Present and Future Possibilities for Intelligent Kitchen with AI and IoT

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Abstract- ***Kitchen automation or smart kitchens is a new area of research with vast scope for the transformation of our world by improvement of the quality of living. Technological concepts such as Artificial Intelligence (AI), Data Science (DS), Machine Learning (ML) or Deep Learning (DL), Internet of Things (IoT), and robotics are used for the advancement of smart kitchens playing vital roles in the home as well as hotel Industries. It describes ways restaurants in the modern era prepare, and cook delicious and tested hygienic food and serve it utilizing robots. These robots are precise cooking appliances that are programmed to follow a chef's recipe. They frequently move more quickly than humans and are incredibly clean. The application of automation and robots in the kitchen has helped to pave the way for the "smart kitchen" revolution. The restaurant chain has seen a boom in new categories of self-sufficient kitchen technologies. Due to the change in the living style of human beings, many factors like time, food, sleep, etc impact human health. Among them, food is a very essential part of our life. Housewives, pregnant women, old age persons as well as children can remotely access all the kitchens automation capabilities in a smart home, including safety measures like a system to detect LPG leaks, energy and effort conservation, along with timer settings options that will automatically send a work completion and related alert notifications. Hence this paper focuses on fabulous new possibilities for Intelligent kitchens with AI and IoT in a smart home. Also presented present and future prospective and underlines the need for a considerable amount of investment in intelligent homes with smart kitchens.***

Indexed Terms- ***Artificial Intelligence, Internet of Things, Smart Home, Intelligent cooking, Intelligent Kitchen, Data Science, Machine Learning, Deep Learning.***

I. INTRODUCTION

The concept of automation now a day's used in many areas. Automation is nothing but the term in which many tasks are performed automatically by integrating hardware and software. Automation also defines the technique of making an apparatus, a process, or a system operate automatically. Automation is a term for technology applications where human input is minimized. According to a literature survey, various types of applications of automation using advanced embedded system platforms in different areas including industrial, home, construction, agricultural, automobile, office, and medical were published. Kitchen automation impacts both our present and our future. There is no doubt that robotics and automation are the future, even though we have not yet reached our full potential. The capacity of technology to reduce the amount of time required for cooking in the commercial kitchen is garnering interest. Food bots streamline the way we prepare food so that ingredients are cooked to perfection with minimal waste. In essence, the ways that food is prepared, handled, palletized, packed, and served could all be changed by robots. Consequently, the trend of robot installation in the food industry has dramatically grown substantially

in recent years. Food safety is a significant concern, and food and beverage items must be processed without human contact to prevent the spread of disease and germs. For such strict criteria, kitchens require hygienic designs for robotic manipulators, machine vision, and end-effectors or grippers [1, 2].

In efforts to realize chore automation, power efficiency, and other domains of economic value in a household, some of the intellectual ability with linked thermostat devices, self-guiding vacuum cleaners, smart lighting, door entry/security systems, kitchen, and laundry appliances could be used [3]. The fundamental idea behind smart technology is to connect to WiFi, Bluetooth, or the Internet of Things (IoT) regardless of the kitchen. It's simple to control smart gadgets through applications or services like Google Assistant and Amazon Alexa as they connect to certain other technology. In the case of a smart restaurant, restaurants can also manually transform their entire menu into 3D and augmented reality (AR). Users can view the whole restaurant menu in 3D and AR live on their table well before placing an order by scanning a QR (Quick Response) code posted on every table of any augmented reality restaurant partner [3-5].

1.1 Concept of Smart Kitchen:

Artificial Intelligence (AI) is a term coined in the year 1956 by John McCarthy, a professor emeritus of computer science at Stanford. AI is nothing but an imitation of human intelligence with help of technologies or computers with self-learning skills to improve efficiency, services, productivity, and many more capabilities.

Internet of Things (IoT) is a very broad term that was coined in the year 1999 by computer scientist Kevin Ashton, Executive Director of the Auto-ID Center at Massachute Institute of Technology (MIT). IoT can be defined as a network of physically intelligent embedded strategies that are equipped with webs, sensors, and handling systems, that are linked to the internet for the interchange of information and data which communicate with each other without human intrusions and sometimes or in some cases with human involvements.

Data Science (DS) signifies the entire procedure of finding meaning in data. Deep Learning (DL) is a subset of Machine Learning (ML). Machine Learning (ML) or Deep Learning (DL) is a modern innovation and it is another form of Artificial Intelligence (AI) that permits software applications to become more precise at forecasting consequences without being openly programmed to do so. ML or DL was first conceived from the mathematical modeling of ANN (Artificial Neural Network) in 1943 by logician Walter Pitts and neuroscientist Warren McCulloch attempted to mathematically map out thought processes and decision-making in human cognition. ML or DL has three types of algorithms that are supervised, unsupervised, and reinforcement learning and usage of historical data as input to guess new output values. ML uses algorithms to analyze data and as well as learn from that data, and make informed decisions based on what it has learned. DL structures algorithms in layers to create an ANN that can learn and make brainy decisions on its own.

An Intelligent or smart kitchen with AI and IoT capabilities consists of convenient smart gadgets with the potential to lower energy costs [6]. These smart gadgets may now be remotely monitored and controlled via voice commands and smartphone apps, which adds another level of ease to daily life by saving time and effort [7].

AI improves in minimizing potential difficulties brought on by human error. So, even though AI may result in fewer employment prospects, businesses nevertheless stand to gain greatly from it. Because it keeps the manufacturing sites hygienic conditions and guarantees safe food production, AI is becoming increasingly important to e-commerce food enterprises. It also aids in keeping the machinery used to produce food as clean as possible. AI aids e-commerce in capturing industry trends and customers' shifting wants in the market. As a result, the efficiency of the clients increases satisfaction and balances the dynamics of demand and availability [6, 7].

Every kitchen appliance is updated using technology to maximize efficiency in a smart kitchen. Old kitchens are renovated to accommodate technology-integrated smart appliances for smoother operation, and new kitchens are turned smart [8]. Utilizing the internet to expedite and simplify food preparation and other kitchen tasks is made possible by smart kitchens.

An app that is compatible with your smart kitchen appliances must be installed. With the help of the app, we can access our home appliances as per our needs from short as well as very long distances. Figure 1 reveals the various appliances controlled by an app or smartphone [8-12].

Figure 1: Smart kitchen using a smartphone

Some common smart kitchen technologies are used for every modern kitchen including smart refrigerators, smart kitchen chimneys, water purifiers, smart cookers, identity theft protection, a smart coffee maker now a day's [12]. By expanding the scale and applying various fitting algorithms for sales forecasts, AI and Data Science (DS) can enhance the quality of restaurants, cafes, online meal delivery chains, hotels, and food outlets. With the use of AI, packaging could be considerably improved, shelf life could be extended, the menu could be combined, and food standards could be improved by creating a much more transparent supply chain system. The future of the food industry is entirely dependent on smart agriculture, robotic farming, and drones due to AI and ML [13, 14].

The aged and those with disabilities have a difficult time working in the kitchen, cooking, and walking around, so they frequently need to employ assistants to make their life simpler. They have the option of using technology to meet their requirements rather than relying on others due to the automated kitchen. Since people's lives are becoming overly busy, they seldom have time to prepare meals or spend a lot of energy in the kitchen. Therefore, appliances should be cutting-edge in terms of saving time and reminding people about important things, such as when the food in their refrigerator is ready to expire so they may buy some essential items soon [13, 15]. Figure 2 shows the major parameters for a smart kitchen environment with IoT and AI.

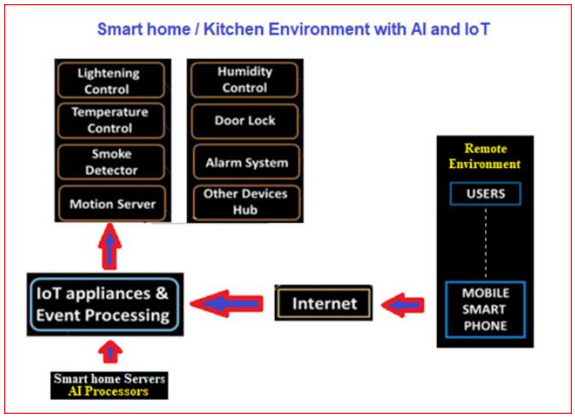

Figure 2: Intelligent Kitchen environment with IoT and AI

II. LITERATURE SURVEY

The significant progress that has been established in smart homes/ kitchens using Artificial Intelligence (AI), Data Science (DS), Machine Learning (ML) or Deep Learning (DL), Internet of Things (IoT) and robotics is discussed in this section. The IoT is a network of physical objects or things that are equipped with hardware, software, sensors, and networking to allow data interchange between connected devices, manufacturers, and users.

For people's safety, security, and comfort, kitchen surveillance becomes increasingly helpful. The modern population expects new gadgets and technological advancements to make daily living simpler. Though the process is still endless, inventors and imitators are constantly looking for new ways to satisfy consumers. To monitor the fields, kitchen automation has become modern and accurate.

Minh et al designed and employed smart home automation systems in kitchen appliances such as refrigerators, stoves, and microwaves which are used for daily life [13]. While supporting the physically challenged, smart devices also provide a valuable service for those who lead busy lives and even children with their demanding schedules. WSNs, mobile phones, and the internet all helped make this possible. With the help of numerous sensors and barcodes, an

Android application will offer a user-friendly interface for controlling kitchen appliances. Here, the identical operations are carried out using an Arduino Uno module. A zig bee unit is used to wirelessly transmit the signals to the raspberry PI module after they have been gathered and processed. Smartphones are used to operate appliances on the raspberry PI running an Open HAB server. The design of a novel kitchen automation system utilizing wireless, embedded systems, MATLAB interfaces, and kitchen monitoring in a smart house is also introduced by the authors.

Chatterjee et al the mechanics of IoT's growth in the furniture and kitchen production industries are explained in this study [16]. Organizations are presently reviewing how corporate knowledge and skill sets match the new technology needs that the developing digital environment describes by applying the IoT idea, and by focusing on a report based they are understanding more about IoT and linked goods as they progress. The lack of open protocols that can link all items independent of provider is one of the current big issues. However, IoT deployment involves more than just technological considerations, and businesses must also grapple with the challenge of creating associated economic procedures.

Sahil Kapadnis reported a new prototype of a kitchen security system using IoT [17]. The system is designed using 4 types of sensors (DHT 11, MQ-3, LPG, and MQ-6) and Arduino Mega. Temperature and humidity were measured using a DHT 11 sensor. Water level sensors are used to find water leaks in the kitchen, MQ-3 sensors are used to find ethanol gas leaks, and MQ-6 LPG gas sensors were used to find gas leaks. The Arduino will control the relay after receiving the sensor output. In the event of a gas leak, an uncontrolled fire, or an extreme temperature rise, the relay serves as a fan switch. In certain circumstances, Arduino will also activate the alarm and the led, as well as communicate data to the server. The user will be informed via SMS and phone whenever a gas or water leak is found, allowing them to shut off the gas valve right away. Temperature and gas sensors are intended to recognize the presence of flame, fire, and gas leakage and to take appropriate action. Every time the device detects a gas leak or a fire and gives an alert in the form of buzzer sounds.

Garg and his team discussed safety while taking into consideration the flame sensor on the burner side and focused mostly on using IoT in the kitchen to detect flame spilling [18]. Additionally, a warning message is given to the user if the PIR (Passive Infrared) sensor detects no motion. Access to the internet is necessary for this system. The system's disadvantage is that all of the gadgets remain unconnected if the internet is down, increasing the likelihood of an accident. The authors attempted to address this problem by using the GSM (Global System for Mobile communication) module as the system and user device's communication medium.

Thakare et al proposed the development and design of a voice monitoring and controlling system for the kitchen atmosphere instantly [19]. The developed system can monitor the status of the kitchen and send a piece of alert information via IoT network instantly, when the conditions get abnormal, to some concerned government bodies cell phone, the ARM (Advanced RISC Machines) 7 LPC (Low Power CMOS) 2148 microcontroller is utilized within the implementation of the sensor module. The machine primarily monitors kitchen atmosphere parameters for example light intensity, room temperature, fire detection, LPG (Liquefied Petroleum Gas) level, and motion detection.

The design and implementation of an immediate voice monitoring and controlling system for the kitchen environment were suggested by Thakare et al. in their study [19]. The ARM 7, sensor module and LPC 2148 microcontroller are used in the development of the designed system, which can monitor the status of the kitchen and send a piece of alert information via IoT network instantaneously to some relevant administrative bodies' cell phones when the conditions get abnormal. The equipment mainly keeps an eye on the conditions in the kitchen, like the amount of light, the temperature, the presence of a fire, the level of LPG, and object tracking.

Reddy et al Utilizing Node MCU, a smart kitchen with automation and monitoring was developed. In terms of hardware, load cell Node MCU, servo motor, gas sensor, temperature sensor, and humidity sensor have all been used [20]. An app and incorporated Node MCU have been used on the software side. Results

from our system are sent to users through SMS (Short Message Service). The system makes it possible to monitor gas leaks in the kitchen, which speeds up response times in the event of a leak. In the event of a gas leak during the night, the system will automatically turn off the main electricity supply to prevent anyone from accidentally turning on a light and setting off a blast. Monitoring the user's kitchen equipment, such as Cylinder.

Minaam et al discussed improving the control of cooking time at the "Basmatio" restaurant in Cairo, Egypt, the paper presents the development, execution, and assessment of an embedded system employing IoT [21]. This system used AVR-Atmeg 32 and allows the chef to select from a variety of timers for various meals. All timers can operate simultaneously, preventing food losses and the need for extra staff.

III. ADVANTAGES AND DISADVANTAGES OF INTELLIGENT KITCHEN WITH AI AND IOT

Advantages such as,

- Convenient
- Time-saving.
- Power saving.
- Energy efficient.
- Less manual effort.
- Low complexity.
- Managing grocery stocks.
- Remote control appliances from a very long distance,
- Low maintenance.
- Increased comfort
- Quickly to operate and more efficient.
- Provide safety and security.

Main disadvantages such as,

- High cost.
- Privacy interruption.
- Internet dependency.

CONCLUSION

From the literature review, it has been observed that Intelligent Kitchen with AI and IoT or smart home is a new approach in the market and is implemented in many countries nowadays because of changes in the living style of human beings as well as technological advancement. Kitchen automation can be possible using the integration of hardware and software as well as recent communication standards or protocols and various types of sensors. Artificial Intelligence (AI), Data Science (DS), Machine Learning (ML) or Deep Learning (DL), Internet of Things (IoT), robotics, and smart sensor-based systems for Intelligent Kitchen with AI and IoT were explored. After researching the literature, it can be noticed that there is a need for a considerable amount of investment in intelligent homes. Systems can more quickly recognize different tasks performed by using AI than they can with human-based systems. Additionally, it has been noted that researchers are actively engaged in this field. Housewives, pregnant women, old age persons as well as children can remotely access all the kitchen automation capabilities in a smart home, including safety measures like a system to detect LPG leaks, and energy and effort conservation. Delicious, uniform quality, and hygienic intelligent cooking and serving along with timer settings options that will automatically send a work completion and related alert notifications are also the future scope in the kitchen or home automation. Thus, there are fabulous new possibilities for Intelligent kitchens with AI and IoT in a smart home.

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