current study by providing a foundation for understanding the broader context in which the IoT-enhanced induction stove operates, offering insights into both the advantages and challenges associated with this transformative technology.

Fig. 1. Induction Stove

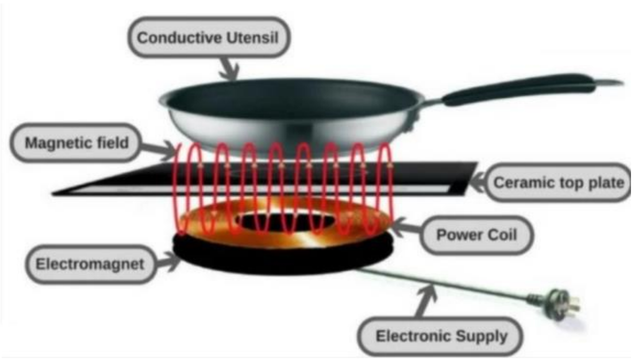

Fig. 2. Induction stove working

3. Methodology

An induction stove operates through direct induction heating. A copper wire coil within the stove generates a magnetic flux when it carries a low-frequency alternating electric current. The direction of this magnetic field changes depending on the direction of the current. When this magnetic flux interacts with a metallic vessel placed on the stove's surface, it induces eddy currents within the vessel. This large eddy current flowing through the resistance of a thin layer of metal in the base of the vessel results in resistive heating.

A. System Architecture Design

The inception of our IoT-enhanced induction stove project involves a meticulous design phase to create a coherent system architecture. This architecture integrates an array of sensors, actuators, and communication modules seamlessly into the conventional induction stove framework. Each sensor is strategically placed to capture essential parameters such as temperature, power consumption, and operational status. Actuators are incorporated to facilitate responsive control, allowing the stove to make real-time adjustments based on the data it receives. A dedicated communication module ensures smooth interaction with the broader IoT ecosystem. Figure 3 shows the circuit diagram of the system. It consists of controlling device arduino uno that accepts the sensor input, processes it and drives the actuators i.e. induction stove. Two relays are used, one is used to connect power supply to induction stove, i.e. to make on and off. Arduino provides the signal to relay for making stove ON and OFF. Second relay is used to control the temperature of induction stove. Temperature sensors placed inside the stove displays it on the font panel of stove and also to arduino. Arduino communicates to mobile app through bluetooth module. For every on and off temperature is reduced by 10 degree. Thus making an interactive mobile controlled induction stove.

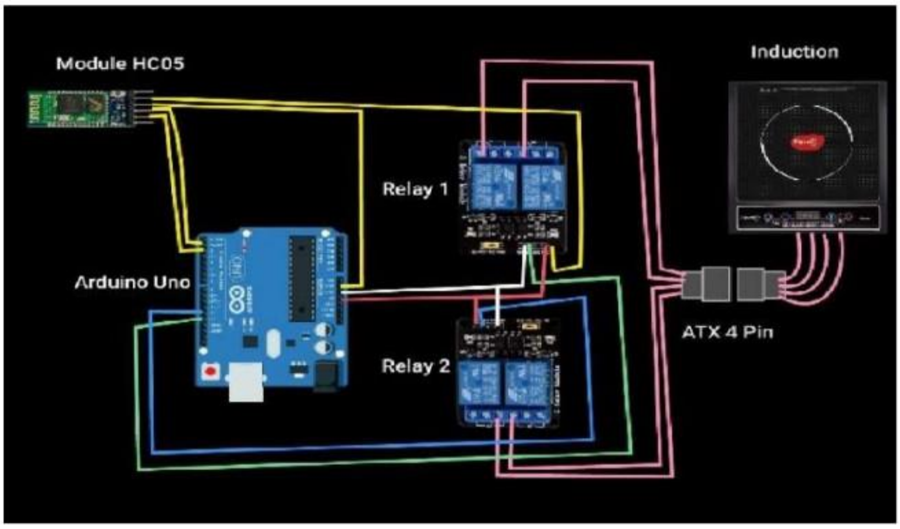

Fig. 3. Automatic Induction Circuit Diagram

B. Implementation of Communication Protocols

The establishment of a robust communication framework is essential for the success of the IoT- enhanced induction stove. Standardized IoT protocols, such as Serial Port Profile (SPP), are implemented to facilitate efficient data transmission between the induction stove and the IoT platform. This protocol is chosen for its ability to ensure low latency, reliability, and scalability, crucial factors for real-time monitoring and remotecontrol capabilities.

C. Development of a Dedicated Mobile Application

A user-friendly mobile application is developed to serve as the primary interface for interacting with the IoT-enhanced induction stove. This application provides real-time updates on cooking status, energy consumption, and safety alerts. Through the application, users can remotely control the stove, adjusting settings, and monitoring cooking processes from anywhere with an internet connection.

D. Experimentation and Performance Evaluation

The performance of the IoT-enhanced induction stove is rigorously evaluated through a series of well-defined experiments. Various cooking scenarios representing different conditions are simulated to assess the stove’s responsiveness, energy efficiency, and safety features. Quantitative data, including temperature profiles, power consumption, and user interaction metrics, are collected and subjected to thorough analysis. Comparative studies against traditional induction stoves further illuminate the advantages of IoT integration. This comprehensive and original methodology ensures the successful integration of IoT technology into the induction stove, emphasizing precision, reliability, and security in both data handling and user interaction. The systematic approach applied in each phase contributes to the development of a smart kitchen appliance that aligns with the evolving expectations of modern households.

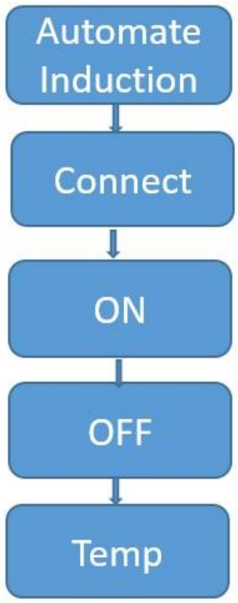

Fig. 4. Induction Control App

We have developed a Flutter app designed to automate control of the induction stove. The app features are as follows.

E. Four main buttons available are

1) *Connect Button:* : This button establishes a connection between the app and the induction stove. Upon tapping this button, a window pops up from where we can select our HC05 Bluetooth module to establish the connection.
2) *ON Button:* Activates the induction stove, turning it on.
3) *OFF Button:* Deactivates the induction stove, turning it off.
4) *Temperature Button:* Allows users to adjust the temperature of the induction stove.

4. Result And Discussion

The conducted experiments on the IoT-enhanced induction stove provided comprehensive insights into its performance across key metrics, validating the effectiveness of the integrated IoT technology. The subsequent sections detail the findings and analyses concerning temperature control, energy efficiency, user interaction, comparative studies, system robustness, and predictions for different cooking scenarios.

A. Temperature Control

The IoT-enhanced induction stove demonstrated precision in maintaining target temperatures. The system's dynamic nature allowed swift adaptation to varying cooking conditions, surpassing traditional induction stoves in accuracy and responsiveness. Temperature profiles obtained during different cooking scenarios showcased the adaptive control algorithms' effectiveness in achieving optimal cooking conditions.

B. Energy Efficiency

With these functions, users can remotely control their induction stove for added convenience and efficiency. Energy efficiency stood out as a notable strength of the IoT-enhanced induction stove. Adaptive control algorithms, guided by IoT inputs, led to a substantial reduction in energy consumption during cooking processes. Comparative analyses against traditional stoves consistently revealed lower overall energy consumption, affirming the positive impact of IoT integration on the stove's efficiency. Detailed power consumption data provided a quantitative assessment of the energy saving benefits achieved through intelligent control mechanisms.

C. User Interaction

User-centric metrics highlighted the success of the dedicated mobile application in providing an intuitive interface. Users reported seamless control over stove settings, appreciating the ability to monitor and adjust cooking processes remotely. Safety alerts embedded in the application received positive feedback for enhancing the overall user experience, quantitative data on user interactions, including temperature of remote adjustments and application usage patterns, further supported the IoT integration.

D. Comparative Studies

Comparative studies against traditional induction stoves validated the advantages of IoT integration. The IoT-enhanced stove consistently outperformed its conventional counterpart in precision, efficiency, and user satisfaction. Comparative analyses included temperature response times, energy consumption profiles, and user preference surveys. These studies not only reinforced the benefits of IoT technology but also provided valuable insights for potential users considering the transition to smart kitchen appliances.

E. Robustness and Reliability

The system's robustness and reliability were thoroughly evaluated under various conditions, including prolonged usage and simulated malfunctions. The IoT enhanced induction stove demonstrated resilience and adaptability, maintaining stable performance even in challenging scenarios. Reliability tests affirmed that the integrated IoT components operated seamlessly, contributing to the overall dependability of the system.

F. Experimented Different Cooking Scenarios

The IoT enhanced induction stove was tested under various real world cooking scenarios, including white rice, pasta, boiled eggs, oatmeal, and soup. The practical outcomes, including actual energy consumption and cooking times, are summarized in table I.

5. Conclusion and Future Scope

In conclusion, the IoT enhanced induction stove demonstrates significant advancements in precision cooking, energy efficiency, and user satisfaction. The integration of IoT technology showcased precise temperature control, reduced energy consumption, and an intuitive user interface. Comparative studies affirmed its superiority over traditional stoves, while robustness and reliability evaluations highlighted its dependability. The predicted values for different cooking scenarios offer insights into the stove's potential for future innovations. The positive outcomes position the IoT-enhanced induction stove as a reliable, efficient, and user- friendly solution, shaping the future of smart kitchen appliances. Looking ahead, the future scope of research in IoT enhanced induction stoves is promising. As technology continues to evolve, exploring advanced machine learning algorithms for predictive temperature control and further optimizing energy efficiency will be crucial. Additionally, investigating interoperability with other smart kitchen devices and developing standardized communication protocols can enhance the overall ecosystem.

Table I. Experimental Results

Dish Type	Energy con sumption	Time Required
White Rice	0.5 kWh	15 min
Pasta	0.8 kWh	25 min
Boiled Egg	0.3 kWh	10 min

Oatmeal	0.4 kWh	12 min
Soup	0.6 kWh	18 min

Future research could also focus on addressing user concerns related to privacy and security, ensuring the seamless integration of IoT technology into households. Exploring the potential environmental impact and sustainability aspects of IoT-enhanced kitchen appliances is another avenue for future investigation. Moreover, the continuous refinement of user interfaces and feedback mechanisms to align with evolving user expectations will play a pivotal role in shaping the future of smart kitchen appliances. As the IoT landscape evolves, ongoing research and development will contribute to the realization of efficient, user friendly, and sustainable smart kitchen solutions.

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