

AUTOMATED AND SELF-SUSTAINING COOK STATION:

FIELD

[0001] The present invention relates to an automated and self-sustaining cook station.

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] Current developments in automated cooking appliances often focuses on mechanisms to automate various aspects of cooking, such as timing, temperature control, and actuation systems for moving cooking utensils or containers. However, such appliances do not provide for any advanced cooking techniques to be used such as, for example, the advanced flipping and content-emptying techniques used by experienced chefs. Furthermore, However, such appliances do not provide for any advanced cooking techniques to be used such as, for example, the advanced flipping and content-emptying techniques used by experienced chefs.

[0004] The use of robotics in food preparation in kitchen environments have therefore been considered, aiming to automate cooking tasks traditionally performed manually. This includes the development of robotic arms capable of handling existing frying baskets manually. However, these developments have been unable to address complex cooking processes, for example, those involving deep frying processes.

[0005] Commercial frying systems also require precise oil management, temperature control, and efficient food handling to ensure consistent results and minimize waste. Existing systems often suffer from inefficiencies such as excessive oil usage, inconsistent cooking results, and labor-intensive operations. Additionally, traditional frying methods do not optimize oil levels dynamically or adjust heating

based on demand forecast data, leading to unnecessary energy consumption. An object of the invention is to ameliorate one or more of the above-mentioned difficulties.

SUMMARY

[0006] According to an aspect of the present disclosure, there is provided an automated and self-sustaining cook station comprising:

one or more basket actuation modules, a cooking vat for holding cooking liquid respectively provided for the or each basket actuation modules, the or each said basket actuation module including a basket dispensing module moveable along the basket actuation module; and a basket for holding food to be cooked supported by the basket dispensing module;

wherein the movement of the basket dispensing module along the basket actuation module moves the basket between a standby position where the basket is located over the cooking vat, and a cooking position where the basket is located within the cooking vat, and

wherein the basket is rotatably supported on the basket dispensing module and can be rotated between at least a pre-flip position for draining excess cooking liquid, and a flipped position for emptying cooked food contents from the basket.

[0007] In some embodiments, the basket dispensing module is further movable in a reciprocating motion along the basket actuation module for shaking the food contents of the basket.

[0008] In some embodiments, the basket actuation module comprises a linear track, the basket dispensing module comprises a carriage supported on and moveable along the linear track, and a motor for driving the carriage.

[0009] In some embodiments, the cook station further comprises a linear gear track mounted on the linear track, wherein the basket dispensing module comprises a pinion gear for engaging the linear gear track, the pinion gear rotating relative to the carriage when the carriage is moved, and wherein the basket is supported on the pinion gear such that linear motion of the carriage is translated into rotary motion of

the basket.

[0010] In some embodiments, the cook station further comprises a gear stopper for preventing rotation of the pinion gear when the pinion gear is not engaged with the linear track to thereby hold the supported basket in a horizontal position.

[0011] In some embodiments, the basket comprises an internal slope surface for directing cooked food to an exit point of the basket when the basket is rotated to the flipped position by the basket dispensing module.

[0012] In some embodiments, the basket is in the form of a fryer basket, skimmer, metal meshes or gripper tongs.

[0013] In some embodiments, the basket is detachable from the basket actuation module.

[0014] In some embodiments, each said basket is respectively provided with a said cooking vat, and wherein independent heating elements are provided for each said cooking vat to allow for selective temperature control of each said cooking vat.

[0015] In some embodiments, the cook station further includes a multi-vat temperature controller for separately controlling temperature of the cooking liquid within each said cooking vat.

[0016] In some embodiments, the cook station comprises a temperature sensor for measuring the temperature of the cooking liquid within the cooking vat to thereby enable the temperature controller to maintain at the cooking liquid at a desired cooking temperature.

[0017] In some embodiments, the cook station further comprises an oil quality sensor for the or each said cooking vat.

[0018] In some embodiments, the cook station further comprises an oil filtration system for automatically initiating an oil filtration process when the oil quality is determined to be below a pre-set threshold.

[0019] In some embodiments, the cook station further comprises an oil level sensor for monitoring oil level within the or each said cooking vat.

[0020] In some embodiments, the cook station further comprises a cooking liquid management system including one or more pumps for pumping fresh cooking liquid to and draining used cooking liquid from each said cooking vat.

[0021] In some embodiments, the cook station further comprises an air filtration module for filtering air contaminants arising during operation of the cooking station.

[0022] In some embodiments, the air filtration module comprises one or more stages including a pre-filter, electrostatic precipitator, clean ozone filter, carbon filter, and ozone filter.

[0023] In some embodiments, the cook station further comprises a fire safety system for oil fire suppression including a sprinkler array and heat detectors located over the cook vat.

[0024] In some embodiments, the cooking liquid comprises a cooking oil or water. According to another aspect of the present disclosure, there is provided a method of controlling an automated and self-sustaining cook station as described above, comprising:

- a) dispensing a food product into the basket while the basket is at the standby position;
- b) lowering the basket to the cooking position to cook the food product;
- c) raising the basket back to the standby position after the food product is cooked;
- d) rotating the basket to the pre-flip position to drain excess cooking liquid from the cooked food product, and
- e) moving the basket to the flipped position to empty the cooked food product from the basket.

[0025] In some embodiments, the method further comprises shaking the basket when in the cooking position and/or in the pre-flip position.

[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 front perspective view of an automated and self-sustaining cook station according to the present disclosure;

[0029] [Figure 2] is a workflow diagram showing the workflow of the automated and self-sustaining cook station according to the present disclosure;

[0030] [Figure 3] are four perspective front views of the basket actuation module of the automated and self-sustaining cook station according to the present disclosure in four different positions;

[0031] [Figure 4] is a detailed view of the carriage of the basket actuation module of [fig. 3];

[0032] [Figure 5(a) to (c)] are three detailed views of the carriage of [fig. 4] in three different positions;

[0033] [Figure 6] is a detailed view of the basket of the automated and self-sustaining cook station according to the present disclosure;

[0034] [Figure 7] is a detailed view of the basket of [fig. 6] supported on the carriage of [fig. 4];

[0035] [Figure 8] is a detailed view of the connection between the basket of [fig. 7] and the carriage of [fig. 4]

[0036] [Figure 9] is a schematic diagram of the air filtration module of the automated and self-sustaining cook station according to the present disclosure; and

[0037] [Figure 10] is a workflow diagram of the oil filtration module of the automated and self-sustaining cook station according to the present disclosure.

[0038] 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

[0039] 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”.

[0040] 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.

[0041] 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.

[0042] The automated and self-sustaining cook station according to the present disclosure is specifically tailored to enhance the efficiency, safety, and quality of cooking processes, such as deep-frying processes. Cook station integrates robotics and smart technology to revolutionise food preparation, focusing on automating cooking processes, elevating kitchen safety, and ensuring food quality through precise control over cooking conditions. The cook station therefore involves mechanical engineering principles for developing an actuation system responsible for maneuvering a cooking utensil such as, for example, a fryer basket. Additionally, the cook station integrates robotics with the design of an arm for collecting food items and employs sensor technology to meticulously monitor the oil's quality and temperature. Furthermore, the cook station extends into environmental engineering aspects by incorporating ventless air filtration and self-oil filtration systems, addressing air quality and waste management within the kitchen environment.

[0043] The automated and self-sustaining cook station according to the present disclosure was developed to overcome several limitations and challenges identified in known technology within the realm of automated cooking systems, specifically those involving deep frying processes. The motivation behind this innovation stems from the critical need to address the following issues:

[0044] Communication with a robotic arm: Existing systems generally lack sophisticated mechanisms for seamless interaction between the frying module and robotic arms, leading to inefficiencies in transferring food out from the basket. The automated and self-sustaining cook station according to the present disclosure preferably introduces an advanced communication protocol that ensures precise and reliable coordination between the fryer module and the robotic arm, enhancing the transfer process. The automated and self-sustaining cook station according to the present disclosure also preferably frees up the robotic arm to handle other cooking processes without having to monitor the fry time. Once the fryer reaches the preset timer, the basket will automatically lift up and be ready for emptying the contents. This minimises the risk of food getting burnt due to the sole reliance of the robotic arm.

[0045] Minimising human intervention: Traditional frying systems frequently require manual oversight for tasks such as loading, monitoring, and unloading food, which not only is labour-intensive but also introduces variability in food quality. The automated and self-sustaining cook station according to the present disclosure can preferably significantly reduce the need for human intervention, automating these processes to achieve consistency in food preparation while freeing up human resources for other tasks.

[0046] Increasing effectiveness and consistency of the food: Prior systems often struggle with maintaining consistent cooking temperatures and times, impacting food quality. The automated and self-sustaining cook station according to the present disclosure can addresses this issue by preferably incorporating smart sensors and control algorithms that precisely regulate oil temperature and cooking conditions, ensuring uniform cooking across all batches. The cook station according to the present disclosure also preferably adjusts oil levels per vat, optimizing frying conditions based on food load and type.

[0047] Oil Management and Demand-Based Heating: Traditional systems do not allow for precise oil management, leading to excessive consumption and waste. The automated and self-sustaining cook station according to the present disclosure preferably includes a selective oil pump-in and drain system that ensures optimal oil replenishment and disposal. The heating system according to the present disclosure may adapt to demand forecasts, dynamically adjusting heating cycles to reduce unnecessary energy consumption.

[0048] Reducing the impact on air quality: The operation of traditional deep fryers can adversely affect air quality, releasing particulates and odors into the environment. The preferred inclusion of a ventless air filtration system in the automated and self-sustaining cook station according to the present disclosure can drastically reduce emissions, mitigating the impact on air quality within the deployment area. This cook station preferably allows robotic food preparation systems to be deployed in indoor environments where installation of commercial overhead exhaust systems is not feasible.

[0049] Remote monitoring of the machine status: Existing technology typically lack the capability for remote monitoring, making it difficult to oversee operations without physical presence. The automated and self-sustaining cook station according to the present disclosure preferably integrates smart technology that allows for real-time remote monitoring of the machine's status, enabling proactive management and immediate response to any issues that arise. The cook station can be monitored remotely via the cloud based dashboard. This can be also utilised to perform preventive maintenance or diagnostics.

[0050] Predictive maintenance: The inability to effectively predict maintenance needs leads to unexpected downtimes in existing systems. By utilising data analytics and machine learning, the automated and self-sustaining cook station according to the present disclosure can predict and schedule maintenance, ensuring high reliability and minimise disruptions to operations.

[0051] Reducing risk of injury from hot liquid medium: Traditional deep frying involves significant risks of burns and injuries from hot oil. The automated and self-sustaining cook station according to the present disclosure minimises these risks by

automating the handling of the fryer basket and enclosing the cooking area, thereby reducing the exposure to hot liquids.

[0052] The automated and self-sustaining cook station according to the present disclosure is a ventless cooking station with various features to increase the operational effectiveness of cooking as follows:

- Basket Actuation Module 30
- Basket Dispensing Module 31
- Sensor Module 38
- Air Filtration Module
- Oil Filtration Module
- Smart technologies
- Workflow of the system
- Easy to clean and Maintain
- Safety features

[0053] [Fig. 1] shows an example embodiment of the automated and self-sustaining cook station 10 including multiple fryer vats 20 for holding oil, and multiple basket actuation modules 30. Each basket actuation module 30 includes a linear track 34 upon which is supported a basket dispensing module 31 actuated for movement along the linear track 34 by a motor 32 located at one end of the linear track 34. Supported on the basket dispensing module 31 is a basket 15 that can be flipped between a standby position and a flipped position by the basket dispensing module 31. A sensor module 38 in the form of a temperature sensor is provided within each vat 20. An air filtration module (not shown) is also provided, with the suction inlets 40 of that air filtration module shown in [fig. 1].

[0054] It is to be appreciated that the automated and self-sustaining cook station 10 is not only limited to frying and can also be used for other food preparation

methods such as, for example, the boiling of dumplings, noodles, and fish balls.

[0055] The automated and self-sustaining cook station 10 can have one or more basket actuation modules 30, customised by the operational requirements, with four such modules 30 being shown in [fig. 1]. Each basket actuation module 30 would be accompanied by a dispensing basket 15 and a removable oil vat 20.

[0056] The cook station 10 is also provided with an automated oil changing system 70 including an oil tank 71 and supply pipes 72 for each oil vat 20 to enable automated changing of the oil within each oil vat 20.

WORKFLOW OF THE SYSTEM

[0057] The typical workflow of the automated and self-sustaining cook station 10 would be as shown in [fig. 2]. A main controller 100 of the cook station 10 will be in 2-way communication with a frying controller 120, which controls the operation of the or each basket actuation module 30. The fryer controller 120 specifically controls the vertical motion of the basket dispensing module 31 including a carriage 36 travelling along the linear track 34 of the basket actuation module 30, as well as the position of the basket 15. The basket 15 can be moved between basket in 162, basket standby 164, basket pre-flip 166, and basket flip 168 positions. These 4 basket actuation module positions are respectively shown in [fig. 3] from lowest to highest positions as follows: Cooking position 162 (Basket In), Standby Position 164 (To Load the Basket), Pre-flip position 166 (To drain the excess cooking liquid), and flipped position 168 (to empty the contents).

- 1) Basket 15 will start at the Standby position 164
- 2) Frying controller 120 will send instruction to dispense food into the basket 15 (see [fig. 2])
- 3) Basket 15 will lower into the cooking position 162
- 4) Basket 15 will raise to the Standby position 164, once the food is cooked
- 5) Frying controller 120 will send information to raise basket to pre-flip position 166

- 6) Main controller 100 will place an additional container to catch the food
- 7) Basket 15 will raise to flip position 168, basket will flip the food into the container
- 8) Basket 15 lowers to the Standby position 164

[0058] Furthermore, sets a target temperature 140 and monitors the temperature status 150 of the cooking liquid such as oil or water to let the main controller 100 know when the cooking liquid is at the target temperature, and cook station 10 is ready to fry. The frying controller 100 in addition monitors the oil quality using an oil quality sensor 160 when oil is being used as the cooking liquid, with this information being regularly sent to the main controller 100.

BASKET ACTUATION MODULE 30

[0059] Referring to [Figs. 4 and 5], the basket actuation module 30 controls the motion of the basket 15. The frying controller 120 will send instructions to the basket actuation module 30 to move the food into the cooking liquid to start cooking, and to retrieve the food after it is cooked. The shaking of the basket 15 also allows for a more consistent cooking and presentation of the food.

[0060] The basket actuation module 30 accomplishes the following motions, namely lifting and lowering the basket 15, shaking of the basket 15, and transferring food out of the basket 15

[0061] Lifting and lowering the basket 15: The actuation of raising and lowering of the basket 15 is done via a linear motion of the carriage 36 along the linear track 34. It allows the basket 15 with the food to lower into the cooking liquid to allow for the food to be cooked, and to raise the basket 15 to remove the food from the cooking liquid to prevent overcooking.

[0062] Shaking of the basket 15: The shaking of the basket 15 is done via a reciprocating motion of the carriage 36 on the linear track 34. This is to ensure the food is cooked evenly, and after cooking to facilitate drainage of the cooking liquid. While shaking the basket 15 in the cooking liquid, it promotes uniform cooking by preventing food from clumping together and ensuring that all pieces are exposed to

the hot oil when used as the cooking liquid equally. Without shaking, certain areas of the food may become overcooked or undercooked, leading to inconsistent results. Typically, this reciprocation motion has a slow acceleration profile with a large amplitude to agitate the solid and liquid so that the food pieces do not clump together. While shaking the basket 15 outside the cooking liquid, it helps to remove excess oil when used as the cooking liquid from the surface of the cooked food. This is crucial for achieving a lighter, less greasy texture and improving the overall taste of the food. Typically, this reciprocation motion has a fast acceleration profile with a small amplitude, so that the cooking liquid is able to be shaken off the surface of the cooked food.

[0063] Transferring food out from the basket: Additional components are attached to the basket 15 to allow linear motion to be translated into a rotary motion. The rotation of the basket 15 allows the contents inside the basket to be poured out into another container. The additional components can be a passive rack and pinion mechanism. It is however also envisaged that an active motorised motor be used to control the rotation of the basket 15. Additionally, the components attached to the basket 15 can be fully submerged in the cooking liquid when the basket 15 is in the fully lowered position.

[0064] Mechanism to translate linear movement into rotary motion: For the motion to be actuated, 4 primary elements are required as shown in [fig. 4]; the driver 32, the guide 34, the encoder 33 and the carriage 36. The driver element 32 provides the force to the system to move the carriage 36 along a guide 35. This is usually a stepper motor, although it is also envisaged that other forms of motors can be used as well. The guide element 34 helps to guide the carriage 36 along a predetermined path, which could be a linear rail 34 or a lead screw. The encoder element 33 keeps track of the position of the carriage 36 along the guide 34 and provides feedback to the driver 32 to stop. This can be an integrated hall sensor inside the motor, or a proximity sensor along the length of the guide 34. The carriage element 36 is part of the basket dispensing module 36 which contains the food. More details of that basket dispensing module 38 will now be described.

[0065] The basket dispensing module 31 can comprise many alternative systems such as a screw driven system, a linear actuator, a belt and Pulley, or motorised rail

guides.

[0066] In the cook station 10 as described herein, an example embodiment of a basket dispensing module 31 used to rotate the basket 15 is shown in [fig. 5]. That module 36 may comprise a linear gear rack 42 mounted on the linear track 34 and engaging a pinion gear 44 supported on the carriage 36 as shown in [fig. 5]. A gear stopper 46 provides a limit to the rotation of the pinion gear 44. In [fig. 5], the pinion gear 44 rotates in a clockwise direction when the carriage 36 travels upwards, with the gear stopper providing a limit on the clockwise rotation of the pinion gear 44. When the carriage 36 moves downwards. The pinion gear 44 rotates in a counterclockwise direction. The basket 15 is free to rotate about a pivot point, with the basket being attached to the pinion gear 44 to allow for the rotation of the basket. The gear 44 is constrained by the gear stopper 46, which allows for the basket 15 to be always in a horizontal position when the pinion gear 44 is not in contact with the rack 42. The reliability of the mechanism does not require a feedback to check the orientation of the basket 15 before cooking the next batch of food. As the driver 32 moves the carriage 36 upwards, the pinion gear 44 will come into contact with the rack 42 as shown in [fig. 5(a)]. This engagement allows the linear motion of the carriage 36 to be translated into the rotary motion of the basket 15. As the carriage 36 continues to move upwards as shown in [fig. 5(b)], the basket 15 will turn further to allow the food content to be poured out of the basket. There are limit switch on the ends of the guide 34 to give feedback to the driver 32 that the carriage 36 is at the end of the guide 34. When the carriage 36 moves downwards as shown in [fig. 5(c)], the basket 15 turns in the opposite direction, allowing the basket to revert back to its original position for standby to cook the next batch of food.

BASKET DESIGN

[0067] Traditional frying baskets, typically rectangular in shape, present a common challenge during the transfer of ingredients after frying. The straight edges and corners of these baskets can lead to inefficient movement of food towards the exit point, often resulting in spillage and waste, as well as potential safety hazards from contact with hot oil or food. This issue not only affects the cleanliness and efficiency of the kitchen operations but also impacts the overall quality of the food service. In contrast, this invention introduces a significant improvement in the design

and functionality of frying baskets to address these challenges. The basket 15 incorporates a food-safe material, specifically chosen stainless steel, known for its durability, hygiene, and ability to withstand high temperatures, making it ideal for culinary applications. What sets this basket apart is the feature of a built-in slope surface 50 within the basket itself as shown in [figs. 6 and 7]. This sloped design directs the fried ingredients towards a designated exit point 52 of the basket 15 when rotated in direction 53, facilitating their seamless transfer into a smaller container without spillage. The slope surface 50 ensures that the movement of food is controlled and predictable, minimizing the risk of dropping or wasting ingredients during the transfer process. This feature not only enhances the safety of kitchen operations by reducing the exposure to hot surfaces and oil but also improves the efficiency of the food preparation process. By ensuring that ingredients are neatly collected in the smaller container, the kitchen workflow is streamlined, and the cleanliness of the work area is maintained. Furthermore, the use of stainless steel for the basket material assists in providing food safety and longevity of the basket 15. Stainless steel is resistant to corrosion, does not interact with food ingredients, and is easy to clean, supporting the overall hygiene and sustainability of the cooking process.

[0068] The size of the basket 15 is limited by the size of the vat 20 that the food is being fried in. Each bucket 15 may be respectively provided with a separate cooking vat 20. It is also envisaged that a single vat 20 containing the cooking liquid can be shared by multiple baskets 15. The basket 15 can be any food holding container and might also come in the form of a skimmer, metal mesh, or a gripper tongs. The basket 15 has a rigid skeletal frame, and the gaps could be covered by meshes. There may be varying mesh sizes for different food, to prevent food from slipping out from the gap in between the mesh. Ease of food transfer with shape of basket: To allow food to be easily transferred out of the basket 15, a special geometrical shape 50 that represents a funnel is used on the basket to facilitate the food from being dispensed out of the basket.

[0069] Ability for food transfer with moving parts on basket: The basket 15 has the ability to dispense food by using mechanical means of rotation, such as gears, which is able to move the basket either in part or in whole. The basket dispensing

module 36 is preferably not affected by oil quality, and able to resist high temperature

[0070] It is to be appreciated that the cook station 10 according to the present disclosure has been described using a cooking medium in the form of a bucket, the use of other cooking medium to contain the food while being submerged in the oil are also envisaged, such as for example a fryer basket, skimmer, metal meshes or gripper tongs

[0071] Easily detachable basket for replacement: The basket 15 is joined to the basket dispensing module 31 with a simple to remove fastening method. The fastening method could be in the form of a hook, or a nut 56, or a magnet connected to a bracket 54 supported on the carriage 36 of the basket dispensing module 31 as shown in [fig. 8]. This allows for the basket 15 to be easily removed for deep cleaning or replaced when the basket is damaged.

SENSOR MODULE

[0072] The automated and self-sustaining cook station according to the present disclosure may incorporate several sensor modules to monitor the critical variables of the system and feedback to the controller which will respond according with the aid of the smart technologies deployed.

[0073] The sensors deployed in the system may include:

- Temperature Sensor
- Oil Level Sensor
- Oil Quality Sensor / Water Quality Sensor
- Air Quality Sensor

[0074] Temperature sensor: The temperature sensor 38 (see [fig. 1]) continuously measures the temperature of the liquid. This data is used by the main controller 100 to regulate the heating elements or burner, ensuring that the liquid remains at the desired temperature for cooking. By maintaining precise temperature control, the sensor helps achieve consistent cooking results and prevents

undercooking or burning of the food.

[0075] Oil Quality Sensor: Over time, as the oil is exposed to high temperatures during frying, it undergoes degradation, leading to changes in colour, flavour, and nutritional content. An oil quality monitor assesses the condition of frying oil by measuring parameters such as temperature, total polar compounds, free fatty acids, colour, smoke point, and viscosity. By tracking the quality of the liquid, operators can determine when it needs to be filtered or replaced to maintain food quality and extend the lifespan of the oil.

[0076] Air Quality Sensor: Air quality sensors track parameters such as particulate matter (PM), volatile organic compounds (VOCs), carbon monoxide (CO), temperature, humidity, and odour. The air sensor, in addition to sensing the quality of air inside the kiosk accommodating the cooking station 10, also senses the air outside the kiosk, to detect the risk of fire, burnt food, or any hazardous air substances

[0077] How are the sensors deployed: The temperature sensor 38 would be constantly immersed in the vat 20, with one sensor in each oil vat. The sensor feeds back to the main controller 100, which sends instructions to a contactor which turns the heating element in the vat either to on or off. The target temperature can be set by the main controller 100 for each cook station 10. The cook station 10 can be either pre-assigned to a single type of food (e.g. fries) or could be dynamically controlled by the main controller 100 to suit the food being cooked/fried. Total Polar Materials (TPM) oil quality sensors also form a component of the advanced monitoring system of the cook station, and are designed to assess the quality of cooking oil. TPM is a widely recognized indicator of oil degradation; as oil is used for frying, it undergoes chemical changes that increase the concentration of polar materials, which are compounds that can affect the taste, quality, and safety of fried food. When the concentration of these materials reaches a certain threshold, it indicates that the oil needs to be changed or filtered to maintain the quality of the food being prepared. TPM sensors operate by measuring the dielectric constant of the oil, a property that changes as the oil degrades and the concentration of polar materials increases. These sensors are immersed in the oil, where they continuously or periodically measure this property. The data collected by the TPM sensors is then

analysed to determine the quality of the oil in real-time. When the TPM levels exceed a pre-set threshold—indicating that the oil quality has degraded to a point where it could negatively impact food quality—the system triggers an alert or directly initiates the oil filtration process.

[0078] Integration with Temperature Sensors: The effectiveness of TPM sensors is further enhanced when integrated with temperature sensors within the frying system. Temperature is a critical factor in oil degradation; higher cooking temperatures can accelerate the breakdown of oil, leading to faster accumulation of polar materials. By monitoring the temperature of the oil, the system can provide a more nuanced assessment of oil quality. For instance, if high temperatures are sustained over a period, it might prompt earlier filtration actions even if the TPM readings are marginally below the threshold, ensuring the oil is always in optimal condition for frying.

[0079] Triggering the Oil Filtration System: The integration of TPM and temperature sensors with the cook station's oil filtration system creates a smart, responsive mechanism for maintaining oil quality. Based on the inputs from these sensors, the system can automatically initiate the oil filtration process at the precise moment it's needed, optimising the use of cooking oil and maintaining food quality without manual intervention. This process might involve circulating the oil through a filter to remove food particles and other contaminants that contribute to oil degradation, or in more advanced setups, chemically treating the oil to reduce the concentration of polar materials.

[0080] Oil Level Sensor: The oil level sensor operates using a distance-based sensing mechanism mounted above the frying vat. This sensor continuously measures the height of the oil surface, calculating the oil level in real time without direct contact with the hot oil. By utilizing non-contact technology, the sensor avoids degradation from prolonged exposure to high temperatures, ensuring a longer lifespan and reducing maintenance requirements. Additionally, the elevated positioning of the sensor allows for easier vat cleaning, as there are no submerged components that require frequent removal or replacement. This setup enhances the reliability of oil level monitoring while maintaining optimal frying conditions and operational efficiency.

AIR FILTRATION MODULE

[0081] The cook station incorporates an air filtration system, where the air above the liquid medium is being sucked into the filtration system and goes through a multi-staged process of filtration to ensure that the odour and small particles in the air is removed before the clean air is released back into the environment. For an effective air filtration, the air inlet 40 of the filtration system should be closer to the liquid medium, so that the harmful fumes from the liquid can be effectively taken into the filtration system. The further the air inlet is from the liquid medium, the greater the amount of harmful fumes that will be diffused in the air, lowering the quality of air. The system uses a ventless air filtration system, which does not require an exhaust or venting. It allows the system to be deployed in environments where ventilation duct is impractical or too expensive to be installed. This increases the possible places that the machine can be deployed.

[0082] The enhancement of the integrated filtration system for air with the addition of a 4-stage filtration process as shown in][fig. 9], including an Electrostatic Precipitator (ESP) 172, Ultraviolet C (UVC) light 174, Carbon filter 176, and Ozone filter 178, substantially elevates the capability of the cook station to improve air quality and environmental impact. This sophisticated filtration sequence ensures the comprehensive removal of smoke, particulates, and odours directly from the cooking area, without the need for external venting solutions. Here's how each stage contributes to the system's effectiveness:

[0083] Pre-filter 170: The pre-filter 170 is the first line of defence against large particles such as dust, hair, and pollen. It helps prolong the life of the main filter by capturing these larger particles before they can clog the finer filtration media.

[0084] Electrostatic Precipitator (ESP) 172: The first stage uses ESP technology to charge particles in the air, including smoke and grease particles, which are then attracted to and captured by oppositely charged plates. This method is highly effective in removing fine particulates from the air, significantly reducing smoke levels emanating from the frying process.

[0085] Ultraviolet C (UVC) Light 174: The second stage employs UVC light to kill or inactivate microorganisms by disrupting their DNA, rendering them harmless. This

stage is crucial for eliminating biological contaminants, such as bacteria and viruses, that can pose health risks, thereby ensuring a safer cooking environment.

[0086] Carbon Filter 176: In the third stage, air passes through a carbon filter, which absorbs and neutralises odours, volatile organic compounds (VOCs), and chemical fumes. The porous nature of activated carbon allows for a vast surface area that effectively traps odour-causing molecules, significantly reducing the odours typically associated with frying.

[0087] Ozone Filter 178: The final stage involves an ozone filter, which further purifies the air by breaking down remaining odours and any other residual contaminants that may have passed through the previous stages. Ozone is a powerful oxidant that reacts with pollutants in the air, effectively neutralising them. This stage ensures the air emitted from the system is clean and free from odours.

[0088] Comprehensive Air Quality Improvement: The integration of these four stages into the fryer's air filtration system offers a comprehensive solution to air quality challenges in the kitchen. By tackling particulates, biological contaminants, odours, and chemical residues, this advanced system significantly reduces the environmental impact of frying processes, promotes a healthier working environment, and mitigates the need for costly and space-consuming external ductwork.

OIL FILTRATION MODULE

[0089] Cooking oil needs replacing after multiple frying cycles due to degradation, which leads to off-flavours, reduced smoke point, and health risks. Replacement of cooking oil is a logistical challenge and will incur huge operational cost. Oil filtration is necessary to reduce the frequency of oil replacement. Traditional commercial fryers either have a built in filtration system or require manual intervention by an operator to filter the oil.

[0090] The cook station 10 focuses on the utilisation of a robotic arm to perform this action. This reduces the cost of integrating filtration systems as it is only required during off peak periods where the machine undergoes a self-cleaning operation. The system monitors the number of cycles, recommendation of filter change or oil change by the effectiveness of filtration from flow rate and the oil quality sensor. The

integration of a special end effector, designed to be gripped by a robotic arm for the purpose of oil filtration in fryer systems, marks a significant innovation in the maintenance and operation of automated frying appliances. This system enhances the efficiency, safety, and sustainability of the frying process by automating the oil filtration and replacement procedure. Here's a closer look at how this technology operates and its benefits:

[0091] **Design and Operation:** The end effector is equipped with two stainless steel pipes, one for extracting used oil from the fryer and the other for pumping fresh, filtered oil back into the system. The used oil is drawn out through the suction pipe and passed through an oil filtration device, where impurities, particles, and degraded oil components are removed. This process ensures that only clean, quality oil is returned to the fryer via the second pipe. The filtration device includes a reservoir for the temporary storage of oil during the filtration process, ensuring a continuous flow and efficient cleaning of the oil before it is pumped back into the fryer.

[0092] The workflow for this oil filtration process is shown in [fig. 10]. When the quality check senses that the oil quality is low [step 180], a pump is actuated [step 184] to activate draining of the oil through a filter medium [step 186], and subsequently delivered into a heat resistant container providing a holding area [step 188]. The filtered oil can then be either pumped back to the cook station [step 190] or collected by a service crew [step 192].

[0093] **Integration with Robotic Arm:** The utilisation of a robotic arm for this process introduces a high level of precision and automation. The arm can be programmed to attach to the end effector and perform the filtration process across multiple fryer systems without manual intervention. This not only increases the speed and efficiency of the oil filtration process but also significantly reduces the risk of accidents and injuries associated with manual handling of hot oil.

[0094] **Enhanced Oil Quality and Sustainability:** By automating the oil filtration process, the invention ensures consistent oil quality, extending the usable life of the oil and reducing waste. Maintaining optimal oil quality is crucial for producing high-quality fried foods, and this system allows for real-time monitoring and adjustment of oil conditions. The ability to efficiently filter and reuse oil supports sustainable kitchen

practices by minimising oil consumption and reducing environmental impact.

[0095] Operational Efficiency: The robotic arm, equipped with the specialised end effector, can service multiple fryers efficiently, minimising downtime and labour costs. This system is particularly beneficial in high-volume commercial kitchens where time and quality are of the essence. By automating the oil maintenance process, kitchens can ensure that their fryers are always operating with clean, high-quality oil, without the need for constant manual checks and adjustments.

[0096] Built-in Fire Safety System for Oil Fire Suppression: The cook station according to the present disclosure incorporates an automated fire suppression system 60 designed to detect and extinguish oil-based fires rapidly. Integrated temperature and flame sensors provide real-time monitoring for fire hazards. The fire suppression system 60 includes a sprinkler array 61 (see [fig. 1]) using a specialized fire retardant to ensure immediate fire mitigation, preventing potential damage and improving kitchen safety. This feature which offers maximum coverage of any potential fire hazard within the cook station 10 is essential for compliance with fire safety regulations and enhances the safe operation of automated frying systems.

[0097] Heat detectors 62 (see [fig. 1]) may also be installed above the potential fire hazard. The heat detectors 62 are triggered by exposure to heat from any fire within the cook station 10, and can work by an arrangement which uses the melting of a metal joint that is connected to a wire which is normally held in tension. When the joint melts due to a fire, this results in the release of the tension in the wire, which triggers the sprinkler array 61 to thereby release the extinguishing agent. A separate arrangement which works separately to that described above may alternatively be used to trigger the sprinkler array 61. That arrangement includes another set of wires connected to a safety pin located within an externally mounted box, placed outside the cook station 10. The pulling of the pin through physical interventions can also trigger the sprinkler array 61 to thereby release the extinguishing agent. The triggering of the sprinkler array 61 that releases the extinguishing agent can also interrupt power to equipment that may be providing fuel (oxygen, gas or electricity) to the fire. The heat detectors 62 may have a temperature detection level that can be custom-suited for different fire applications.

[0098] Blanching System for Noodles and Pasta: The cook station according to the present disclosure can also be used as an automated frying and blanching system which is highly adaptable and can also be used for blanching food products such as noodles and pasta by replacing oil with water. This flexibility makes it a versatile solution for commercial kitchens that require multi-functional cooking equipment. Blanching is a cooking process in which food is briefly boiled or steamed and then rapidly cooled. This technique is commonly used to soften food, enhance texture, and preserve color and flavor. It is an essential step in preparing noodles, pasta, and vegetables, ensuring consistent cooking quality and efficiency in large-scale food preparation.

[0099] How the cook station according to the present disclosure adapts for Blanching:

[00100] Water-Based Cooking with Dynamic Level Control: Instead of oil, the cooking vats 20 can be filled with water for blanching operations. Integrated water level sensors continuously monitor and adjust the water level to ensure optimal submersion and prevent overflow or drying out.

[00101] Precise Temperature Regulation:

[00102] The same heating system used for oil frying can be adapted to maintain precise water temperatures for blanching. Real-time temperature sensors prevent overheating and ensure the perfect blanching environment for different food types.

[00103] Automated Lift, Tilt, and Shake Mechanism:

[00104] The auto-lift mechanism can gently submerge and remove food baskets from the water, preventing overcooking. The tilting function allows controlled drainage of excess water from the food. The integrated shaking mechanism ensures that excess water is removed from the blanched food before it is transferred to the next stage of processing.

[00105] Water Filtration and Circulation System:

[00106] The cook station according to the present disclosure can feature a built-in water filtration and circulation module, ensuring clean water is maintained throughout

the blanching process. This reduces water wastage and ensures consistent cooking quality.

[00107] Seamless Transition Between Frying and Blanching Modes:

[00108] The modular design of the cook station according to the present disclosure allows operators to switch between frying and blanching modes with minimal setup time. The same control system of the cook station according to the present disclosure manages both functions, simplifying operation and improving workflow efficiency in commercial kitchens.

[00109] Benefits of Using the System for Blanching:

[00110] Consistent Cooking: Automated control ensures uniform blanching results for every batch.

- Efficiency: Reduces manual labor and speeds up food preparation.
- Versatility: Can be used for multiple cooking applications, including frying and blanching.
- Energy Savings: Optimized heating cycles reduce energy consumption.
- Improved Food Quality: Maintains precise cooking parameters to achieve the desired texture and consistency.

[00111] The cook station according to the present disclosure in summary introduces a fully automated frying and blanching system that includes:

- Automated Lift, Tilt, and Shake Mechanism: The cook station according to the present disclosure features an auto-lift mechanism to move food baskets in and out of the fryer vats with precision. The tilting function ensures uniform drainage of excess oil and allows for controlled extraction of cooked food. An integrated shaking mechanism is included to further remove excess oil from the food basket, improving overall food quality and reducing oil retention.
- Multi-Vat Controller: A central control unit is capable of managing multiple

frying vats independently. Each vat can operate at different temperatures, enabling parallel processing of different food products.

- **Selective Oil Pump-In and Drain System:** The cook station according to the present disclosure incorporates an intelligent oil management module that selectively pumps in fresh oil and drains used oil based on real-time monitoring. Oil levels are optimized per vat to reduce waste and prolong oil life.
- **Real-Time Oil Level Sensor:** The cook station according to the present disclosure utilizes high-precision sensors to monitor the oil level in each frying vat. Dynamic adjustments ensure that the required oil volume is maintained for efficient frying.
- **Temperature Control and Demand Forecasting:** Each vat has independent heating elements that allow for selective temperature control. The cook station according to the present disclosure leverages demand forecasting algorithms to adjust heating and cooling cycles dynamically, reducing energy consumption during low-demand periods.

Advantages of the cook station according to the present disclosure:

- Reduces oil waste through precise oil volume control.
- Enhances cooking consistency with automated lift, tilt, and shake mechanisms.
- Improves energy efficiency with adaptive heating based on demand.
- Minimizes manual intervention, reducing labour costs.
- Supports multiple frying vats with independent settings, increasing system flexibility.

[00112] 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.

[00113] 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 and self-sustaining cook station comprising:

one or more basket actuation modules, a cooking vat for holding cooking liquid respectively provided for the or each basket actuation modules, the or each said basket actuation module including a basket dispensing module moveable along the basket actuation module; and a basket for holding food to be cooked supported by the basket dispensing module;

wherein the movement of the basket dispensing module along the basket actuation module moves the basket between a standby position where the basket is located over the cooking vat, and a cooking position where the basket is located within the cooking vat, and

wherein the basket is rotatably supported on the basket dispensing module and can be rotated between at least a pre-flip position for draining excess cooking liquid, and a flipped position for emptying cooked food contents from the basket.

[Claim 2] An automated and self-sustaining cook station according to claim 1, wherein the basket dispensing module is further movable in a reciprocating motion along the basket actuation module for shaking the food contents of the basket.

[Claim 3] An automated and self-sustaining cook station according to claim 1 or 2, wherein the basket actuation module comprises a linear track, the basket dispensing module comprises a carriage supported on and moveable along the linear track, and a motor for driving the carriage.

[Claim 4] An automated and self-sustaining cook station according to claim 3, further comprising a linear gear track mounted on the linear track, wherein the basket dispensing module comprises a pinion gear for engaging the linear gear track, the pinion gear rotating relative to the carriage when the carriage is moved, and wherein the basket is supported on the pinion gear such that linear motion of the carriage is translated into rotary motion of the basket.

[Claim 5] An automated and self-sustaining cook station according to claim 4, further comprising a gear stopper for preventing rotation of the pinion gear when the pinion

gear is not engaged with the linear track to thereby hold the supported basket in a horizontal position.

[Claim 6] An automated and self-sustaining cook station according to any one of the preceding claims, wherein the basket comprises an internal slope surface for directing cooked food to an exit point of the basket when the basket is rotated to the flipped position by the basket dispensing module.

[Claim 7] An automated and self-sustaining cook station according to any one of claims 1 to 6, wherein the basket is in the form of a fryer basket, skimmer, metal meshes or gripper tongs.

[Claim 8] An automated and self-sustaining cook station according to claim 6 or 7 wherein the basket is detachable from the basket actuation module.

[Claim 9] An automated and self-sustaining cook station according to any one of the preceding claims, wherein each said basket is respectively provided with a said cooking vat, and wherein independent heating elements are provided for each said cooking vat to allow for selective temperature control of each said cooking vat.

[Claim 10] An automated and self-sustaining cook station according to claim 9, wherein the cook station further includes a multi-vat temperature controller for separately controlling temperature of the cooking liquid within each said cooking vat.

[Claim 11] An automated and self-sustaining cook station according to claim 10, comprising a temperature sensor for measuring the temperature of the cooking liquid within the cooking vat to thereby enable the temperature controller to maintain at the cooking liquid at a desired cooking temperature.

[Claim 12] An automated and self-sustaining cook station according to any one of the preceding claims further comprising an oil quality sensor for the or each said cooking vat.

[Claim 13] An automated and self-sustaining cook station according to claim 12, further comprising an oil filtration system for automatically initiating an oil filtration process when the oil quality is determined to be below a pre-set threshold.

[Claim 14] An automated and self-sustaining cook station according to any one of the preceding claims, further comprising an oil level sensor for monitoring oil level within the or each said cooking vat.

[Claim 15] An automated and self-sustaining cook station according to any one of the preceding claims, further comprising a cooking liquid management system including one or more pumps for pumping fresh cooking liquid to and draining used cooking liquid from each said cooking vat.

[Claim 16] An automated and self-sustaining cook station according to any one of the preceding claims, further comprising an air filtration module for filtering air contaminants arising during operation of the cooking station.

[Claim 17] An automated and self-sustaining cook station according to claim 16, wherein the air filtration module comprising one or more stages including a pre-filter, electrostatic precipitator, clean ozone filter, carbon filter, and ozone filter.

[Claim 18] An automated and self-sustaining cook station according to any one of the preceding claims, further comprising a fire safety system for oil fire suppression including a sprinkler array and heat detectors located over the cook vat.

[Claim 19] An automated and self-sustaining cook station according to any one of the preceding claims, wherein the cooking liquid comprises a cooking oil or water.

[Claim 20] A method of controlling an automated and self-sustaining cook station according to any one of the preceding claims, comprising:

- f) dispensing a food product into the basket while the basket is at the standby position;
- g) lowering the basket to the cooking position to cook the food product;
- h) raising the basket back to the standby position after the food product is cooked;
- i) rotating the basket to the pre-flip position to drain excess cooking liquid from the cooked food product, and
- j) moving the basket to the flipped position to empty the cooked food product from the basket.

[Claim 21] A method of controlling an automated and self-sustaining cook station according to claim 20, further comprising shaking the basket when in the cooking position and/or in the pre-flip position.