AI Kitchen

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ABSTRACT

Purpose: *Using several smart gadgets makes the kitchen smart. The picture of the kitchen from ancient has drastically changed. Now, the kitchen is glorified using modern technology. The kitchen chimney, microwave oven, etc., is more convenient for the kitchen. Now, AI has come, and every day, more and more devices are becoming AI-enabled. In this scenario, we demonstrated the project in an AI-enabled kitchen. There are several advantages of AI-enabled kitchens over intelligent kitchens. AI will handle our most repetitive and monotonous work. Also, AI will take care and protect from any accident before it happens, which generally happens due to forgetfulness or carelessness.*

Design/Methodology/Approach: *We installed a CPU inside the home. We installed an action controller in the kitchen that connects all kitchen gadgets. One PTZ camera is installed in such a place that captures the gas oven and the entire kitchen environment. Our camera is the point-to-zoom (PTZ) type, so it can rotate the lens and zoom to capture any incident for better understanding or to detect the perfect image for accurate detection. Our camera is running all the time, which means round the clock. It always captures the image and processes the image by CPU. If any event matches with the event database, it sends the command to the action controller to take the action. If a new event is detected, it will learn from it and save it into the database for future use.*

Findings/Result: *The complete system is the conceptual-based research work. However, every part of the module or section is based on practical research work. So, once the system is deployed in the practical field, it will work without issues. In a typical kitchen, we must always pay attention, like the regulator is on if the milk is left for a long time in the gas oven. So, this kind of tension and anxiety will go for retired. All events will be taken care of by our AI-enabled system. Once the system is installed, it will run autonomously; there is no need to take care of or follow up. Once the system detects some issue, the system will notify the concerned person.*

Originality/Value/Novelty: *Nowadays, intelligent gadgets are taking place in the home. Smart devices, especially in the kitchen, make life easy. Using AI, we can get more benefits and security for the kitchen. We studied several research works. Most of the researchers automated kitchen gadgets. But still, the problem exists. All gadgets should be under centralized control to get better safety and control. Through this research work, we described how to create safety and control in the kitchen environment. This research works to provide more value to the modern, smart kitchen.*

Type of Paper: *Conceptual Research.*

Keywords: AI-enabled kitchen, the centralized control of kitchen gadgets, kitchen automation, how to add AI to our kitchen, ABCD listing of AI Kitchen

1. INTRODUCTION :

Problem statement: the smart kitchen is well known. When we think about intelligent kitchens, several high-end kitchen gadgets decorated to work around the kitchen come to mind. Now, AI is

playing a significant role in our everyday lives. So, if we control our kitchen gadgets from centralized control, that would be great efficient devices.

Indication of methodology: Control all kitchen devices from a centralized control. At first, we installed a PTZ camera from where the camera sees or captures every event. The camera is connected to the CPU. The other important device is the action controller, responsible for managing the kitchen's various intelligent gadgets. It is used to trigger the devices like on/off, set value for device operation, etc.

Essential findings of others in this field: we study the various research projects. There is enormous work carried out in the home automation field. The researchers are now engaged in building intelligent home automation. Some researchers have tried creating standards in the home automation field using AI. The researcher Bouchard et al. (2012). [3] describe the Guidelines for efficient smart home design for rapid AI prototyping. The research work (of Rego et al. (2022). [6]) describes the Artificial intelligence system for multimedia services in smart home environments. The research work (Roshak et al. (2021). [7]) describes Over 70 recipes for building AI solutions for smart homes, industrial IoT, and smart cities. In the research work (Iannizzotto et al. (2020). [8]), the researcher focuses on more intelligence in our smart home applications instead of cloud-based applications. The researcher (Edu et al. (2020). [15]) worked on Smart home personal assistants.

What is done in this paper: We study how to design kitchen automation using AI-based control. For this, we study several technologies that are feasible for us. Many excellent and efficient technologies are available now for kitchen automation. We introduce most of those technologies into our projects to build a contemporary AI kitchen for better living.

Principal conclusion: Nowadays, a smart home or kitchen is common. But after the booming field of AI, we understand that if we add AI to our kitchen automation field, we can benefit more from the technology. So here we demonstrate how we can build our AI-enabled AI kitchen with the help of the latest technology in the AI field.

2. REVIEW OF LITERATURE/ CURRENT STATUS :

Much research has been carried out on AI home design. Here, we included some research projects where we found noticeable work already done. Table 1 lists a couple of research works and used technology in their research work.

Table 1: Lists research work and technology used in AI home design.

S. No.	Focus/Subject	Technology/Algorithm/ Module/Components	Reference
1	Practical guidelines to build smart homes: lessons learned	AI is for cognitive assistance, motion sensors, and video cameras.	Bouchard et al. (2014). [1]
2	Is my home smart or just connected?	Artificial Intelligence	Furman et al. (2020). [2]
3	Guidelines to efficient smart home design for rapid AI prototyping: a case study	AI, IoT	Bouchard et al. (2012). [3]
4	The intelligent wife: Why Siri, Alexa, and other smart home devices need a feminist reboot	smart home devices	Strengers et al. (2021). [4]
5	Devices and data and agents, oh my: How smart home abstractions prime end-user mental models	IoT, Sensors	Clark et al. (2017). [5]
6	Artificial intelligent system for multimedia services in smart home environments	Artificial intelligent, multimedia	Rego et al. (2022). [6]
7	Artificial Intelligence for IoT Cookbook: Over 70 recipes for building AI solutions	IoT, Artificial intelligent	Roshak et al. (2021). [7]

	for smart homes, industrial IoT, and smart cities		
8	More intelligence and less clouds in our smart homes: a few notes on new trends in AI for smart home applications	IoT, Artificial intelligent	Iannizzotto et al. (2020). [8]
9	The future home is wise, not smart	IoT, Artificial intelligent	Leitner et al. (2015). [9]
10	Smart home environment: Artificial intelligence-enabled iot framework for intelligent living and intelligent health	IoT, Artificial intelligent	Geetha et al. (2021). [10]
11	AI-Enabled Smart Home Interface Using Gesture based Controls	IoT, Artificial intelligent, Gesture based Controls	Mahith et al. (2019). [11]
12	Explainable activity recognition for smart home systems	IoT, Artificial intelligent	Das et al. (2023). [12]
13	AIoT-enabled smart surveillance for personal data digitalization: Contextual personalization-privacy paradox in smart home	AIoT, smart surveillance system	Zhang et al. (2023). [13]
14	Major requirements for building Smart Homes in Smart Cities based on Internet of Things technologies	IoT	Hui et Al. (2017). [14]
15	Smart home personal assistants: a security and privacy review	IoT	Edu et al. (2020). [15]
16	Robust triboelectric information-mat enhanced by multi-modality deep learning for smart home	deep learning	Yang et al. (2023). [16]
17	Smart home sensing and monitoring in households with dementia: user-centered design approach	sensing and monitoring system	Tiersen et al. (2021). [17]
18	A review of smart homes—Past, present, and future	IoT	Alam et al. (2012). [18]
19	A Review of Potential AI-Based Automation for IoT-Enabled Smart Homes	AI, IoT	Leong et al. (2023). [19]
20	Real-time indoor localization in smart homes using semi-supervised learning	Localization, semi-supervised learning	Ghourchian et al. (2017). [20]

In the table below, we included a couple of our projects, which are the backbone of the current research project. The researcher can acquire knowledge before implementing the AI kitchen project. Because the AI kitchen project combines various projects, it is only possible to face many challenges in understanding small projects.

Table 2 lists the author's research on IoT, Data saving to the cloud, and sensors.

S. No.	Focus/Subject	Technology/Algorithm/ Module/Components	Reference
1	Let Us Create Multiple IoT Device Controller Using AWS, ESP32 And C#	AWS, ESP32 And C#	Chakraborty et al. (2023). [21]
2	Let Us Create An IoT Inside the AWS Cloud	AWS Cloud	Chakraborty et al. (2022). [22]

3	Let Us Create a Physical IoT Device Using AWS and ESP Module	AWS, ESP Module	Chakraborty et al. (2022). [23]
4	Let Us Create an Alexa Skill for Our IoT Device Inside the AWS Cloud	Alexa Skill, AWS Cloud	Chakraborty et al. (2023). [24]
5	Let Us Create A Lambda Function for Our IoT Device In The AWS Cloud Using C#	AWS Cloud, Lambda Function	Chakraborty et al. (2023). [25]
6	Let Us Create Our Desktop IoT Soft-Switchboard Using AWS, ESP32 and C#	AWS, ESP32 and C#	Chakraborty et al. (2023). [26]
7	Alexa Enabled IoT Device Simulation Using C# And AWS Lambda	C#, AWS Lambda	Chakraborty et al. (2023). [27]
8	IoT-Based Switch Board for Kids Using ESP Module And AWS	ESP Module, AWS	Chakraborty et al. (2023). [28]
9	Let Us Create an Alexa-Enabled IoT Device Using C#, AWS Lambda and ESP Module	C#, AWS Lambda and ESP Module	Chakraborty et al. (2023). [29]
10	IoT-Based Industrial Debug Message Display Using AWS, ESP8266, And C#	AWS, ESP8266 And C#	Chakraborty et al. (2023). [30]

3. OBJECTIVES OF THE PAPER :

Description of objectives.

1) To study the feasibility of designing an AI-based system for our kitchen.
2) Review the research work already carried out in our AI-enabled kitchen.
3) To analyse the performance of our kitchen automation system.
4) To compare the efficiency of the various systems integrated into AI-enabled kitchens.
5) To prove the capability of the AI-based kitchen automation system.
6) To design an AI-based automated kitchen.
7) To interpret the functional block diagram of the AI-based kitchen automation system.
8) Analysing the AI-enabled kitchen using ABCD analysis framework.

4. METHODOLOGY :

Figure 1 depicts the project block diagram. Two main parts play a significant role. One is the CPU, and the other is the action controller. Let us discuss the CPU first, then examine the action controller.

CPU: The CPU is the heart of the project. The CPU is the system unit, server, or workstation PC. This system can work with high configurations of laptops without issues. Generally, the laptop is okay for temporary testing purposes but not for a long time or a round-the-clock operation. The CPU, running around the clock, has extra protection for the proper heat dissipation mechanism—the CPU we are using here is mainly as high-end as possible. We need the RAM >=16GB; the CPU should be RJ45 and the Wi-Fi interface. Because some cameras have ethernet interfaces and some have Wi-Fi enabled, we need both hardware interfaces to cover both cameras. The CPU should have a USB port for the USB to the RS485 module or converter to send the signal to the action module. By default, the RS485 interface is not available in the CPU. We need to add the module. Once we purchased the CPU, generally, it came with a preloaded operating system. After that, we need to install Python development IDE. After that, we need to install the latest Image detection libraries like YOLOv7 or later. Then install USB to RS485 module driver. Then, we need to install the connected PTZ camera driver. Now, create the project. Add Yolo library reference to the project. Read the image from the camera. Try various operations like zooming the camera using the driver API function call. Now, using the camera, read the image, extract the feature, and detect the event. Once the event is successfully detected, the work is almost done. Create a command template for the action controller. Test the event and check that the event detection is successfully happening. Check the API parameter passing for image detection if some error detection happens.

Action Controller: figure 1 depicts the action controller. The central part of the action controller is the Arduino board, built with ATMEGA 2560 microcontroller chip. It has sufficient digital IO ports.

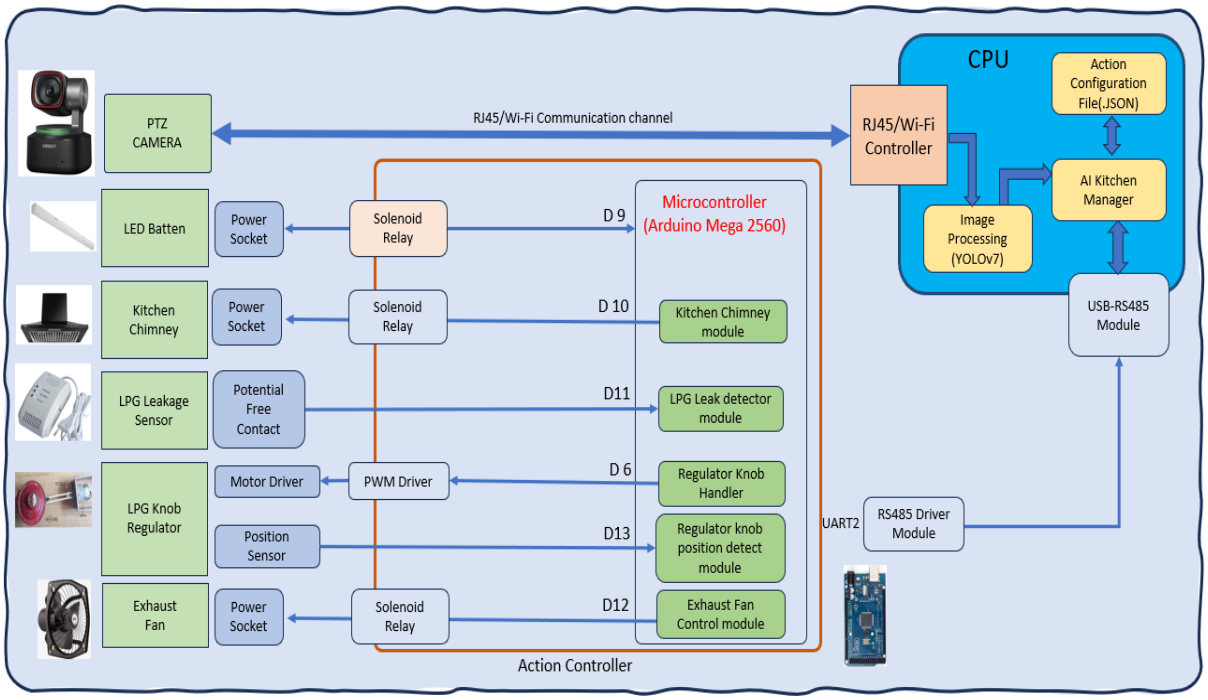

Fig. 1: the project block diagram

And four UART ports. The UART2 is connected to the CPU through the RS485 module. In the hardware, there are two solenoid relays to trigger the IO. We added one PWM driver to drive the LPG knob to rotate the motor.

LED batten: The LED batten is used to light up the kitchen. The action controller automatically controls this light. When sufficient light is unavailable inside the kitchen, the action controller triggers the light. When no one is there, and it is nighttime, it will automatically switch off the light.

Exhaust Fan: the exhaust fan is essential for the kitchen. The common practice is when we enter the kitchen, we turn on the fan. At night, we switched off the fan. Sometimes, we forget to turn off the fan. Now, the scenario has changed. It will be taken care of by AI. In the action configuration file, we can set various actions for the exhaust fan. The system will compare with that action and trigger the fan on or off on that basis automatically.

LPG Knob Regulator: the LPG knob regulator control attachment has two purposes. One is to read the status of the position of the knob, which is required to know by the action controller. The two types of connection are present from the action controller. One is the magnetic sensor connected to the microcontroller's digital input. The other one is attached to the controller's PWM engine. The controller generates the PWM signal fed to the PWM driver. Then it drives the motor to do the knob on or off.

LPG Leak detector: we installed the LPG detector for safety purposes and to prevent accidents from gas leakage. It has the potential for free contact, which is connected with one digital input of the microcontroller. When it detects the gas leakage, the contact will close, and the controller take action as soon as possible.

Kitchen chimney: instead of an exhaust fan, there is a kitchen chimney available in some kitchens. It has the same function as an exhaust fan.

Table 3 depicts a couple of examples of the kitchen event and the respective actions.

Table 3: Example action list for kitchen event

PLACE	Detected Activity	ACTION
Kitchen	Cooking started	Exhaust fan on
	Cooking stop and LPG regulator in off-state	After 5 mins. Exhaust Fan off.
	The milk is boiling on the Gas burner, and no one inside the kitchen	If it starts boiling, wait a couple of minutes and close the Gas knob
	Cooking is over	The kitchen light goes off. The exhaust fan is off.
	…	
	…	
	…	
	…	
	Fire detected	1) Check the LPG GAS knob; if on, do it off 2) Exhaust fan on 3) Call the concerned person; if no response is received, call the fire station

5. ABCD ANALYSIS OF AI KITCHEN :

ABCD analysis is a framework to analyse the advantages, benefits, constraints, and disadvantages of a system [31-36]. Here we have listed the advantages, benefits, constraints, and disadvantages of AI Kitchen.

5.1 Advantages:

(1) we can get the incident notification before it happens.
(2) It helps to coordinate all kitchen work inside, which is more desirable in a busy modern schedule.
(3) when we are out of the station, we can get a complete kitchen picture from the camera using our mobile phone.
(4) it guides us to nicely control the various kitchen gadgets.
(5) the electricity power consumption is completely managed and will become optimized.

5.2 Benefits:

(1) Most of the kitchen supervision systems do not need to be installed.
(2) AI manages it, so we can concentrate on other creative tasks.
(3) it minimizes the panic due to the events like. Did we switch off the gas? Did we turn off the exhaust fan, the light in the kitchen, etc.?
(4) we will be in complete peace of mind which is mostly wanted things for everyone.
(5) By coordinating various tasks, we can minimize the time spent inside the kitchen premises.

5.3 Constraints:

(1) there is a prime constraint to detecting all events using only image processing.
(2) Another constraint is that the system depends on an electrical power supply. The complete system cannot detect any events when a power cut happens.
(3) The learning phase is higher than the just smart system. The system needs to learn for a long time to learn from the incident. After that, it may be fully-fledged and workable.
(4) the complete system is growing and developing. It is now so expensive. Most people cannot afford it until technology costs are minimized.
(5) to deploy inside the kitchen, many electrical and physical resources need to change.

5.4 Disadvantages:

(1) the system is a sophisticated device. Frequently need maintenance, which consumes our valuable time.

(2) No one system is hundred percent reliable. It is AI based system. Still, we should not have faith ultimately. There are lots of things that can happen. After all, it is the electronic devices. The complete system is built with thousands of components. Any time defects can occur in any component. Then, it will not be able to detect the event.
(3) if an obstacle happens, some event cannot be adequately detected, impacting event detection.
(4) if the system takes care of our responsibilities, and if it continues, we gradually become irresponsible in our daily work.
(5) this AI kitchen is gradually making us too lazy to do our work.

6. SUGGESTIONS :

To execute the project, here are a couple of suggestions we have for those who are going to implement or carry out the project to add some value:

- Use the latest image design library to detect the event more accurately and efficiently.
- Use a high-end system unit as much as possible so that the system can detect the event as fast as possible.
- The connected wire between the CPU and the action controller should be fireproof. The council wiring is good, especially the wire inside the kitchen environment.
- No hanging wire should be kept, as it can create serious problems.

7. CONCLUSION :

This research shows how we can build an AI-based kitchen automation system. We initiate the project with purpose, methodology, and result. Then, we add an introduction to the problem statement and an indication of the method. We added a few projects that are noticeable contributions to this field, like the research work by researcher Bouchard et al. (2012) [3] describes the Guidelines for efficient smart home design for rapid AI prototyping. After that, we include the literature review or the current status of the research on the relevant fields. Then, we add the objective of the paper. After that, we discuss the methodology of the project using a block diagram and depicting the picture of the action controller image. We added a couple of suggestions for the advanced researcher who will develop the project. Also, we added a couple of limitations to the project, encouraging us to continue the project but to take care of it. Finally, we added the reference researcher paper source from which we benefitted from executing the project.

8. LIMITATIONS :

A couple of limitations are present in this research work. The limitations are as follows:

- In the kitchen, there is much oily smoke. Frequently, it would be best if we cleaned the camera lens.
- The complete system is sophisticated, so where we install this system, we need to install the kitchen chimney or exhaust fan. It incurs the project cost, but it will create a hazard-free operation.
- The LPG leak detector needs to clean the window in a while. We must program the system depending on the usage and smoke emitting the environment.
- The CPU must not be installed inside the kitchen environment for safety reasons.

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