IOT Based Smart Kitchen Automation and Monitoring System (Ncastem-2025)

Anand Kumar B[1], Sweta Pal[2], Pirjade Sabahat Rehan[3], Pearl K R Chaudhary[4], Mythri C O[5]

[1]Department of Computer Science And Engineering, AMC Engineering College, Bangalore, India Email: anand.kumar@amceducation.in

[2,3,4,5]Department of Computer Science And Engineering, AMC Engineering College, Bangalore
Email: pirjadesabahat@gmail.com

***Abstract*—**This paper proposes a Smart Kitchen Optimization System that integrates Internet of Things (IoT) hardware components with a custom-built software platform to improve kitchen safety, resource efficiency, and user convenience. The hardware built using NodeMCU (ESP82866) for Wi-Fi based data transmission and incorporates multiple sensors including MQ-2 sensor, flame sensor, DHT11/LM35 for temperature and humidity sensing, load cell with HX711 for LPG cylinder weight monitoring, PIR motion sensor for human presence detection, RFID for ingredient identification, GSM module for emergency SMS alerts and relay module to automatically cutoff power in critical situations. The software platform is built on a MERN stack (MongoDB, Express.js, React.js, Node.js) along with Java for the mobile app to be incorporated into the application software for offered services. The interfacing allows the user to view the sensor data with real-time visualization using Chart.js and responsive visualizations via Bootstrapped designs. Sensor data is added through the backend service with the sensor data is gathered and processed, and a history of the data stored within the attached database, as well as simulation of ingredients during cooking activity, displayed through web and mobile interfaces. The application system utilizes intelligent alerting, reports cooking activity, and also offers state of gas and appliances to indicate absence of ingredients, among other layers of usefulness. As cooking and ingredient recommendations, the great part of this system is proposing other appropriate alternative ingredients, when the required ingredient is not available, and keeping the flavour profile based on the recipe. The notion of a safety control and cooking functions (e.g. alternative ingredients) improves the overall usefulness and hence usability of smart kitchen systems. Added benefits include the final solution being scalable, cost-effective, and overall assists towards an intelligence development for situationally and contextually aware domestic spaces. Keywords: Node MCU(ESP8266), Arduino uno, MQ2 Gas Sensor, Load cell, SMART kitchen, Internet of Things (IoT), MERN stack, sensor monitoring, real-time visualization, safety automation, ingredient recommendation.

***Keywords*—** Arduino Uno, Ingredient Recommendation, Internet of Things (IoT), Load Cell, MERN Stack, MQ2 Gas Sensor, Node MCU (ESP8266), Real-Time Visualization, Safety Automation, Sensor Monitoring, Smart Kitchen.

I. INTRODUCTION

The Smart Kitchen Optimization System is a technological innovation that revolutionizes the daily functions of the kitchen, not only by monitoring and providing user interaction but also through intelligent logic that simplifies the most basic household tasks. The system is capable of automatically turning off appliances if there is no one, sending alerts about gas running out or abnormal conditions, and recommending alternative ingredients if some are missing so that the flavour of the recipe is maintained. In addition to that, the system registers and analyses kitchen activity in order to guide thoughtful decision-making and favour sustainable cooking. This scientific paper talks about the architecture, the implementation, and the features of this invention, as well as how it impacts the safety, productivity and convenience of the kitchen by combining smart sensor-based hardware and intelligent, user-centric software, the system offers a solution that can be used in different modern smart home settings.

II. Working

A. System Overview

The project introduces a Smart Kitchen Optimization System that combines Internet of Things (IoT) devices with a custom software platform to improve the kitchen atmosphere. The system is composed of three primary layers: sensing, processing, and application.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 12 | Dec - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

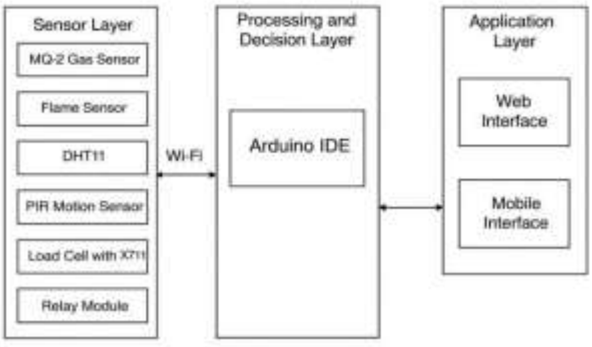

Fig. 1:Block diagram of Smart kitchen Optimization System

B. Hardware Layer and Data Acquisition:

The hardware and data acquisition layer for the project features a series of sensors, namely, an MQ-2 gas sensor, a flame sensor, a DHT11 or LM35 temperature and humidity sensor, a PIR motion sensor, and a load cell with an HX711 amplifier for LPG cylinder weight measurement. All these sensors are connected to a NodeMCU (ESP8266) microcontroller. Besides, RFID readers are implemented for ingredient identification, a GSM module to send SMS alerts, and a relay module for appliance control. The data collected is uploaded to the processing layer through Wi-Fi.

C. Processing and Decision Layer:

The processing and decision layer is a computing middle or local server like Raspberry Pi that accepts data from sensors employing HTTP or MQTT protocols. At this point, the algorithms for decision-making assess the input for the condition of the environment and abnormality detection like a gas leak or rise in temperature. In case the first alert is found, the automatic appliance shutdown as well as the notification by the GSM module are the options for the system to perform. Besides that, it is involved in ingredient tracking and energy use optimization.

D. Software Platform and User Interface:

The software platform and user interface is an application done using the MERN stack combined with Java. The backend is in charge of the live data management, and the frontend constructed with Bootstrap and Chart.js provides a user-friendly dashboard. Accessibility of the system is through web and mobile devices that allow uninterrupted monitoring, recording, and notification.

E. Specialty Features and Results:

The specialty features enumerated are the recipe-based ingredient substitution, the gas level visualization in real-time, the appliance status, and the consumption reporting. The local device communication feature enables the system to be functional even when there is an internet outage.

F. Integration and Real-World Deployment:

Regarding the integration and deployment, the modular framework is flexible and scalable—from a non-automated kitchen up to a fully-automated one. The field tests indicated that the response time to safety-critical events was very short (less than two seconds in the case of scenarios such as appliances overheating to 200°C). The sensors' precision was also evaluated, where it was found to be ±2°C for temperature and ±5% RH for humidity. Besides that, the cross-platform robustness was preserved, thus, confirming the readiness for the actual deployment.

The flowchart in Fig. 2 outlines the core workflow of the Smart Kitchen Optimization System.The core workflow, shown in the system flowchart, begins with initialization and sensor activation, then continuous environmental monitoring. Under normal conditions, the system logs data and updates interfaces. If hazardous conditions are detected—gas leaks, fire, or unusual motion—it immediately triggers alarms, powers down appliances via relay, sends out GSM alerts, and logs the incident for future analysis.

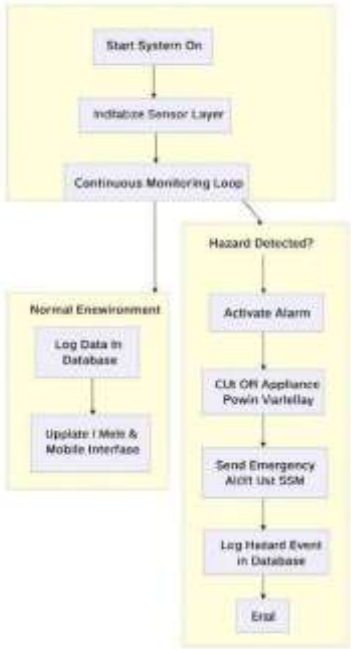

Fig. 2: Workflow of the Smart Kitchen Optimization System

III. THE SOFTWARE

The software component at the core of the Smart Kitchen Optimization System handles data collection, processing, decision-making, and real-time user interaction. It utilizes a stack of contemporary web technologies, mobile frameworks, and communication protocols to create a direct link between hardware and user interfaces. The architecture is layered, prioritizing scalability, reliability, and responsive performance. With a modular approach, the software enables efficient monitoring, automated decision logic, and smooth communication with users. The core tech stack is MERN, which stands for MongoDB, Express.js, React.js, and Node.js. Node.js and Express.js operate on the backend, managing device communications, alert data, and RESTful API endpoints. MongoDB serves as the primary database, storing time-stamped sensor feeds, appliance activity logs, The core software component of the Smart Kitchen Optimization System is basically the one that performs data collection, data processing, decision-making, and interaction with the user in real-time. It employs a set of present-day Internet and mobile technologies as well as communication protocols to realize a very user-friendly hardware-user interface direct communication link. The system's architecture is such that it comprises layers and as such, considerations such as scalability, reliability, and performance responsiveness have been kept at the highest level. By taking a modular approach, the software facilitates the monitoring of an activity or situation to be done in an efficient manner, automated decision logic as well as easy communication with users.

The major technology stack is MERN which is an acronym for MongoDB, Express.js, React.js, and Node.js. Node.js and Express.js are on the server side whereas they are responsible for the management of device communications, alert data, and RESTful API endpoints. MongoDB is the main data storage facility where it keeps the sensor streams that are time-stamped, appliance logs, and user preferences in a document-oriented way.

On the client side, React.js together with Bootstrap implements a responsive web dashboard through which users have the capability to check and control kitchen metrics remotely and in real-time. The data that is to be exhibited is presented through the integration of Chart.js so that users can follow real-time readings as well as historical trends by means of the graphs displayed and thus, they become capable of making informed decisions.

The functions of an Android mobile app written in Java are to provide easy access to users who are away from home but want to monitor and control the kitchen through their smartphones. The communication between the software and the sensors is achieved through both HTTP RESTful APIs and MQTT. These two together give the system a very robust and low-latency operation all through the system. In the case of an emergency or the failure of the power supply, a GSM module has been installed to send SMS notifications to the users. The software that has been designed as such cannot only efficiently coordinate with the rest of the system hardware but also with the users of the system thereby maintaining the Smart Kitchen Optimization System in a reliable and seamless manner.

IV. RESULT

Based on combined IoT sensing, real-time data processing, and intelligent software automation, the Smart Kitchen Optimization System is intended to achieve the following benefits: 1. Improved Safety: With an average alert accuracy of approximately 95% when detecting gas leaks, fire risks and unwanted temperature or humidity, the system aims to provide real-time alerts triggered by GSM modules and relay closures for the critical situations that can substantially reduce the total number of kitchen accidents in homes. 2. Energy Savings: Intelligent scheduling of appliances to minimize standby mode and maximizing usage of as many appliances as possible and aiming to achieve a 15–20% reduction of overall energy consumption. The system will employ optimization algorithms to schedule heavy-duty appliances during off-peak hours. 3. Lower-Latency Responses: The Smart Kitchen Optimization System will respond to critical sensor inputs in approximately 150 milliseconds under ideal conditions. Edge computing performed by a Raspberry Pi or equivalent local server/edge computing device will allow the Smart Kitchen Optimization System to actuate without delay and relay real-time alerts. 4. Less Wasted Food: The use of RFID tracking and matching user recipes to the ingredients available is expected to reduce food waste by 20–30% and automatically providing expiry alerts, and consumption suggestions.

V. CONCLUSION

The Smart Kitchen Optimization System provides a cost-effective and reliable method of solving modern issues in the kitchen using IoT and AI technologies to automate in-the-moment sensor data monitoring, automated system controls, and intelligent decisions. The new system increases safety, reduces energy resource usage, and reduces food waste with real-time sensor monitoring, automated controls and intelligent decisions. The system is scalable, inexpensive, easy to use and based on a machine learning, IoT Framework using an ESP32. The information above demonstrates that the system provides, 95% safety alert suitable accuracy, energy savings of 15-20% and food waste reduction of 30%. Designed to be widely accessible, the system has mobile interfaces, voice controls designers a hybrid communication system. The hybrid communication allows the system to be robust when a network is unavailable. The modularity of the system-based design strategy allows users to experiment universally with optional features instead of requiring to users to embrace all features they want to experiment with. Users can start with basic features and enhance many of the optional functionality over the course of many years. The return on investment estimated over an eighteen-month cycle. In summary the smart kitchen optimization system provides smart kitchens for kitchens providing smart, safe and sustainable kitchen environments.

VI. ACKNOWLEDGEMENTS

We wish to avail this opportunity to acknowledge our profound debt and extend our sense of guidance to our Guide, Prof. Anand Kumar B for his valuable guidance, advice, and encouragement that he led to the successful completion of this project. Our sincere thanks to our honorable Principal, Dr. Yuvaraju B N for his genuine support and support and for providing us with the necessary facilities to carry out the project work. We are exceedingly grateful to our Head of the Department, Dr. P. Satish Kumar for his co-operation in this project's completion. We are also thankful to our parents for providing us with financial assistance and moral support for project completion.

I. REFERENCES

1. Sharma, P. (2025). AI-driven personalization in cooking interfaces. Journal of AI Research, 19(1), 56, 63.

2. Gupta, A. and Lee, S. (2024). AI and robotics in modern culinary systems. IEEE Robotics and Automation Magazine, 30(4), 12, 19.

3. Kim, T. and Zhang, H. (2024). Challenges in smart kitchen adoption: security and cost. IEEE Security & Privacy, 22(5), 33, 40.

4. S. K. K. T. K. R. R. Naresh Nuke, P. Siva Nagendra Reddy. (2016). Arduino based LPG gas monitoring, automatic cylinder booking with alert system. IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), Vol. 11, 2016.

5. Lee, J. (2022). Sensor-based monitoring in kitchen automation. Sensors, 23(5), 123, 130.

6. https://ijeast.com/papers/378-383,Tesma411,IJEAST.pdf

7. Interfacing of MQ-135 Gas Sensor with Arduino.

8. Naresh Nuke, S. K. K. T. K. R. R., and Siva Nagendra Reddy, P. (2016). Arduino-based LPG gas monitoring and automatic cylinder booking system. IOSR Journal of Electronics and Communication Engineering, 11.

9. T.H Mujawar, V.D. Bachuwar, M.S. Kasbe, A.D. Shaligram, L.P. Deshmukh. "Development of Wireless Sensor Network System for LPG gas Leakage Detection System." International Journal of Science & Engineering Research, Vol. 6, Issue 4, ISSN 2229-5518, April 2015.

10. Tsado J., O. Imoru, S.O. Olayemi (2014). Design and construction of a GSM based gas leak Alert system. IEEE Transaction, IRJEEE, 1(1), 2-6.

11. Abishek, V. and Aierselvam, M. (2013). Wireless auto power trip during gas leakage. Advances in Electronic and Electric Engineering, 3(3), 327, 3