

AUTOMATED STANDALONE FOOD PREPARATION KIOSK AND METHOD OF OPERATION THEREOF:

FIELD

[0001] The present invention generally relates to automated food preparation systems, and in particular to an automated standalone food preparation kiosk and method of operation thereof.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] Market demands on the food and beverages industry, and in particular on fast food outlets, necessitate ongoing improvements in the speed of delivery of food, while at the same time ensuring that both the food quality and regulatory requirements are maintained. To this end, various companies have sought to develop robotic and automation technology that generally provide solutions that mostly target highly repetitive tasks within a kitchen by breaking down the entire workflow into sub processes. This however only partially addresses the problems faced in the F & B industry, as a complete solution should ideally also address the processes and workflow within the kitchen as well as address requirements such as fire safety, air filtration and food safety and hygiene. Furthermore, existing solutions do not directly support F & B business when scaling up to multiple premises, and also do not assist the day-to-day operations, manpower constraints, traceability and quality within multiple premises.

[0004] An object of the invention is to ameliorate one or more of the above-mentioned difficulties.

SUMMARY

[0005] According to an aspect of the present disclosure, there is provided an automated standalone food preparation kiosk comprising:

at least a food dispensing zone, a robotic zone, and a cooking zone;

wherein the food dispensing zone comprises an automatic dispensing system for dispensing food or liquid ingredients;

the robotic zone comprises a multi-axis robotic arm for receiving food or liquid ingredients from the food dispensing zone, for delivering the food or liquid ingredients to the cooking zone, and for assembling and transferring finished dishes to a food collection area; and

the cooking zone comprising at least one automated cooking appliance for receiving and cooking the food or liquid ingredients delivered by the robotic arm.

[0006] In some embodiments, the automatic dispensing system comprises a configured dispensing array providing a plurality of designated storage slots for respectively accommodating at least one prefilled and sealed ingredient pod therein; to thereby allow for automatic retrieval of the ingredient pods being dispensed, each ingredient pod being filled with a measured portion of the food or liquid ingredient..

[0007] In some embodiments, the automatic dispensing system comprises a multi-axis gantry system of retrieving the selected ingredient pods, the gantry system using the robotic arm for retrieving the ingredient pods.

[0008] In some embodiments, each ingredient pod is provided with an identification marker for providing information including identification of the food or liquid ingredient contained within the ingredient pod, expiry date of the contained food or liquid ingredient.

[0009] In some embodiments, the automatic dispensing system is temperature controlled to thereby allow for the storage and dispensing of fresh, frozen and shelf-stable food or liquid ingredients.

[0010] In some embodiments, the food dispensing zone further comprises specialised dispensers for dispensing seasoning powders and liquid-based ingredients, the dispensers including a weight sensor and/or volumetric flow meter for accurately dispensing the ingredient contained therein.

[0011] In some embodiments, the robotic arm is selectively equipped with suction or magnetic grippers, tray holders, and bin mounts for transporting the food or liquid ingredients between the dispensing and cooking zones, for mixing, assembling dishes, and transferring finished dishes to the food collection area.

[0012] In some embodiments, the robotic arm further being selectively equipped with one or more cleaning attachments for cleaning within the kiosk, the cleaning attachments including a vacuum cleaning attachment for removing debris including crumbs, loose food particles and dry residues, a wipe-down attachment having an absorbent cleaning pad and spray nozzles for removing grease and oil residues, spilled sauces and other general surface contaminants.

[0013] In some embodiments, the automated standalone food preparation kiosk further comprises a self-washing station including a washing chamber and a high-pressure spray nozzle system for accommodating and washing the seasoning bowls or food transfer containers transferred thereto by the robotic arm.

[0014] In some embodiments, the self-cleaning station further comprises a detergent dispenser, and a water filtration system for filtering water prior to delivery to the high-pressure spray nozzle system.

[0015] In some embodiments, the self-cleaning station further comprises an automated drying system for removing residue water from the washed seasoning bowls or food transfer containers using a high velocity compressed air and/or heated air.

[0016] In some embodiments, the automated standalone food preparation kiosk further comprises a label printer and dispenser providing labels showing information of the order, the robotic arm collecting and applying a said label to a completed food order, or bringing the completed food order to the label printer and dispenser where the label is then applied.

[0017] In some embodiments, the automated standalone food preparation kiosk further comprises at least one UVC germicidal disinfection lamp located within a key area of the kiosk such as a food storage area or preparation area within the kiosk.

[0018] In some embodiments, automated standalone food preparation kiosk further comprises an internal environmental monitoring system comprising at least one air quality sensor, smoke detector, temperature sensor, and humidity sensor for monitoring conditions within the kiosk including air quality, smoke, temperature and humidity.

[0019] In some embodiments, automated standalone food preparation kiosk further comprising an integrated fire safety system comprises at least one smoke alarm and temperature sensor for respectively monitoring each said zone of the kiosk, the fire safety system responding when measurements from the smoke alarm or temperature sensor exceed a predefined threshold. the response including one or more of the following:

- a) automatic shutdown of electrical components in an affected said zone to eliminate potential sources of fire ignition;
- b) triggering the smoke alarm to notify nearby personnel; and
- c) automatically or manually initiating a passive fire suppression mechanism to extinguish a fire within a specific zone of the kiosk.

[0020] In some embodiments, the automated standalone food preparation kiosk further comprises one or more access doors provided with IOT enabled safety locks connected to a main controller requiring user authentication to thereby only allow entry of the access door by authorized personnel.

[0021] In some embodiments, the automated standalone food preparation kiosk further comprises an order collection window for allowing the collection of food orders completed by the kiosk and including a cloud-based smart locking and unlocking mechanism and authentication system for only allowing access to the completed order at the order collection window by a customer or delivery person

[0022] In some embodiments, the automated cooking assembly is adapted to provide food preparation processes including frying, oven cooking, blending and blanching of food ingredients therein.

[0023] In some embodiments, the food distribution, robotic and cooking zone are respectively provided within two or more separate modules of the kiosk.

[0024] In some embodiments, the automated standalone food preparation kiosk further comprises a cutting mechanism for cutting a plastic seal provided on the ingredient pod.

[0025] According to another aspect of the present disclosure, there is provided a method of fulfilling a food order using an automated standalone robotic food preparation kiosk according to any one of the preceding claims, comprising:

- a) placing an order through an interactive touch screen interface located on the kiosk, via a third-party food delivery app, or via a QR code displayed on the kiosk;
- b) transmitting details of the order to a cloud-based order management server for managing order queues, prioritising orders based on complexity and preparation time, and handling real-time menu updates;
- c) forwarding the order details to a cloud-based main server for analysing the order by breaking the order down to individual tasks for the kiosk including ingredient dispensing, cooking and assembling,
- d) sending the order detail and associated individual tasks to a central computer system of the kiosk;
- e) sending instructions to the robotic arm and other automated systems to begin the order fulfilment process; and
- f) assembling all components of the order into a final container and placing the order in a designated storage area with the kiosk.

[0026] Other aspects and features will become apparent to those of ordinary

skill in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] In the figures, which illustrate, by way of example only, embodiments of the present invention,

[0028] [Figure 1] is a cross-sectional side front view of a first possible embodiment of an automated standalone food preparation kiosk according to the present disclosure separated into three separate modules;

[0029] [Figure 2] is a perspective view of the automated standalone food preparation kiosk of [fig. 1];

[0030] [Figure 3] is a perspective view of the automated standalone food preparation kiosk of [fig. 1] with the dispensing zone separated from the rest of the kiosk;

[0031] [Figure 4] is a perspective view of the cooking zone of the automated standalone food preparation kiosk of [fig. 1];

[0032] [Figure 5] is a perspective view of a second possible embodiment of an automated standalone food preparation kiosk according to the present disclosure;

[0033] [Figure 6] is a perspective view of the automated standalone food preparation kiosk of [fig.5] when separated into separate modules;

[0034] [Figures 7(a) and (b)] are respective detailed views of the multi-axis robotic arm according of the automated standalone food preparation kiosk according to the present disclosure;

[0035] [Figures 8(a) and 8(b)] are respective views of seasoning/food transfer containers and a self-washing station for the containers according to the automated standalone food preparation kiosk according to the present disclosure;

[0036] [Figure 9] is a flowchart showing the ordering fulfilment workflow;

[0037] [Figure 10] is flowchart showing the internal environment monitoring system workflow:

[0038] [Figure 11] is a flowchart showing the fire safety system workflow;

[0039] [Figures 12] is a flowchart showing the access control panel workflow, and

[0040] [Figures 13(a) to 13(c)] are respective perspective views of an ingredient pod according to the present disclosure.

[0041] Other arrangements of the invention are possible and, consequently, the accompanying drawings are not to be understood as superseding the generality of the preceding description of the invention.

DETAILED DESCRIPTION

[0042] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0043] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0044] Example embodiments of the present invention will now be described with reference to the accompanying drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout the description. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which this invention belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

[0045] The present invention relates to a modular robotic food preparation kiosk. The food preparation kiosk according to the present disclosure can encompass robotics, artificial intelligence (AI), internet of things (IoT) technologies, and software engineering, integrated to create a comprehensive system designed to automate the process of preparing and serving food in a variety of settings, including but not limited to fast food outlets, cafeterias, hospitals, and retail environments.

[0046] While most companies are focusing on the robotics aspect, the modular robotic food preparation kiosk according to the present disclosure focuses on tackling the operational and scalability challenges that come with robotics solutions. Most restaurants hold kitchen operators accountable for the store downtime, quality, speed and inventory management. However, in order for a robotics kiosk to be truly autonomous, the systems need to be capable of handling multiple operational workflows simultaneously. The modular robotic food preparation kiosk according to the present disclosure focuses on solving the following key problems:

[0047] System downtime: Remote control capabilities using a command centre in the event of system failure. This includes features such as remote robot arm control, remote individual power control, waypoint data logging and error codes classification.

[0048] Integration with existing services: Ordering architecture that allows ordering data from various methods:

- Onsite touch screen Ordering system with payment terminal
- Web based ordering system
- API integration with 3rd party companies. e.g. Delivery Partners
- Mobile App based ordering system - for loyalty or subscription programs

[0049] Safety and Security - Preventing Misuse: Access to the kiosk using multiple panels for isolating different operators with different user rights. E.g. Raw materials delivery personnel has dedicated access to the freezer door using 2FA authentication. Similarly, air filtration system maintenance personnel have dedicated access to the filtration panel. All the panels are isolated from each other. The access codes can be centrally controlled by the command centre. Only registered users can

access the codes via registered phone number.

[0050] Lack of IoT and robotics friendly appliances: Common strategy for most robotics companies is to build robots/automation systems to handle existing kitchen appliances. e.g. designing an actuator to grab a microwave handle. The modular robotic food preparation kiosk according to the present disclosure focuses on building smart kitchen appliances of the future that are designed for robots to use. e.g. microwave ovens with built in doors that can be automatically opened by having Open APIs.

[0051] Market & Regulatory Challenges: Fully autonomous kiosks is a new category or method of operating restaurants (or express restaurants). Most countries have regulatory requirements for operating kitchens and popup stores. However, for fully autonomous and unmanned restaurants there are no clear guidelines. The modular robotic food preparation kiosk according to the present disclosure seeks to cater to such potential requirements and is taking into consideration of key features such as:

- Fire Safety System (Monitoring and Suppression) - Built in systems as well as ability to connect external lines.
- Air Filtration System (Smoke Filtration and Air Filtration) - changeable systems based on jurisdiction/local laws.

[0052] Food Safety and Hygiene: In an unmanned system, it is very important for the system to record the key data points of raw ingredients such as temperature, date of stock, etc. The modular robotic food preparation kiosk according to the present disclosure ensures traceability and logging of every cooking process till the order is dispatched. This includes all the key sensor data such as freezer temperature, oil temperature, cook duration, weight/count of ingredients as well as images of food before final dispatch.

KIOSK ARCHITECTURE:

[0053] The modular robotic food preparation kiosk 100 according to the present disclosure is an automated and self-contained system designed to revolutionise the food service industry by automating the entire process of food

preparation, from order taking to cooking and serving. Equipped with advanced technology, this kiosk integrates a touch screen for customer orders, a payment terminal, and a cloud-based server for efficient order management. The heart of the kiosk 100 is a sophisticated multi-axis robotic arm 121 that carries out a variety of tasks across different zones of the kiosk, including dispensing ingredients, cooking, seasoning, assembling dishes, and cleaning. The system is designed to handle multiple orders simultaneously, ensuring a seamless and efficient operation. Additionally, the kiosk features an array of sensors and modules for environment monitoring, fire suppression, and pest control, making it a safe and hygienic option for food preparation.

[0054] In a first possible embodiment of the modular robotic food preparation kiosk 100 according to the present disclosure, the kiosk 100 can have at least two and preferably three different operational zones as shown in [figs. 1 to 4], each zone being formed from a series of different modules as follows:

[0055] Dispensing Systems (Food dispensing Zone.110): This area is equipped with modular dispensers for various ingredients, ensuring precise and hygienic dispensing. The dispensing zone is outfitted with an array of modular, automated temperature-controlled dispensers 111 including solid ingredient dispensers 112 and liquid ingredient dispensers 113. Each dispenser 111 is equipped with sensors to precisely measure and release the correct amount of each ingredient based on the recipe requirements. The system is capable of adjusting the dispensed quantity in real-time, ensuring accuracy and reducing waste. Ingredients are stored in sanitised, airtight containers within the dispensers 111 to maintain freshness and prevent contamination. The process begins when the kiosk computer sends a signal to the dispenser controller with the ingredient ID and required quantity. The dispenser then activates, measuring out the ingredient using a combination of weight sensors and volumetric flow meters. Once the correct amount is dispensed, a transport system 114 transports the ingredients to the pickup point for the robotic arm 121 to collect.

[0056] Key Modules in the dispensing Zone 110:

- Modular Dispensing Systems for various food and temperature states 111

- Seasoning powder and food dispensers 112
- Beverage Can Dispensers 113

[0057] According to another possible embodiment of the modular robotic food preparation kiosk 100 according to the present disclosure as shown in [figs. 5 to 8b], the dispensing zone 110 of the unmanned food kiosk 100 is equipped with a highly adaptable, temperature controlled dispensing system, designed to ensure precise, hygienic, and efficient ingredient handling. This system is responsible for the controlled dispensing of various solid and liquid ingredients, including fresh, frozen, and shelf-stable components, which are critical to food preparation within the kiosk. The dispensing mechanism is further enhanced by the integration of a multi-axis gantry system 115 that uses the robotic arm 121 to enable the retrieval of sealed ingredient pods of varying sizes and materials from a configured storage grid 116. The gantry system 115 can operate in three axes across an X-Y-Z coordinate framework, allowing it to access different rows and columns, each specifically designated for a particular ingredient type. This modular arrangement enables the kiosk to dynamically manage its inventory and efficiently select ingredients based on incoming customer orders. It is also envisaged that the gantry system operates in two axes together with a passive stop.

[0058] At the core of this dispensing system is the use of sealed food pods 117, which are employed to maintain food safety, freshness, and contamination control. These pods 117 are pre-filled with measured portions of ingredients, ensuring consistency in dispensing while also streamlining the replenishment process. Each pod 117 is securely stored within the dispensing array 116, where it remains airtight and sanitised to uphold hygiene standards. The system is programmed to retrieve the required food pod only upon request, preventing unnecessary exposure to external contaminants.

[0059] The retrieval process is initiated when the kiosk's central computer system processes a customer order and sends a command to the gantry controller. The controller determines the precise location of the required ingredient pod 117 based on the configured storage grid 116. The three-axis gantry system 115 then moves along its horizontal (X and Y) and vertical (Z) axes, positioning itself over the

designated storage slot before engaging its gripping mechanism to securely grasp the sealed pod. Once the pod 117 is retrieved, the gantry system transports it to the designated dispensing point, where it is either opened for controlled dispensing or transferred to the robotic arm 121 for further processing. A cutting mechanism 118 as shown in [fig. 13(c)] can be used to cut a plastic seal 117A provided on the top of each of the ingredient pods 117 as shown in [fig. 13(b)]. This step allows the robotic arm 121 to dispense the ingredients contained in the pod 117 into the cooking appliance 131.

[0060] Each ingredient pod 117 is embedded with an identification sticker containing a barcode, QR code, RFID, NFC tag, or a similar unique identifier as shown in [fig.13(a)]. These labels serve multiple functions, including ingredient verification, expiry date tracking, and inventory management. The gantry system's carriage is equipped with an advanced sensor array capable of scanning these labels in real-time. Before transporting a food pod, the system automatically reads its unique identifier to ensure it matches the order requirements. If the pod's expiry date has passed or if it does not align with the specified recipe, the system flags the issue and prevents its use, reducing the risk of food safety violations. Additionally, this automated tracking capability allows the kiosk to maintain a real-time inventory database, ensuring that stock levels are continuously updated and that replenishment alerts are generated when supplies run low.

[0061] Beyond standard ingredient retrieval, the modular dispensing zone 100 also incorporates specialized dispensers 111,112,113 for seasoning powders, and liquid-based ingredients. These dispensers operate in conjunction with the gantry system 115, allowing for a fully automated, on-demand dispensing workflow. When a seasoning or beverage is required, the system first verifies availability within its inventory database. If the item is in stock, the appropriate dispenser is activated, precisely measuring out the required quantity using a combination of weight sensors and volumetric flow meters. This comprehensive approach to ingredient management ensures that every component used in the kiosk is securely stored, accurately dispensed, and efficiently tracked. By integrating a 3-axis gantry retrieval system 115, the kiosk significantly enhances its ability to handle a diverse range of food ingredients while maintaining strict hygiene and quality control standards. The

seamless coordination between the gantry, ingredient storage, and robotic arm transport system enables a fully autonomous food preparation workflow, ultimately reducing waste, increasing operational efficiency, and ensuring consistent meal quality for customers.

[0062] Robotics and Transport Systems (Robotic Zone 120): The centrepiece of the kiosk 100 is a state-of-the-art multi-axis robotic arm 121 designed for high precision and flexibility. This arm is responsible for transporting ingredients between zones, mixing, assembling dishes, and transferring finished dishes to the storage array or cooking appliances. The arm is equipped with a variety of attachments, including suction grippers, magnetic grippers, tray holders, and bin mounts, which can be automatically changed based on the task at hand. Its movement is coordinated by advanced algorithms that optimise the path for speed and efficiency, reducing preparation time and minimising the risk of spills or mishaps. The robotic arm 121 also plays a critical role in the kiosk's self-cleaning process, using specialised attachments to sanitise surfaces and equipment after a certain number of orders is completed.

[0063] Key Modules in Robotic Zone 120:

- Robotic Arm 121
- Power Distribution Module with Fuses
- Self washing system 122
- Seasoning bowl drying system
- Collection Window with Door Flap for order dispatch
- Label Printing station for printing and sticking onto the final packaging
- Lid Closing Station to cover the final packaging

[0064] The central automation system within the unmanned food kiosk 100 is a state-of-the-art multi-axis robotic arm 121, designed for high precision and dynamic adaptability in food handling and preparation workflows. This robotic arm 121 acts as the primary transport mechanism, seamlessly moving ingredients, packaging, seasonings, and prepared meals between different subsystems within the kiosk 100.

[0065] In a possible embodiment, the robotic arm 121 is equipped with a pneumatic suction gripper 124 as its end effector, with the robotic arm 121 being capable of securely grasping and transferring a variety of food-related objects, including: food containers (raw ingredient trays, cooked meal trays, and disposable containers), labels (stickers for order verification, branding, and nutritional details), packaging elements (bags, lids, and wrapping sheets), and seasoning bowls (for controlled mixing of condiments and spices).

[0066] The pneumatic suction gripper 124 also enables the robotic arm 121 to handle delicate and irregularly shaped objects with precision. The gripper can feature:

- Multiple suction cups arranged in an adjustable configuration to accommodate objects of varying sizes.
- Vacuum control system that dynamically adjusts suction force based on object material and weight.
- Integrated pressure sensors to prevent excessive force, reducing the risk of damage to packaging or food items.
- Quick-release (air eject) mechanism for rapid pickup and drop-off of containers, labels, and seasoning bowls without delays.

[0067] Transfer Mechanism Across Different Points: The robotic arm 121 operates within a dynamic environment, where it follows optimised paths to interact with multiple subsystems:

[0068] Ingredient Handling & Transfer: The robotic arm 121 retrieves raw ingredient containers 117 from the storage array 116 (freezer/chiller compartments). It precisely moves these containers 117 to the dispensing system, where ingredients are measured and portioned. Once dispensing is complete, the arm 121 returns the ingredient containers 117 to their respective storage slots.

[0069] Meal Assembly & Packaging: After the cooking process is complete, the robotic arm 121 lifts the cooked food trays 132 and transfers them to the assembly station. If necessary, it lifts and places separate compartmentalised food containers to ensure correct portioning.

[0070] Labelling Process: Once a meal is packaged, the robotic arm 121 moves to the label printer and dispenser and picks up a pre-printed label (e.g., order ID, nutritional info, branding, best before time/date). The arm then applies the label onto the correct container using its vacuum-assisted placement mechanism, ensuring proper adhesion without misalignment. Alternatively, the robotic arm 121 can bring the container to the label printer and dispenser where the label is then applied. This function is essential for food traceability and quality assurance in an unmanned kiosk.

[0071] Seasoning & Garnishing Transfer: When a meal requires condiments or garnishes (e.g., sauces, spice mixes), the robotic arm 121 retrieves seasoning bowls from the ingredient storage rack. The arm transports the seasoning bowl to the garnishing station, where it tilts or dispenses the required amount over the dish. If needed, the robotic arm 121 can return unused seasoning bowls to their designated storage area.

[0072] Waste Disposal & Self-Cleaning Integration: Once food handling is completed, the robotic arm 121 collects used or empty ingredient trays and transports them to the waste compartment (trash bin). During scheduled cleaning cycles, the arm uses specialised attachments to sanitise work surfaces, ensuring compliance with food safety regulations.

[0073] Intelligent Path Optimization & Coordination: The robotic arm operates under an advanced motion control algorithm that optimises its movement for:

- Minimal travel distance, reducing overall preparation time.
- Collision avoidance, preventing interaction with other moving components.
- Adaptive scheduling, allowing it to dynamically switch between tasks based on real-time demand.

[0074] Cooking Devices (Cooking Zone 130): This zone houses the kiosk's cooking appliances, including automated fryers 131, stir fry drums, and boilers, equipped with built-in air filtration systems 134 to maintain a clean and odour-free environment. Cooking devices are programmed to adjust their settings (temperature, cooking time, etc.) automatically based on the dish being prepared, ensuring

consistent quality and taste. Ingredients dispensed from the dispensing zone 110 are either directly picked up by the robotic arm 121 and placed into the cooking devices or pre-assembled in the central zone before cooking. Sensors monitor the cooking process, adjusting parameters in real-time for optimal results. Once cooking is completed, the robotic arm 121 transfers the dishes to the assembly area for final touches or directly to the storage array for pickup.

[0075] Key Modules in the Cooking Zone 130:

- Multiple cook stations such as automatic fryers 131
- Fryer modules that can be configured to be a noodle blancher
- Integrated 4 stage air filtration system 134
- Fire Suppression System
- A high speed oven (combination of microwave+convection oven)
- Order Status display screen

[0076] The distinct zones are designed to operate cohesively as a single unit while retaining the flexibility to be shipped, assembled, and expanded independently. The integrated power and networking infrastructure across zones facilitate seamless communication and synchronisation, allowing for efficient operation and scalability. Daisy-chaining capabilities future-proof the kiosk, enabling the addition of more zones or functionalities as market demands evolve or new technologies become available.

[0077] In the first embodiment of the kiosk 100 shown in [figs. 1 to 4], the food dispensing zone 110, robotic zone 120, and cooking zone 130 may be respectfully located in different physical modules 101, 102, 103. Alternatively, multiple zones may be located in a single module. The second embodiment of the kiosk shown in [figs. 5 and 6] provides a first module 104 for accommodating the food dispensing zone 110, and a second module 105 for accommodating both the robotic zone 120 and the cooking zone 130. A further module 106 is also provided to accommodate therein a beverage vending machine 140 having a discharge flap 141 to allow for collection of the dispensed beverage. The software architecture for the kiosk 100 sends a command (via API) to the vending machine to dispense the correct drink and/or

condiment. The user then collects the food from the main kiosk (120/130) and collects the drink via the discharge flap (141).

ORDERING FULFILMENT WORKFLOW:

[0078] Customer Order Placement: Referring to [fig. 9], customers place their orders through an interactive touch screen interface 150 located on the kiosk or via third-party food delivery apps 152, 154, 156. The interface is intuitive, offering menu options, customization features, and payment solutions. Upon order is confirmed, a QR code is sent to the customer's email or displayed on the app. A physical receipt is printed with the unique QR code as well.

[0079] Customer Order Placement via QR Code: Customers can place their orders by scanning a designated QR code displayed on the kiosk or promotional materials using their smartphones. This directs them to a web-based ordering interface where they can browse the menu, customize their meals, and proceed with payment using various digital payment methods such as credit/debit cards, mobile wallets, or UPI. Once the transaction is completed, the system generates a unique order confirmation, which is sent via email or displayed within the app.

[0080] Order Transmission to Cloud Server: Once an order is placed and payment is processed, the details are transmitted to a cloud-based order management server 158. This server manages the order queue, prioritises orders based on their complexity and preparation time, and handles real-time menu updates and availability.

[0081] Order Processing and Task Segmentation: The order management server 158 then forwards the information to a cloud based main server 160 which analyses each order, breaking it down into individual tasks (e.g., ingredient dispensing, cooking, assembling). This segmentation facilitates the distribution of tasks across the kiosk's various zones and equipment. This is a smart planner that orchestrates the different sub tasks to successfully execute an order.

[0082] Dispatch of Commands to Kiosk Computer: Orders and their associated tasks are sent from the cloud based main server 160 to the kiosk's central computer system 162. This system 162 acts as the operational brain of the kiosk

100, orchestrating the execution of each task 166 by the appropriate module 170, 172, 174, 176 (dispensing, cooking, assembly).

[0083] Execution of Tasks by Robotic Systems: The central computer 162 dispatches commands to the multi-axis robotic arm 121 and other automated systems to begin the order fulfillment process. This includes dispensing ingredients, cooking, seasoning, and assembling the final product.

[0084] Monitoring and Adjustments: Throughout the preparation process, environment sensors and cooking equipment feedback systems 168, 174 monitor the progress and quality of the order. Adjustments are made in real-time to ensure optimal results.

[0085] Order Assembly and Storage: Once all components of an order are prepared, the robotic arm 121 assembles the final dish into bowls or plates and then places them in a designated storage area within the kiosk, awaiting customer pickup.

[0086] Customer Notification and Order Pickup: Customers are notified through the touch screen interface 150 or their mobile device 152 when their order is ready. Upon scanning a receipt or entering a code at the kiosk 164, the robotic arm retrieves the order from storage and presents it to the customer at the collection window.

INTERNAL ENVIRONMENTAL MONITORING:

[0087] The modular robotic food preparation kiosk 100 according to the present disclosure employs a comprehensive environmental monitoring system 180 as shown in [fig. 10], designed to ensure optimal operation conditions, safety, and compliance with health regulations. This system incorporates a variety of sensors 1 to continuously assess conditions within the kiosk, including air quality, smoke, temperature, and humidity, among others. These sensors provide critical data for maintaining the integrity of the food preparation process and the safety of the environment.

[0088] Key Components of the Environmental Monitoring System:

[0089] Air Quality Sensors: Air quality sensors 182 measure levels of volatile

organic compounds (VOCs), carbon dioxide (CO₂), and particulate matter (PM_{2.5}/PM₁₀), ensuring that the air within the kiosk remains clean and free of harmful pollutants. This is crucial in maintaining a healthy environment for both the food being prepared and the customers.

[0090] Smoke Detectors: Positioned strategically throughout the kiosk, smoke detectors 184 provide early warning signals in the event of fire, triggering the integrated fire suppression system to activate, minimising risk and damage.

[0091] Temperature Sensors: Temperature sensors 186,188,190 monitor the ambient temperature inside the kiosk as well as the temperatures of critical components and cooking zones. These sensors help in maintaining optimal operating temperatures and preventing overheating of equipment.

[0092] Humidity Sensors: Humidity sensors 192 track the humidity levels within the kiosk to prevent condensation and moisture buildup that could lead to food spoilage or damage to the electrical components.

[0093] Real-Time Monitoring 194: The environmental monitoring system 180 is connected to an online dashboard that provides business owners and technicians with real-time updates on the kiosk's condition. This dashboard is accessible remotely, allowing for constant surveillance and quick response to any issues that may arise. The system 100 conducts a threshold check 196 of the different operational parameters being monitored, and will provide a 'normal operation signal' 198 if these parameters are within threshold. A warning alert 200 may be provided when the parameter thresholds are at a warning level, or may control a system shutdown 202 of the kiosk 100 when the parameter thresholds are at a shutdown level. Email or push notifications 204 may be provided to registered users when the thresholds are at the warning and shutdown levels.

SELF-CLEANING AND SURFACE WIPE-DOWN SYSTEM

[0094] The Automated Standalone Food Preparation Kiosk 100 features a fully autonomous self-cleaning and surface wipe-down system, ensuring hygienic food preparation without human intervention. Unlike conventional automated kitchens that require manual cleaning, the system integrates a multi-stage robotic cleaning

process, using a vacuum-based crumb and debris removal system first, followed by a robotic wipe-down mechanism and UVC germicidal disinfection. This layered approach ensures that all food contact surfaces, ingredient storage areas, and cooking zones remain clean and sanitized throughout operation.

[0095] Step 1: Vacuum-Based Crumb and Food Particle Removal: Before any wiping or disinfecting, the robotic arm is programmed to pick up a vacuum cleaning attachment designed to remove crumbs, loose food particles, and dry residues from ingredient dispensing areas where powders, seasonings, or dry ingredients may accumulate; cooking zones, such as the fryer or high-speed oven, where crumbs from battered or breaded items could collect; and food assembly and packaging areas, ensuring that no loose particles remain on surfaces before the next order is processed.

[0096] Step 2: Automated Wipe-Down Using Robotic Cleaning Attachment: Once the vacuum process is completed, the robotic arm switches to a dedicated wipe-down attachment, featuring an absorbent antimicrobial cleaning pad and spray nozzles. This step removes grease and oil residues from food preparation areas; spilled sauces, seasoning, or liquid ingredients that may have splashed during dispensing; and general surface contaminants, ensuring a clean workspace for the next food order. The wipe-down process is enhanced by a controlled dispensing system, where food-safe cleaning agents and filtered water are applied to the surface before being wiped down, ensuring effective removal of grease and stubborn residues. The robotic arm follows a preset cleaning path, ensuring that all high-contact areas are covered, including food trays, preparation surfaces, and transfer zones. Additionally, for areas exposed to high levels of oil and grease, the system deploys a separate grease-absorbent pad attachment, optimized for fryer surfaces and high-temperature cooking zones.

[0097] Step 3: UVC Germicidal Disinfection and Anti-Mold Features: To ensure optimal food safety and hygiene, the kiosk is equipped with UVC germicidal lamps strategically placed within key areas, such as food storage compartments and preparation zones. These lamps operate on a pre-set schedule, activating during non-operational hours to effectively eliminate bacteria, viruses, and mold spores.

This automated disinfection process helps maintain a sterile environment, reducing the risk of contamination and extending the freshness of stored ingredients. Additionally, the anti-mold features prevent microbial growth in humid areas, further enhancing food safety and ensuring compliance with stringent health regulations.

[0098] Self-Washing Station 122 for Seasoning Bowls or Food Transfer Containers 125: The self-washing station 122 as shown in [fig. 8(b)] is an automated cleaning system designed to efficiently wash and sanitize seasoning bowls used in food preparation. Integrated within the kiosk 100. The self-washing station 122 includes a sink 126 for accommodating, the containers 125 to be cleaned. The station 122 ensures thorough cleaning while optimizing water usage and maintaining hygiene standards. The system features a high-pressure water spray mechanism that targets residual seasoning, oils, and food particles, followed by a detergent cycle and a final rinse with filtered water. The self-washing station 122 therefore also includes a mounting bracket 128B for holding a pip and nozzle of the water spray mechanism. This bracket 128B allows the nozzle to be pointed upwards inside the sink 126 thereby allowing the nozzle to be mounted at different angles and heights. A splash guard 128A is also provided to prevent the water mist from the station 122 drifting towards the cooking zone 131 wherein is accommodated the cooking appliances 131. Water is delivered to the nozzle using a high pressure water pump 129 which can increase the water pressure to the nozzle or pull water from a water container if the deployment site of the kiosk 100 has no provision for a water supply. The automated process ensures consistency in cleaning while reducing manual intervention and the risk of cross-contamination.

[0099] The self-washing station consists of multiple key components to ensure efficient cleaning, filtration, and drainage:

1. Rotary or Fixed Bowl Placement System: Seasoning bowls are placed in a designated washing chamber (similar to a sink) with secure holders to prevent movement during the wash cycle. A rotational or multi-nozzle spray arm ensures even coverage for thorough cleaning.
2. High-Pressure Spray Nozzles: Strategically positioned nozzles deliver high-pressure water jets mixed with food-safe detergent to break down seasoning residue.

The spray pattern is optimized to reach all corners of the bowls, ensuring complete removal of oil and food particles.

3. Detergent Dispenser and Rinse Cycle: A controlled dosing system dispenses an appropriate amount of food-safe detergent. A second set of nozzles provides a fresh water rinse, ensuring no detergent residue remains.

4. Water Filtration System: The self-washing station is equipped with a robust water filtration system to ensure that only clean, contaminant-free water is used during the washing process. The system includes a multi-stage filtration unit that treats incoming water before it reaches the spray nozzles. First, a sediment pre-filter removes larger particles such as sand, rust, and debris to prevent clogging and protect downstream components. Next, an activated carbon filter eliminates chlorine, organic compounds, and odors that may affect the cleanliness of the seasoning bowls. For additional purification, an ultrafiltration (UF) membrane or reverse osmosis (RO) unit can be integrated to remove bacteria, heavy metals, and dissolved impurities. A final UV sterilization stage ensures microbial disinfection before water is used in the wash cycle. This filtration system guarantees that only purified water is used, reducing the risk of contamination, enhancing food safety, and prolonging the lifespan of internal components by preventing scale buildup.

5. Drain Trap System: The system incorporates a drain trap with a grease and solid separator to prevent clogging. The trap collects food waste and oily residues, allowing easy disposal while preventing blockages in the plumbing system.

6. Automated Drying System: To ensure seasoning bowls are thoroughly dried after the wash cycle, the system incorporates a high-velocity compressed air drying mechanism. Compressed air passes through an FDA-approved air filter to remove contaminants, ensuring that only clean, food-safe air is used in the drying process. High-pressure air jets are strategically positioned within the drying chamber to effectively remove residual water, preventing moisture retention that could lead to bacterial growth or mold formation. The powerful air stream accelerates the drying process, significantly reducing wait times and making the bowls ready for immediate reuse. Additionally, the system can include temperature-controlled warm air infusion, further enhancing drying efficiency while maintaining food safety standards.

7. Scheduled or On-Demand Operation: The system can be programmed to run at specific intervals or activated on demand via the kiosk interface. Sensors detect when bowls are placed in the chamber, triggering an automatic wash cycle.

INTEGRATED FIRE SAFETY SYSTEMS:

[00100] The fire safety system within the modular robotic food preparation kiosk according to the present disclosure is designed with multiple layers of protection to ensure rapid detection and effective response to fire incidents. Each zone of the kiosk is equipped with its own set of smoke alarms and temperature monitors, allowing for precise and localised fire detection and suppression efforts. Below is a detailed process flow shown in [fig. 11] that outlines the steps and methods employed by this advanced fire safety system:

Continuous Monitoring 300,302,304: Each zone within the kiosk (dispensing, cooking, and assembly zones) is continuously monitored by smoke alarms and temperature sensors. These sensors are calibrated to detect the early signs of fire, such as smoke and abnormal temperature increases.

Initial Detection and Localised Response: Upon detecting smoke or temperatures exceeding predefined thresholds, the system immediately initiates a localised response. This includes:

- Actuator Shutdown 306,308,310: Automatically shutting down electrical actuators and heating/cooling coils in the affected zone to eliminate potential sources of fire ignition.
- Smoke Alarm Activation 312,314,316: Triggering the smoke alarm specific to the affected zone, alerting nearby personnel and initiating automated emergency protocols within the kiosk.
- Automatic or manual activation of Passive Fire Suppression: If the system detects continuous fire signals (persistent smoke and high temperatures) despite the initial shutdown of actuators and coils, it escalates the response. A manual override can be provided to allow for manual activation of the automatic fire suppression by nearby personnel or a member of the public in

the case of an emergency,

- **Passive Fire Suppression 318,320,322:** The system activates the passive fire suppression mechanism designed for the specific zone. This could involve the release of non-toxic fire-suppressing agents that effectively extinguish the fire without damaging the kiosk's components or the prepared food.
- **System-Wide Safety Measures 330:** Simultaneously, all non-essential electrical systems within the kiosk are shut down to reduce the risk of fire spreading and to conserve power for emergency operations.
- **Integration with Building Fire Alarm Panel 324,326,328:** Alongside the activation of the kiosk's internal fire suppression measures, a signal is sent to the building's fire alarm panel (if integrated). This ensures a coordinated emergency response, alerting building occupants and enabling building-wide safety protocols.

SMART LOCKS FOR CONTROLLED ACCESS:

[00101] The modular robotic food preparation kiosk according to the present disclosure incorporates an access control and security system designed to ensure operational efficiency, hygiene, and security. This system utilises a cloud-based two-factor authentication (2FA) mechanism, restricting access to the kiosk's various zones and functions based on user roles and permissions. Below and shown in [fig. 8] is a detailed description of the system, its implementation, and its significance in maintaining the kiosk's integrity and functionality.

[00102] **Access Control System Design:** The kiosk is divided into several zones, each with specific functions such as food restocking, maintenance, pest control, and cleaning. Access to these zones is controlled through panels or doors equipped with smart locks. These locks are connected to a cloud-based security system 350 that manages access permissions.

ACCESS CONTROL AND SECURITY SYSTEM FOR OPERATIONAL ISOLATION

[00103] The Automated Standalone Kiosk for Food Preparation incorporates a

cloud-based access control and security system designed to ensure operational efficiency, hygiene compliance, and security. The system utilizes smart locks and role-based authentication, enabling controlled access to various kiosk compartments based on user roles and predefined permissions. Each functional zone within the kiosk is designed for isolated access, preventing cross-contamination, operational interference, or unauthorized system tampering.

[00104] This system ensures that only authorized personnel can perform specific operational tasks—such as food replenishment, waste disposal, maintenance, and order collection—without disrupting the ongoing food preparation process. The access control system is fully integrated with the kiosk’s cloud-based management dashboard, allowing for remote monitoring, real-time authentication, and audit logging of all access events.

2. ACCESS CONTROL SYSTEM DESIGN

[00105] The kiosk structure is divided into multiple secured zones, each with a dedicated smart lock-controlled access panel. These zones function independently, with specific access prerequisites based on user roles. The authentication system utilizes two-factor authentication (2FA) and supports Bluetooth-based mobile verification, SMS OTP (one-time passcode), and RFID-based credentials. Each access panel is controlled by an electronic lock that can be remotely activated or disabled via the kiosk’s cloud management system. The system logs all access events, including user identity, time of access, and task performed, ensuring full traceability.

2.1 WASTE DISPOSAL ACCESS PANEL (TRASH COMPARTMENT)

[00106] Purpose: Designed for daily removal of food waste and non-recyclable materials without interfering with the kiosk’s internal operations.

[00107] Access Requirements: Restricted to building management contractors or authorized waste collection personnel.

- Externally accessible trash compartment, allowing waste removal without requiring access to the kiosk’s food processing zones.

- Smart-lock controlled hatch, preventing unauthorized access.
- Real-time waste level sensors that trigger an alert for disposal when the compartment reaches capacity.

2.2 FOOD REPLENISHMENT ACCESS PANEL (FOOD DISPENSING ZONE 110)

[00108] Purpose: Provides an isolated entry point for food handling personnel to restock sealed ingredient pods, seasonings, and raw ingredients into the storage and dispensing system.

[00109] Access Requirements:

- Restricted to food-safety certified personnel with verified credentials.
- Authentication required via mobile app (Bluetooth or OTP-based access) or RFID employee ID cards.

[00110] Design Features:

- Separated from the cooking zone to ensure ingredient integrity and hygiene compliance.
- Temperature-controlled compartments for ingredient storage.
- Cloud-based inventory tracking, logging all ingredient restocking events for traceability.
- Tamper alerts in case of unauthorized access attempts.

2.3 MAINTENANCE HATCH

[00111] Purpose: Provides secure access for technical servicing, diagnostics, and repairs of electrical, robotic, and mechanical subsystems within the kiosk.

[00112] Access Requirements:

- Restricted to trained technicians or authorized maintenance personnel.
- Requires multi-level authentication, including a secure technician login and temporary access authorization from the remote operations team.

[00113] Design Features:

- Physical separation from food storage, cooking, and dispensing areas.

- Smart lock-controlled access panel to prevent unauthorized tampering.
- Dedicated service compartment containing:
 - Power distribution modules and fuses
 - Multi-axis robotic arm servicing ports
 - 3-axis gantry system calibration points
 - Environmental sensors and fire suppression control modules

2.4 ORDER COLLECTION WINDOW 120A (see [fig. 5])

[00114] Purpose: Provides a secure and automated pickup point for customers or delivery personnel to collect completed food orders.

[00115] Access Requirements:

- Customers authenticate via: QR code scan from their mobile device or printed receipt.
- App-based order confirmation, triggering window access upon arrival.
- Delivery personnel verification for third-party pickups.

[00116] Design Features:

- Pickup window 120A, four of which are shown in [fig. 5], remains locked until authenticated access is granted, preventing unauthorized order collection.
- The robotic arm 121 places the completed order in the pickup bay, ensuring zero human contact with the meal post-packaging.
- Integrated UVC sanitation cycle between order collections to maintain hygiene.

3. SMART LOCKING MECHANISM AND CLOUD-BASED SECURITY

[00117] All access control components are integrated with a cloud-based smart locking mechanism, allowing:

- Role-based authentication, ensuring that only qualified personnel can access specific compartments.

- Two-factor authentication (2FA) for enhanced security, using Bluetooth, SMS OTP, or RFID credentials.
- Remote access control, allowing system administrators to grant or revoke access in real-time.
- Event logging and auditing, tracking:
 - Who accessed which compartment.
 - Time and duration of access.
 - Tasks performed (e.g., replenishment, maintenance, waste disposal).
- Unauthorized access detection, triggering:
 - Security alerts for failed access attempts.
 - Temporary lockdown of access panels if repeated tampering occurs.
 - Remote access override capabilities for emergency situations.

4. SYSTEM ARCHITECTURE OVERVIEW

[00118] Two-Factor Authentication (2FA) Mechanism:

[00119] User Registration and Role Assignment 352: Individuals requiring access to the kiosk panels are registered in the cloud-based system with their contact information and the unique identification code embedded in the user mobile app. Each registered user is assigned a specific role, determining their access privileges to the various panels within the kiosk.

[00120] Access Control via Bluetooth and SMS OTP 354: The door lock controller is designed to recognize Bluetooth signals from a registered mobile app or an SMS one-time passcode (OTP) as forms of authentication. This two-factor authentication process ensures that access is granted only to authorised individuals. Once the door controller recognises an authorised user, it will unlock the Electromagnetic lock or equivalent active locking systems

[00121] Role-Based Access 356: Depending on the assigned role, a user may have access to all or selected panels. For example, a maintenance technician might have access to mechanical and electronic components, while a restocking personnel would only access food storage areas.

Importance of Isolating Access Panels

[00122] Isolating access panels and restricting entry to specific user roles is critical for several reasons:

[00123] Ensuring Food Hygiene: By limiting access to food storage and preparation areas to only those trained in hygiene protocols, the risk of contamination and spoilage is significantly reduced. This is essential for complying with food safety regulations and ensuring customer health.

[00124] Safeguarding Technology: Technical components of the kiosk, such as the operational computer, robotic systems, and environmental sensors, require specialised knowledge for maintenance and troubleshooting. Restricting access to these components ensures that only trained professionals can perform necessary tasks, preventing accidental damage or misuse.

[00125] Security and Accountability: The system creates a log of all access events, providing an audit trail that can be used for security purposes and to track the performance of maintenance and restocking activities.

Cloud User Management:

[00126] The cloud-based architecture of the access control system offers significant advantages in managing manpower:

[00127] Flexibility in Staff Allocation: Staff members can be easily assigned to different kiosk locations as needed, with their access permissions updated in real-time through the cloud system. This flexibility is invaluable for businesses operating multiple kiosks.

[00128] Easy Revocation of Access: When an individual is no longer affiliated with the organisation, their access rights can be immediately revoked through the cloud system, enhancing security and preventing unauthorised access.

[00129] Scalability: The system can scale to accommodate an increasing number of kiosks and users, making it ideal for businesses in growth phases.

OPS DASHBOARD / COMMAND CENTRE:

[00130] The Ops Dashboard/Command Centre is a sophisticated web portal designed as the central nervous system of the modular robotic food preparation kiosk according to the present disclosure. It provides comprehensive tools for real-time visualisation, configuration, management, and diagnostics of the kiosk. The portal is engineered to interface with every component of the kiosk, facilitating seamless communication and operational efficiency. This section outlines the design, functionalities, and capabilities of the Ops Dashboard/Command Centre, providing details pertinent to its logical structure for consideration in patent documentation.

Design and Interface

[00131] The Ops Dashboard/Command Centre is crafted with a user-friendly interface, providing intuitive navigation and access to various modules and data points. It is accessible via web browsers on computers, tablets, and smartphones, ensuring that business owners and technicians can monitor and manage the kiosk remotely. The portal is designed with high-level security features, including encrypted data transmission, secure login mechanisms, and multi-factor authentication to protect sensitive operational data.

Core Functionalities

[00132] Order Status and Sales Data Visualization:

- Real-time tracking of orders through each preparation stage, from receipt to completion.
- Sales data analytics, including daily, weekly, and monthly sales reports, popular items, peak times, and customer preferences.
- Graphical representations of sales trends, enabling effective marketing and stock management strategies.

[00133] Kiosk Configuration and Management:

- Recipe Management: Allows for the addition, modification, and removal of recipes. Includes ingredient lists, preparation steps, cooking times, and temperatures.

- **Process Flows:** Configuration of process flows for new menu items, optimising the sequence of tasks for efficiency and quality.
- **Cook Stations Management:** Facilitates the integration of new cooking stations or the modification of existing ones, including setting parameters and maintenance schedules.

[00134] Remote Monitoring and Diagnostics:

- **System Status:** Continuous monitoring of the kiosk's operational status, including active orders, equipment functionality, and environmental conditions.
- **Maintenance and Diagnostics:** Tools for remote diagnostics of system components, identifying issues and executing maintenance protocols without physical presence.
- **Alerts and Notifications:** Customizable alerts for system errors, maintenance needs, or operational anomalies, ensuring prompt attention to potential issues.

[00135] Signal Communication with Kiosk Components:

- The dashboard communicates directly with each component of the kiosk, sending commands and receiving status updates in real-time.
- Utilises a secure and efficient protocol for data exchange, ensuring that operations are synchronised and adjustments are made promptly.

[00136] Technical Support and User Training: The portal includes a comprehensive knowledge base and support system, offering technical documentation, troubleshooting guides, and training modules. This ensures that users can effectively manage and operate the kiosk, maximising uptime and productivity.

[00137] Scalability and Integration: Designed for scalability, the Ops Dashboard/Command Centre supports the integration of additional kiosks, allowing business owners to manage a network of kiosks from a single interface. It also facilitates the integration with third-party systems, such as inventory management software and payment processing services, providing a cohesive operational ecosystem.

CLOUD INTEGRATION WITH DELIVERY APPS (3rd party apps)

Process Flow:

[00138] Order Placement: A customer places an order through a third-party food delivery app. The app uses a RESTful API to transmit the order details (including menu items, quantities, and customer preferences) to the kiosk's cloud-based server.

[00139] Order Validation and Queueing: The cloud server validates the received order for completeness and availability. It then prioritises and queues the order based on its estimated preparation time and current workload.

[00140] Order Processing: The server breaks down the order into individual tasks (dispensing, cooking, seasoning, assembling) and sends these tasks to the kiosk computer.

[00141] Task Distribution: The kiosk computer allocates tasks to the respective zones (dispensing, cooking, assembly) and commands the multi-axis robotic arm and other devices to execute them.

[00142] Status Updates: As the order progresses, the kiosk computer updates the cloud server with the status (preparing, ready for pickup). The server, in turn, updates the third-party app and, consequently, the customer.

Order Completion and Notification: Once the order is ready, the server sends a final update to the app, notifying the customer that their order is ready for pickup.

[00143] The Automated Standalone Food Preparation Kiosk 100 according to the present disclosure represents a fully unmanned, self-contained "kitchen in a box", a significant advancement over the closest prior art, which primarily focuses on single-process automation, such as dedicated pasta machines, salad bowl assemblers, or fried food vending systems. Unlike these prior solutions, the kiosk 100 is designed to handle multiple types of cooking processes simultaneously, allowing for a diverse menu offering that combines different food types within a single unit. This means the kiosk can, for example, boil pasta while simultaneously frying chicken tenders and preparing fries, all while managing ingredient retrieval, seasoning, packaging, and order dispatch. This multi-tasking capability ensures

efficient meal preparation without bottlenecks, reducing wait times and maximizing throughput—a significant advantage over existing automated food systems, which are constrained by linear workflows that limit meal variety and require separate installations for different cuisines.

[00144] At its core, the system is equipped with a multi-axis robotic arm and a three-axis gantry retrieval system, working in unison to coordinate ingredient selection, food handling, cooking, seasoning, and packaging across multiple appliances simultaneously. By dynamically orchestrating tasks across different cooking stations, the system optimizes parallel workflows rather than executing tasks sequentially, as seen in prior art. This allows customers to have a greater degree of meal customization, choosing from a variety of main dishes, side dishes, and flavor profiles within a single order, rather than being restricted to a predefined, single-category meal. For instance, a customer could order a pasta dish with a side of crispy fries or a rice-based meal with fried chicken and a custom seasoning mix, all prepared and assembled seamlessly within the same unit.

[00145] Another key advantage of the automated standalone food preparation kiosk according to the present disclosure is its scalability and modular architecture, which enables the system to accommodate different types of cooking appliances (such as fryers, high-speed ovens, blenders, and boiling units) within a single kiosk, ensuring operational flexibility without requiring separate machines for different food categories. This eliminates the need for dedicated standalone vending systems for each food type, making our system more space-efficient and cost-effective for deployment in high-traffic areas such as airports, malls, and food courts.

[00146] The system's fully autonomous nature further sets it apart from traditional commercial kitchens, which require significant human intervention for food handling, cooking, and cleaning. With integrated environmental monitoring, automated cleaning, fire suppression, and real-time cloud-based order management, our kiosk can operate 24/7 with minimal oversight, making it ideal for unattended locations or businesses looking to reduce labor costs while maintaining food quality and consistency.

[00147] In summary, our “kitchen in a box” approach delivers a true multi-

cuisine, fully unmanned food preparation system that is far more advanced than prior art solutions, which are typically constrained to single-category food workflows. By enabling parallel cooking, seamless coordination between different appliances, and greater meal customization, our invention bridges the gap between robotic automation and full-service kitchens, providing a versatile, high-efficiency alternative to traditional food preparation methods.

[00148] It should be appreciated by the person skilled in the art that the above invention is not limited to the embodiment described. It is to be appreciated that modifications and improvements may be made without departing from the scope of the present invention.

[00149] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.

CLAIMS:

[Claim 1] An automated standalone food preparation kiosk comprising:

at least a food dispensing zone, a robotic zone, and a cooking zone;

wherein the food dispensing zone comprises an automatic dispensing system for dispensing food or liquid ingredients;

the robotic zone comprises a multi-axis robotic arm for receiving food or liquid ingredients from the food dispensing zone, for delivering the food or liquid ingredients to the cooking zone, and for assembling and transferring finished dishes to a food collection area; and

the cooking zone comprising at least one automated cooking appliance for receiving and cooking the food or liquid ingredients delivered by the robotic arm.

[Claim 2] An automated standalone food preparation kiosk according to claim 1, wherein the automatic dispensing system comprises a configured dispensing array providing a plurality of designated storage slots for respectively accommodating at least one prefilled and sealed ingredient pod therein; to thereby allow for automatic retrieval of the ingredient pods being dispensed, each ingredient pod being filled with a measured portion of the food or liquid ingredient.

[Claim 3] An automated standalone food preparation kiosk according to claim 2, wherein the automatic dispensing system comprises a multi-axis gantry system of retrieving the selected ingredient pods, the gantry system using the robotic arm for retrieving the ingredient pods.

[Claim 4] An automated standalone food preparation kiosk according claim 2 or 3, wherein each ingredient pod is provided with an identification marker for providing information including identification of the food or liquid ingredient contained within the ingredient pod, expiry date of the contained food or liquid ingredient.

[Claim 5] An automated standalone food preparation kiosk according to any one of claims 2 to 4, wherein the automatic dispensing system is temperature controlled to thereby allow for the storage and dispensing of fresh, frozen and shelf-stable food or

liquid ingredients.

[Claim 6] An automated standalone food preparation kiosk according to any one of claims 2 to 5, wherein the food dispensing zone further comprises specialised dispensers for dispensing seasoning powders and liquid-based ingredients, the dispensers including a weight sensor and/or volumetric flow meter for accurately dispensing the ingredient contained therein.

[Claim 7] An automated standalone food preparation kiosk according to any one of the preceding claims, wherein the robotic arm is selectively equipped with suction or magnetic grippers, tray holders, and bin mounts for transporting the food or liquid ingredients between the dispensing and cooking zones, for mixing, assembling dishes, and transferring finished dishes to the food collection area.

[Claim 8] An automated standalone food preparation kiosk according to claim 7, wherein the robotic arm further being selectively equipped with one or more cleaning attachments for cleaning within the kiosk, the cleaning attachments including a vacuum cleaning attachment for removing debris including crumbs, loose food particles and dry residues, a wipe-down attachment having an absorbent cleaning pad and spray nozzles for removing grease and oil residues, spilled sauces and other general surface contaminants.

[Claim 9] An automated standalone food preparation kiosk according any one of the preceding claims further comprising a self-washing station including a washing chamber and a high-pressure spray nozzle system for accommodating and washing the seasoning bowls or food transfer containers transferred thereto by the robotic arm.

[Claim 10] An automated standalone food preparation kiosk according to claim 9 wherein the self-cleaning station further comprises a detergent dispenser, and a water filtration system for filtering water prior to delivery to the high-pressure spray nozzle system.

[Claim 11] An automated standalone food preparation kiosk according to claim 9 or 10, wherein the self-cleaning station further comprises an automated drying system for removing residue water from the washed seasoning bowls or food transfer

containers using a high velocity compressed air and/or heated air.

[Claim 12] An automated standalone food preparation kiosk according to any one of the preceding claims, further comprising a label printer and dispenser providing labels showing information of the order, the robotic arm collecting and applying a said label to a completed food order, or bringing the completed food order to the label printer and dispenser where the label is then applied.

[Claim 13] An automated standalone food preparation kiosk according to any one of the preceding claims, further comprising at least one UVC germicidal disinfection lamp located within a key area of the kiosk such as a food storage area or preparation area within the kiosk.

[Claim 14] An automated standalone food preparation kiosk according to any one of the preceding claims, further comprising an internal environmental monitoring system comprising at least one air quality sensor, smoke detector, temperature sensor, and humidity sensor for monitoring conditions within the kiosk including air quality, smoke, temperature and humidity.

[Claim 15] An automated standalone food preparation kiosk according to any one of the preceding claims, further comprising an integrated fire safety system comprising at least one smoke alarm and temperature sensor for respectively monitoring each said zone of the kiosk, the fire safety system responding when measurements from the smoke alarm or temperature sensor exceed a predefined threshold, the response including one or more of the following:

- a) automatic shutdown of electrical components in an affected said zone to eliminate potential sources of fire ignition;
- b) triggering the smoke alarm to notify nearby personnel; and
- c) automatically or manually initiating a passive fire suppression mechanism to extinguish a fire within a specific zone of the kiosk.

[Claim 16] An automated standalone food preparation kiosk according to any one of the preceding claims, further comprising one or more access doors provided with IOT enabled safety locks connected to a main controller requiring user authentication to

thereby only allow entry of the access door by authorized personnel.

[Claim 17] An automated standalone food preparation kiosk according to any one of the preceding claims, further comprising an order collection window for allowing the collection of food orders completed by the kiosk and including a cloud-based smart locking and unlocking mechanism and authentication system for only allowing access to the completed order at the order collection window by a customer or delivery person.

[Claim 18] An automated standalone food preparation kiosk according to any one of the preceding claims, wherein the automated cooking assembly is adapted to provide food preparation processes including frying, oven cooking, blending and blanching of food ingredients therein.

[Claim 19] An automated standalone food preparation kiosk according to any one of the preceding claims, wherein the food distribution, robotic and cooking zone are respectively provided within two or more separate modules of the kiosk.

[Claim 20] An automated standalone food preparation kiosk according to claim 3 or 4 further comprising a cutting mechanism for cutting a plastic seal provided on the ingredient pod.

[Claim 21] A method of fulfilling a food order using an automated standalone robotic food preparation kiosk according to any one of the preceding claims, comprising:

- g) placing an order through an interactive touch screen interface located on the kiosk, via a third-party food delivery app, or via a QR code displayed on the kiosk;
- h) transmitting details of the order to a cloud-based order management server for managing order queues, prioritising orders based on complexity and preparation time, and handling real-time menu updates;
- i) forwarding the order details to a cloud-based main server for analysing the order by breaking the order down to individual tasks for the kiosk including ingredient dispensing, cooking and assembling,

- j) sending the order detail and associated individual takes to a central computer system of the kiosk;
- k) sending instructions to the robotic arm and other automated systems to begin the order fulfilment process; and
- l) assembling all components of the order into a final container and placing the order in a designated storage area with the kiosk.