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(54) **CONTROL DELEGATION IN AN AUTOMATED LOOP COOKING PROCESS**

(57) Digital control means employed for food cooking provide many benefits to the food preparation process and result, allow creative and versatile cooking. Cookware with sensors, induction cooktops with remote controls, external apps for remote management is known prior art solutions. However, most induction cooktops lack the functionality to control the cooking process flexibly with external devices and apps. Smart cookware items have their digital controls, however, mostly limited by data input, display, and power supply capabilities. Smart devices/apps (smartphones, tablets) are flexible by software, bringing compatibility between cookware and cooktops, allow smart data input and display for cooking sophisticated recipes, however, with limitation on reliable, uninterrupted and "fail-safe" controls. This invention is directed to improve induction cooking, providing flexibility and safety throughout the cooking process until the food prepared and cooktop switched-off. The invention discloses method, system, and device to control at least cooking temperature precisely and safely, by delegating controls from the external application to the induction cooktop digital control module and cookware digital control module.

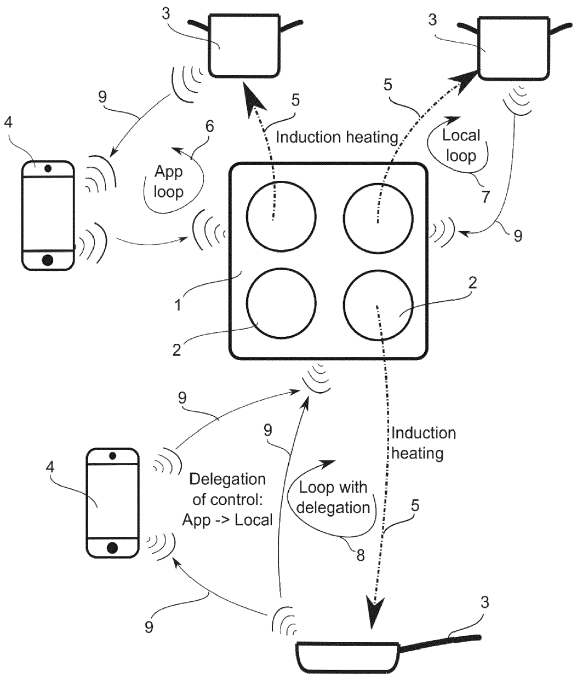

FIG. 1

EP 4 387 394 A2

Description

Field of the invention

[0001] The present invention relates to cooking by an induction cooktop with improved control, smart temperature regulation, and safety. Specifically, the invention is directed to using cookware with integrated sensors (e.g., measuring the cooking temperature), induction cooktops having advanced controls such as integrated digital modules and remote control, and external devices/apps for smart and safe cooking.

Background of the invention

[0002] When cooking food, for obtaining a good result the heat must be adjusted to obtain the required temperature for the desired cooking process. Traditionally, temperature control is achieved by employing a temperature sensor specially implemented inside the cookware, e.g., in the bottom layer of the pan or pot. The cookware control electronics read an instant temperature value from the sensor and sends it to the induction cooktop or an external smart device and application (e.g. in a smartphone) controlling operation of the cooktop. Therefore, the induction cooktop is controlled by an algorithm determining how much power to supply to the heating coil to achieve the desired temperature in the cookware.

[0003] Induction cooktops usually have several heating zones and a control module with manual setting of heating levels in the zones. Induction cooktops comprise also safety means in the cooking process. Some advanced induction cooktops are arranged easy to switch on or off automatically, some others feature built-in timers, built-in temperature sensors, and even remote control from simple smartphone apps.

[0004] Using more than one cookware item and using several heating zones simultaneously, the complexity of smart cooking may exceed the convenience and reduce safety. When employing a plurality of smart devices for automated cooking there can appear certain safety issues. For example, the controlling smartphone can discharge or the controlling application can disconnect from the cooktop in the middle of the cooking process. A cookware item providing its temperature indications to the cooktop can occasionally be displaced to another heating zone or its battery can discharge. An operator may change in the middle of cooking when another cook comes to the kitchen with its own smart device/app to supervise further the cooking process. In such and similar complex situations an interruption of the cooking process or even burning the food or catching fire is possible.

[0005] The US patent/application US20170299195A1 discloses a cooktop fire prevention module with remote control cooking features. A cooking appliance having a cooktop that is regulated by a fire prevention module is provided. In addition to its fire prevention and safety features, the fire prevention module includes a communication module that enables communication between the cooktop appliance and a remote device, such as a smartphone or tablet computer. Using this communication link, the fire prevention module can be used to expand the ability of a user to monitor and/or control the operation of the cooktop appliance from a remote location. For example, using a software application on their smartphone, a user may monitor the temperature of a cooking utensil and initiate a particular cooking profile, or be notified when an unsafe cooking condition might be present and that the cooktop unit has been automatically deactivated to remedy the situation. This is a simple extension to monitor and manage the cooktop operation remotely, e.g. when the operator is in another room. However, the possibility of failure is not mitigated, e.g., if the external device stops to communicate with the cooktop.

[0006] Another patent application US20170122569A1 discloses a cooktop appliance control system and a method for operating a cooktop appliance is provided. The method includes determining a temperature of a cooking utensil positioned on a heating element of the cooktop appliance, as well as determining a temperature of a food in the utensil positioned on the heating element of the cooktop appliance. The method also includes calculating a temperature differential between the temperatures of the food in the cooking utensil and of the cooking utensil itself. Subsequently, the method includes controlling a heating temperature of the heating element to reduce the temperature differential when the temperature differential is greater than a predetermined threshold to, e.g., reduce the risk of burning a portion of the food in the utensil. There is a disclosed cooking temperature control loop for the utensil, and a remote control mentioned by smartphone is which performs a conventional remote control.

[0007] One more patent application DE102017220958A1 / ES201631543A discloses a household appliance system with at least one domestic appliance (12), which has at least one internal communication unit (14), and at least one control unit (18) characterized in that it also comprises at least one external unit of communication (16), which is provided in at least one operating state for communicating with the internal communication unit (14), and in that the control unit (18) is provided to prevent control of the household appliance (12) by means of the external communication unit (16) depending on at least the relative position and/or at least the distance between the internal communication unit (14) and the external communication unit (16). This invention monitors and prevents the operation from the remote controlling device/app the device/app it moves away too far from the cooktop. There was disclosed nothing about the support of automatic cooking by using a temperature control loop and more advanced functions.

[0008] Another application is EP3489583A1/DE102017220815B4 disclosing a method for controlling a cooking appliance with an external control device. In the method for controlling a cooking appliance with heaters and an internal cooking appliance control using an external control device which is arranged outside the cooking appliance (e.g., a mobile telephone), this external control device gives control commands to the cooking appliance control. The external controller is classified by the cooking appliance controller either as an automatic controller or as a manual controller, with its control commands being implemented by the cooking equipment controller after classification. During or after an operation of the cooking appliance, it is checked continuously or at intervals whether the classification still applies. This patent application discloses only changing control by the external device modes - from the manual (by an operator) to automatic (by an app) and vice versa. In the case, if control is performed by the control module from cookware item, only the automatic control is applicable and no manual control is available then.

[0009] In summary, the reviewed prior art sources do not disclose the flexible management of multiple intelligent devices in complex smart cooking systems (comprising at least a cooktop, an external device/app, a cookware item). External devices /apps can disappear from the network or be shut down, or some new external devices appear in the wireless network (for example, one user /app started cooking process with his smartphone, then leaves the kitchen and, therefore, needs transfer the cooking process to another user and his smartphone/app). Cookware items can occasionally be displaced from one heating area to another one (or even to another cooktop) in the middle of the cooking process, or go to power saving mode where only thermal sensor data can be transmitted but no active control performed. Most conventional induction cooktops have no digital wireless control or have only minimal modules arranged to receive external commands from external devices/apps. However, most of the conventional induction cooktops can allow implementing easily a simple and cheap digital control unit for remote controls. In such sophisticated plurality and interaction of smart device types, special management is required for smart and safe cooking. This problem is solved by "delegation of controls between and among the devices" as disclosed in the present invention.

Summary of the invention

[0010] This invention is directed to employ induction cooktops for smart cooking and safety throughout the cooking process until the food prepared and cooktop switched-off. The invention discloses a method and system to control the cooking process precisely and safely, by delegating controls between or among intelligent devices, such as external devices/apps, digital control modules in the cooktop, cooktop heating zones, and smart cookware items.

[0011] Conventional induction cooktops often lack the functionality of being controlled flexibly and remotely by external applications. Smart cookware items have their compact digital controls limited by data input, display, and power supply capabilities. Smart external devices/apps (e.g., smartphones, tablets, or standalone smart displays) are flexible by software, compatible between cookware items and cooktop controls, allow to input and display versatile data, cook by sophisticated recipes, use cooking knowledge from Internet sources, however, they are limited due to interrupted controls and lack of "fail-safety".

[0012] The method of control delegation orchestrates the plurality of intelligent devices into the automated cooking process or processes, to work together in a controllable manner and safely. At one moment, one device has central control rights that at any time can be delegated to other devices to continue the cooking process. Otherwise, the method allows the cooking system to shut down the cooktop or its heating area automatically if no such devices were discovered or control conditions insufficient.

[0013] The system comprises several intelligent devices interacting by their functions throughout the cooking process. Each device (cooktop, cookware item, and external device/app) has its control capabilities with certain limitations, altogether they complement each other for an automated control loop cooking process. The device having a central control role of the automated loop cooking process can delegate its control functions to other devices in the control loop.

[0014] The digital module of the cooktop control provides an integrated fail-safe module which can monitor external devices and accept commands from the controlling devices, also it can control the cooking process by itself, and eventually switch-off the cooktop if the cooking process finished or safety issues were detected. The digital module is arranged into a conventional cooktop allowing the cooktop to be controlled by external means, e. g., by smart cookware items or external devices/apps (e.g., smartphones or smart displays).

[0015] An aspect of the invention relates to a method to control a cooking process by an automated control loop arranged to control cooking temperature in a cookware having at least a thermal sensor and a wireless communication block, the cookware being set onto a cooktop having at a least wireless comminication block, the method comprising the steps of:

- reading values at least from cookware sensors;
- transferring the obtained sensor values to a controlling device;

- estimating heating power according to a predefined temperature for a next time interval;

- transferring the estimated heating power at least to the cooktop;

- applying the estimated heating power in the cooktop during the next time interval,

wherein at least a part of the automated control of the cooking process is delegated from the controlling device to at least one other device at least in the automated control loop.

[0016] According to an embodiment, the cookware further comprises a digital control module to execute said step of reading values at least from said cookware sensors.

[0017] According to an embodiment, the cooktop further comprises its digital control module to execute at least a part of the delegated automated control, such as said step of estimating heating power for a next time interval.

[0018] According to an embodiment, the cooktop further comprises a digital control module to execute said step of applying the estimated heating power in the cooktop during the next time interval.

[0019] According to an embodiment, the digital control module of the cooktop is arranged to execute at least a part of the delegated automated control, such as said step of estimating heating power for a next time interval.

[0020] According to an embodiment, the controlling device is a smartphone, a tablet or any smart terminal-type device having wireless connection and running a controlling app.

[0021] According to an embodiment, said step of delegating at least a part of the automated control of the cooking process from the controlling device to at least one other device at least in the automated control loop is performed upon said controlling device being shut down, disconnected or the controlling device temporarily leaving the kitchen.

[0022] According to an embodiment, said at least part of the automated control of the cooking process is delegated by the controlling device.

[0023] According to an embodiment, said delegation from the controlling device to at least one other device at least in the automated control loop comprises transmitting control data from said controlling device to said at least one other device.

[0024] According to an embodiment, said step of delegating at least a part of the automated control of the cooking process from the controlling device to at least one other device at least in the automated control loop comprises changing from an app mode to a local mode, said app mode and local mode being operational modes of said automated control of the cooking process.

[0025] According to an embodiment, said cookware is a first cookware, wherein a second cookware is set onto said cooktop, and wherein a cooking process of said second cookware is being controlled by a second automated control loop.

[0026] Another aspect of the invention relates to a cooking system with automated cooking temperature control loop comprising at least:

- cookware with a thermal sensor and a digital control module arranged at least to read the cooking temperature and transfer its values to external devices,

- a controlling device arranged to request and receive the cooking temperature values, to estimate heating power according to a predefined temperature for the next time interval, and to transfer the heating power values to external devices.

- an induction cooktop with at least one heating zone and a digital control module arranged to receive the heating power values and provide induction heating to the cookware,

wherein at least a part of the automated control function from the controlling device is delegated to at least the digital control module of the cookware or the digital control module of the cooktop.

[0027] According to an embodiment, cooking temperature is controlled on more than one heating zones of the induction cooktop.

[0028] Another aspect of the invention relates to a digital control module for use inside of induction cooktops, the module comprising at least:

- a power and signal interface block,

- a programmable digital processor,

- a wireless communication block,
  wherein

- the power and signal interface block comprises programmable logics arranged for interconnection between a user interface panel and a heating power control block of the induction cooktop,

- the digital control module supplies and regulates induction power in the cooktop heating areas below the values set on the user interface panel, and

wherein the digital control module is applicable in the cooking system according to any of the preceding paragraphs.

[0029] According to an embodiment, said digital control module is implemented in an induction cooktop between the user interface panel and heating power control block of the induction cooktop.

[0030] Another aspect relates to a method to control a cooking process by an automated control loop, the method comprising at least control steps of

- reading values at least from cookware sensors;

- transferring the obtained sensor values to a controlling device/app;

- estimating control means for a next time interval;

- transferring the estimated control means at least to the cooktop;

- applying the estimated control means at least in the cooktop during the next time interval,

wherein the step of estimating control means is feasible by more than one device in the automated control loop,

characterized in that at least a part of the automated control of the cooking process is delegated from the controlling device/app to at least one other device at least in the automated control loop.

[0031] According to an embodiment, it is arranged to control cooking temperature in cookware having at least a thermal sensor and wireless communication, the cookware being set onto a cooktop having at least wireless communication and remotely controlled induction heating.

[0032] According to an embodiment, the cookware further comprises its digital control module to execute at least a part of the delegated automated control.

[0033] According to an embodiment, the cooktop further comprises its digital control module to execute at least a part of the delegated automated control.

[0034] According to an embodiment, the controlling device is a smartphone, a tablet or any smart terminal-type device having wireless connection and running the controlling app.

[0035] According to an embodiment, the controlling device is a digital control device or module having wireless connection and performing the step of estimating control means for the next time interval.

[0036] Another aspect relates to a cooking system with automated cooking temperature control loop comprising at least:

- cookware with a thermal sensor and a digital control module arranged at least to read the cooking temperature and transfer its values to external devices,

- an external controlling device/app arranged to request and receive the cooking temperature values, to estimate heating power according to a predefined temperature for the next time interval, and to transfer the heating power values to external devices.

- an induction cooktop with at least one heating zone and a digital control module arranged to receive the heating power values and provide induction heating to the cookware,

characterized in that at least a part of the automated control function from the external controlling device/app is delegated to at least the digital control module of the cookware or the digital control module of the cooktop.

[0037] According to an embodiment, cooking temperature is controlled on more than one heating zones of the induction cooktop.

[0038] According to an embodiment, the cooking temperature is controlled from more than one external controlling devices/apps to the induction cooktop.

[0039] Another aspect relates to a digital control module for use inside of induction cooktops, the module comprising at least:

- a power and signal interface block,
- a programmable digital processor,
- a wireless communication block,
  characterized in that
- the power and signal interface block comprises programmable logics arranged for compatible and transparent interconnection between the user interface panel and heating power control block of the induction cooktop,
- the digital control module supplies and regulates induction power in the cooktop heating areas below the values set on the user interface panel,

[0040] According to an embodiment, the digital control module is applicable in the cooking system according to any of the preceding paragraphs.

[0041] According to an embodiment, the digital control module is implemented in an induction cooktop between the user interface panel and heating power control block of the induction cooktop.

The drawings

[0042] To understand control delegation in an automated loop cooking process, and appreciate its practical applications, the following pictures are provided and referenced hereafter. Figures are given as examples only and in no way should limit the scope of the invention.

fig. 1 depicts delegation of control in an automated loop of a cooking process; and

fig. 2 depicts a cooking system comprising a cooktop with its digital control module, cookware with digital control modules and external controlling device/app, all these devices working together in the automated control loop of the cooking process.

Detailed description

[0043] This description discloses details of the control delegation method in an automated control loop cooking process, a cooking system employing a said method, and a digital control module 19 implemented into a conventional induction cooktop 1 thus allowing such a modified cooktop to use safely in said the system and with said method.

The digital control module in a cooktop

[0044] The induction cooktop 1 comprises a digital control module 19 arranged to take part in an automatic control loop cooking process. Module 19 is embedded in between the native User Interface Panel (UIP)/Manual control module 18 of the induction cooktop 1 and the power electronics (POWER) board or Induction heating coil controller 16 which controls the power supply to induction coils 15 for heating the cookware 3. This modification in the cooktop is done as follows:

Before installation of module 19	UI panel 18 <----------> POWER board 16
After installation of module 19	UI panel 18 <------> DC module 19 <------> POWER board 16

[0045] The digital control module 19 passes through or intercepts and modifies certain signals of the digital and analog communication between the UI panel 18 and the POWER board 16. As a part of the present invention, module 19 provides the following features:

1. Module 19 can be installed into the cooktop 1 straightforwardly: it only extends the cable connecting the UI panel 18 and the POWER board 16. The interface block 20 of the module comprises programmable logic that can be configured for various operation modes corresponding or adaptable to controls of different cooktop types and models.

2. The module 19 allows the cooktop 1 to be operated normally - or with external device/app 4 and smart cookware

3 to provide very precise temperature control for food cooking. Both modes of the cooktop 1 control (manual and digital) can be utilized simultaneously. It means, that the module 19 at the beginning of operation is transparent for the control signals between UIP 18 and heating power controller 16. Meanwhile, for the electronically regulated cooking, when activated from the external device/app 4, it starts a smart heating mode. If the smart mode fails, the module 19 automatically switches to the manual mode and switch off the induction heating coils 15.

3. Module 19 is made and implemented into the cooktop 1 in such a way that it never increases heat power beyond the manual setting on the UI panel 18. The module can only decrease (i.e. regulate) power levels below the manual setting by the user on the UI panel 18. This means that the embedded digital control module 18 is safe because the cooktop 1 cannot be turned on remotely. The user always has to activate and set the allowed maximum power level on the UI panel 18 of the cooktop 1.

4. Module 19 allows a control loop for induction cooktop power module 16, from cookware thermal sensor 11 with electronics 12 and external smart devices/apps 4. When the user selects a UI power level, e.g. 1, 2, 3, 4, 5, 6, 7, 8, 9 or P (booster), the maximum heating power of the corresponding cooktop zone 2 is limited to the power indicated by the UIP level (or other lower-level stored in the module's non-volatile memory) and at the same time the desired temperature of the cookware 3 is also pre-set in module 19. Therefore, the power level and temperatures pre-set allow easy and fail-safe cooking (no burned food, etc.). 'P' is a "booster" setting in some cooktops. It provides high power, however, it does not change over the desired temperature but employs the maximum available heating power (for limited periods): this mode allows to reach the desired temperature quickly and afterward the heating power is regulated to much lower levels. Another example is a pre-set "recipe" power level (e.g., "perfect soft-boiled egg" recipe can be started by just setting the power level to e.g. '2') - such a more sophisticated setting of the desired temperature can be configured from the external device/app 4.

5. The above features can be set equally for all cooktop zones 2 (regardless of a cooking zone), or it can be set for a combination of cookware 3 and/or zone 2, e.g., '2' can be one setting for the pot and "4" for the frying pan, etc.

[0046] The structure of module 19 is presented in Fig. 2. Module 19 comprises an interface block 20 with programmable logics, digital processor 21, and wireless communication 22 block supporting one or more communication standards, e. g., Wi-Fi, Bluetooth, Infrared, etc. The module 19, once implemented into the cooktop 1, is accessible remotely via the wireless network, e.g., responds with Web interface for setting further control configurations.

Delegation of control

[0047] The method describes central control delegation in the control loop from an external control device/app 4 to the induction cooktop 1, cookware 3, or another external device/app 4.

[0048] In order delegation to work, the cooking system is considered to have sufficient digital control means to control the automated loop cooking process and to take over the central control function when the controlling device (e.g. 4) leaves the loop 6. Such substitute controlling devices can be cooktop 1 with the digital control module 19, smart cookware item 3 having integrated sensor 11 with control electronics 12 and digital processor 14, and other external devices/apps 4 in the wireless network.

[0049] Furthermore, there can be multiple control loops 6, 7 on different heating areas/zones 2 of the cooktop 1, with several cookware items 3 and with more than one external device/apps 4. The remote or external devices 4 can be personal smart devices such as smartphones, tablets, or smart local terminals with wireless connection for input/output (touchscreen), Internet access and located in the kitchen nearby the cooktop 1 for operating it.

[0050] The control module 19 of the cooktop 1 and control modules 12 of cookware items 3 in real practice lack features of extensive data input and output. Therefore, the initial data input and setup of a more sophisticated cooking process is convenient via the external devices/apps 4. Further, the initialized setup can be changed to be done automatically in a closed control loop by the external device/app 4 which controls the cookware items 3 and cooktop heating zones 2 accordingly to the cooking process steps, temperature settings, and provides indications to the operator/cook, etc.

[0051] However, in many real situations, the cooking process control may be useful and safer to delegate from the external/device/app 4 to the cooktop 1 or/and the cookware item 3 or another external device/app (for example, to another person), or another cooktop (for example, between two cooktops in a shared kitchen). For example, to prevent losing control if the smartphone 4 was shut down, disconnected, or the operator has temporarily left the kitchen together with his/her smartphone 4.

[0052] Therefore, the delegation of central control is arranged for other devices being able to control the cooking process. According to the present invention, the delegation is done by several steps as per example:

1) The controlling device/app 4 requests and verifies other devices in the automated control loop 6 if they could take over the control.

2) The controlling device/app 4 sends the control data (array of parameters) to devices that could take over the control: to the cookware item 3, to the cooktop module 19, or both.

3) The priority queue for control may be set for the available candidates. The first control candidate is the external device 4, the second one is smart cookware item 3, and the third one is the cooktop control module 19.

4) The first candidate to take over the control is designated, presumably, the cookware item 3. The candidate sets the watchdog timer to send keep-alive messages checking if the present controlling device 4 is accessible.

5) If the external device/app 4 disappears from the wireless network and does not respond to keep-alive messages, the designated control candidate begins to control the cooking process automatically.

6) The cooktop controller 19 also sends periodical keep-alive messages to check if the controlling external device/app 4 is online. If the controlling device/app 4 disappears from the wireless network, the cooktop 1 searches for other control candidates, or takes over the control with its control module 19, or eventually ceases the cooking process by switching-off the heating areas 2.

7) Delegations can be done in several automated control loop cooking processes 6, 7, for example, if the operator/cook prepares several foods in several cookware items 3 on several heating zones 2, and decides temporarily to leave kitchen area, therefore, the all cooking processes have to stay controlled without the smart device/app 4.

8) Another type of delegation of automated loop cooking process control is from one external device/app 4 to another external device/app 4. For example, in the case when one person leaves the kitchen and another person takes over the control. Such delegation can be arranged directly between the two external devices/apps 4 if both persons are in the kitchen. Alternatively, the delegation can be done via the smart cookware items 3 or the cooktop control module 19.

9) One more delegation of cooking process control is from one cooktop to another cooktop. For example, this is useful in a kitchen having several cooktops, e. g. shared kitchens, with several cooktops 1 each having several heating areas 2, or each heating area 2 having own digital controller 19. In this case, the different cooktop control module 19 is selected to participate in the temperature control loop and by displacing the cookware item 3 from one cooktop 1 to another, it allows to continue the cooking process as initially predefined. In this case, the central controlling node can be the external device/app 4 or digital controller 12 of the cookware item 3.

[0053] The automated loop control modes can be mixed on a single cooktop for several cookware items as in FIG. 1. One cookware item can cook the food autonomously in local-mode 7, while another cookware is in App mode 6 with an external device/app 4, while third one is in App mode 6 with another external device/app 4, while the forth cookware item 3 can be in Local mode 7 but only sending the temperature data to the cooktop 1 and cooktop digital module 19 fully estimates control means and controls the cooking process.

[0054] The preferred embodiment of control delegation is for the cooking temperature controlling process. Initially, the cookware 3 communicates with the external device/app 4, e.g., using Bluetooth Low Energy (BLE). The application 4 controls the cooktop 1 and the power delivered from the cooktop heating coil 15 to the cookware item 3.

Using the external device/app, the temperature can be set to within ±1°C precision. The app controls the heat and guides the user to cook more delicious food.	The digital control module is embedded in the cooktop. The app connects to the cooktop. The app controls the cooktop and heating of the cookware. Our sensors, radio module and electronics are embedded in the cookware.	The app connects to the cookware. The app now knows the exact temperature.

[0055] There are 2 primary operation modes:

1. Application mode:

- Cookware 3 (temperature) ---> app (temperature setpoint) ---> cooktop (power).

2. Local mode:

- cookware (temperature, temperature setpoint) ---> cooktop (power),
  or
- cookware (temperature) ---> cooktop (temperature setpoint, power)

[0056] In the Application or App mode, the external device/app 4 is connected remotely to both the cookware item 3 and the cooktop 1. The automated control loop works repeatedly by these steps:

1. The cookware 3 sends temperature value from the thermal sensor 11 to the external device/app 4;

2. The app 4 calculates the power needed to deliver to the cookware item 3 on the heating zone 2;

3. The app 4 sends the power setpoint to the cooktop 1;

4. The cooktop 1 uses induction in heating zone 2 to heat the cookware 3;

5. The app 4 receives from the cooktop 1 information on the actual power delivered to the cookware 3;

6. Steps 1 to 5 repeated per fixed time intervals.

[0057] In the Local mode, the cooktop 1 is connected by wireless connection directly to the cookware 3, and the following steps are performed:

1. The cookware 3 sends temperature to the cooktop digital controller 19;

2. The cooktop digital controller 19 calculates the power to deliver to a heating coil 15;

3. The cooktop 1 uses power and induction to heat the cookware 3;

4. Steps 1 to 3 per fixed time intervals.

[0058] To change from App mode 6 to Local mode 7 (FIG. 1), the following steps are performed:

1. The App 4 requests the cooktop 1 if the cooktop 1 supports the Local mode 7 operations.

1+. The App 4 requests the cookware 3 if the cookware 3 supports the Local mode 7 operation.

2. The App 4 sends the temperature setpoint to the cookware 3;

3. The App 4 sends the cookware 3 identification to the cooktop 1, to inform the cooktop 1 of the placement zone 2 of the cookware 3 (on which heating zone 2).

4. App 4 starts a watchdog timer in the cookware 3. This ensures the cookware 3 will disconnect from the App 4 if it is not serviced within the watchdog timeout interval.

5. The App 4 eventually disconnects from the cookware 3, this can happen for several reasons, e.g:

   a. The mobile device 4 with the app comes out of range, i.e. the user walks away.

   b. The mobile device 4 runs out of battery and shut off;

c. The user shut off the mobile device 4;

d. The mobile device 4 is locked or the app is put in the background by the user to save battery - interrupting the execution of the app 4;

e. The app 4 disconnects intentionally, i.e. the preferred mode of the app is set to Local mode (loop) 7.

6. The cooktop 1 connects to the cookware 3 and receives the setpoint temperature and current temperature directly from the cookware 3 instead of just power setpoints from the app 4. The cooktop 1 then proceeds to regulate the power into the cookware 3, on behalf of the app (i.e. the system is now in Local mode).

The cooking system with control delegation

[0059] The cooking system operates by employing the method of control delegation described above and, therefore, comprises at least 2 control nodes (cooktop digital controller 19, cookware item controller 12 and external device/app 4) which can interact mutually to take over automated control of the cooking temperature in a flexible and safe way along the entire cooking process until the food is prepared and the cooktop 1 is switched-off and a certain indication signal is provided (sound, message, light, etc.).

[0060] The functionality of cooktop digital controller 19 and cookware item 3 can be different due to taking over the automated loop control. For example, the cookware item 3 can have a simplified controller 12 which only responds to the request for the temperature indication but is not able to take over control of the cooking process. On the other hand, the cooktop controller 19 can also be a simple integrated controller that accepts only remote commands for changing the power supply to induction coils 15. In the case, if only the external device/app 4 can control the cooking process, then a delegation of the control in the loop 6 is not possible, it is possible only to delegate the control to another external device/app 4. Therefore, at least one more suitable control node is required to be in the system - either in the cookware item 3 or the cooktop 1, or both.

[0061] Therefore, it is preferable to implement into the cooktop 1 a digital control module 19 having the necessary control functions as described above in this chapter.

[0062] Smart cookware items 3 having advanced control features and modules 12 can control the cooking process automatically and provide additional flexibility. For example, if the cookware item 3 with food inside has delegated control process from the external app 4, and started the automated temperature control loop, and afterward cookware item 3 was displaced by the operator/cook onto another cooktop 1 then the cookware item 3 can automatically initiate and continue the predefined cooking process also on the another cooktop 1.

[0063] It is noted that delegation of control also describes the decentralization of role-based control systems. This means that control delegation in the automated loop cooking process concept described by this invention is considered as wide as possible practically, e.g. with multiple cooktops, heating zones, cookware items, automated loop cooking processes, external controlling devices/apps, cooks, etc. There are no limitations set to this invention by types and numbers of intelligent devices in the cooking system and by the control delegation method.

List of reference signs:

[0064]

1 An induction cooktop
2 A heating area or zone of the induction cooktop
3 Cookware item having at least a thermal sensor and wireless communication means
4 External controlling device/app (smartphone, tablet, smart display, etc);
5 Regulated induction heating from the cooktop heating zones to the cookware items
6 The application-mode automated control loop of the cooking temperature
7 The local-mode automated control loop of the cooking temperature
8 Delegation of central control from the Application-mode to the Local-mode automated control loop
9 Links or channels of wireless communications
10 Cooktop surface
11 A thermal sensor in the cookware
12 The digital control module in the cookware item
13 Wireless communication block in the cookware item (in the digital control module)
14 The digital processor in the cookware item (in the digital control module)
15 Induction heating coil in the cooktop heating area/zone

16 Induction heating coil/power board controller in the cooktop
17 A thermal sensor in the heating coil of the cooktop (typically found in induction cooktops)
18 The manual control module of the cooktop or User Interface Panel
19 Digital control module integrated into the cooktop, in between the heating coil /power board controller and the User Interface Panel/Manual control module
20 Interface block of the cooktop digital control module, the interface block comprising configurable logics and arranged in between the Induction heating coil/power board controller and User Interface Panel/Manual control module
21 The digital processor in the cooktop digital control module
22 Wireless communication block in the cookware item

Claims

1. A method to control a cooking process by an automated control loop (6, 7, 8) arranged to control cooking temperature in a cookware (3) having at least a thermal sensor (11) and a wireless communication block (13), the cookware (3) being set onto a cooktop (1) having at a least wireless comminication block (22), the method comprising the steps of:

    - reading values at least from cookware sensors (11);
    - transferring the obtained sensor values to a controlling device;
    - estimating heating power according to a predefined temperature for a next time interval;
    - transferring the estimated heating power at least to the cooktop (1);
    - applying the estimated heating power in the cooktop (1) during the next time interval,

    wherein at least a part of the automated control of the cooking process is delegated from the controlling device to at least one other device at least in the automated control loop (6, 7, 8).

2. The method according to claim 1 wherein the cookware (3) further comprises a digital control module (12) to execute said step of reading values at least from said cookware sensors (11).

3. The method according to claim 2 wherein the cooktop (1) further comprises its digital control module to execute at least a part of the delegated automated control, such as said step of estimating heating power for a next time interval.

4. The method according to any of the preceding claims, wherein the cooktop (1) further comprises a digital control module (19) to execute said step of applying the estimated heating power in the cooktop (1) during the next time interval.

5. The method according to claim 4, wherein the digital control module (19) of the cooktop (1) is arranged to execute at least a part of the delegated automated control (7, 8), such as said step of estimating heating power for a next time interval.

6. The method according to any of the preceding claims wherein the controlling device is a smartphone, a tablet or any smart terminal-type device having wireless connection and running a controlling app.

7. The method according to claim 6, wherein said step of delegating at least a part of the automated control of the cooking process from the controlling device to at least one other device at least in the automated control loop is performed upon said controlling device being shut down, disconnected or the controlling device temporarily leaving the kitchen.

8. The method according to any of the preceding claims, wherein said at least part of the automated control of the cooking process is delegated by the controlling device.

9. The method according to any of the preceding claims, wherein said delegation from the controlling device to at least one other device at least in the automated control loop comprises transmitting control data from said controlling device to said at least one other device.

10. The method according to any of the preceding claims, wherein said step of delegating at least a part of the automated control of the cooking process from the controlling device to at least one other device at least in the automated

control loop comprises changing from an app mode to a local mode, said app mode and local mode being operational modes of said automated control of the cooking process.

11. The method according to any of the preceding claims, wherein said cookware is a first cookware, wherein a second cookware is set onto said cooktop, and wherein a cooking process of said second cookware is being controlled by a second automated control loop.

12. A cooking system with automated cooking temperature control loop comprising at least:

- cookware (3) with a thermal sensor (11) and a digital control module (12) arranged at least to read the cooking temperature and transfer its values to external devices,
- a controlling device arranged to request and receive the cooking temperature values, to estimate heating power according to a predefined temperature for the next time interval, and to transfer the heating power values to external devices.
- an induction cooktop (1) with at least one heating zone (2) and a digital control module (19) arranged to receive the heating power values and provide induction heating to the cookware (3),

wherein at least a part of the automated control function (6, 7, 8) from the controlling device is delegated to at least the digital control module (12) of the cookware (3) or the digital control module (19) of the cooktop (1).

13. The cooking system according to claim 12, wherein cooking temperature is controlled on more than one heating zones (2) of the induction cooktop (1).

14. A digital control module (19) for use inside of induction cooktops (1), the module comprising at least:

- a power and signal interface block (20),
- a programmable digital processor (21),
- a wireless communication block (22),

wherein

- the power and signal interface block (20) comprises programmable logics arranged for interconnection between a user interface panel (UIP) (18) and a heating power control block (16) of the induction cooktop (1),
- the digital control module (19) supplies and regulates induction power in the cooktop (1) heating areas (2) below the values set on the user interface panel (UIP) (18), and wherein the digital control module is applicable in the cooking system according to any of the claims 12 or 13.

15. The digital control module (19) according to claim 14, wherein said digital control module is implemented in an induction cooktop (1) between the user interface panel (UIP) (18) and heating power control block (16) of the induction cooktop (1).

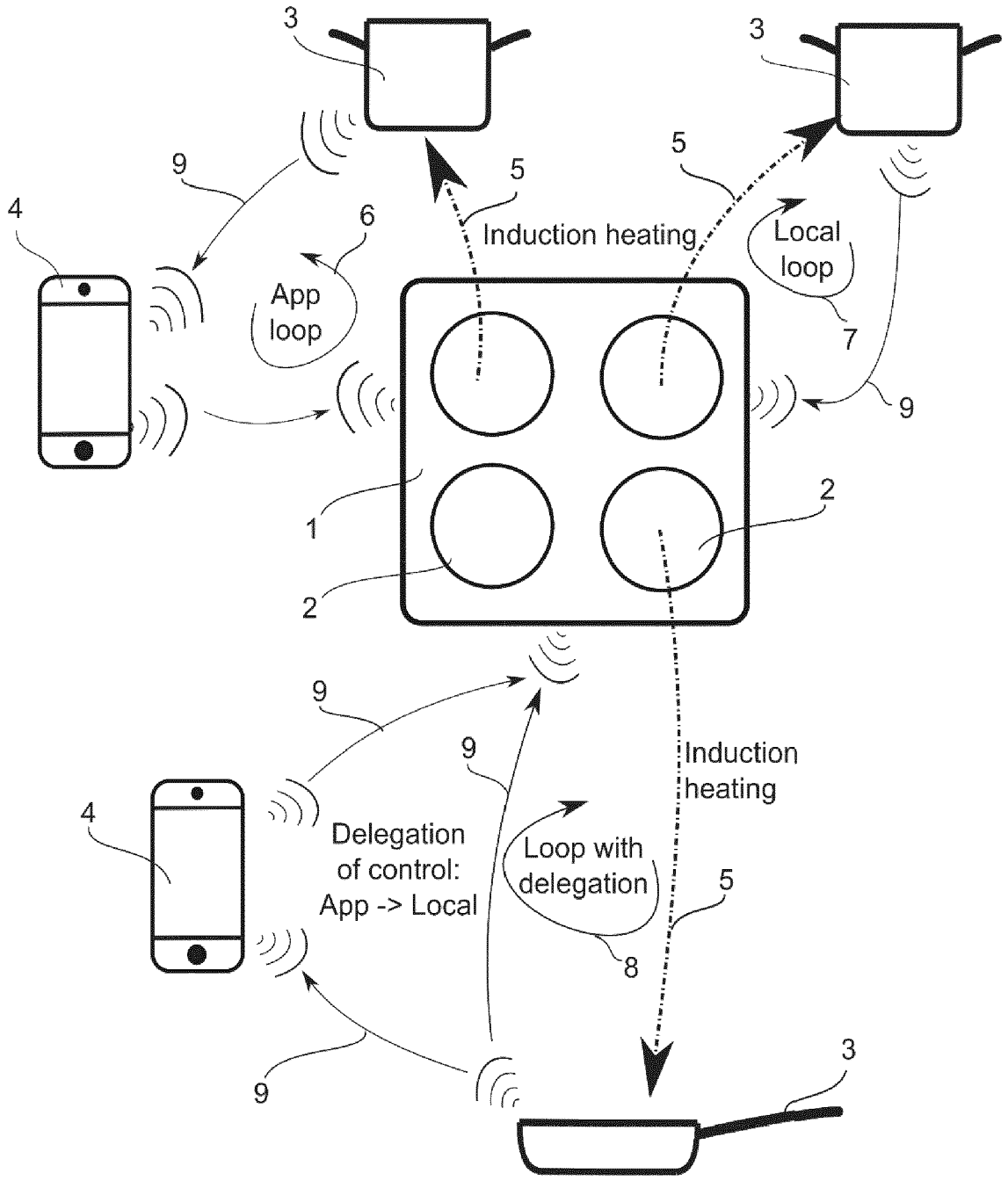
3
3
9
5
5
4
6
Induction heating
Local
loop
App
loop
7
9
1
2
2
9
9
Induction
heating
4
Delegation
of control:
App -> Local
Loop with
delegation
5
8
9
3

FIG. 1

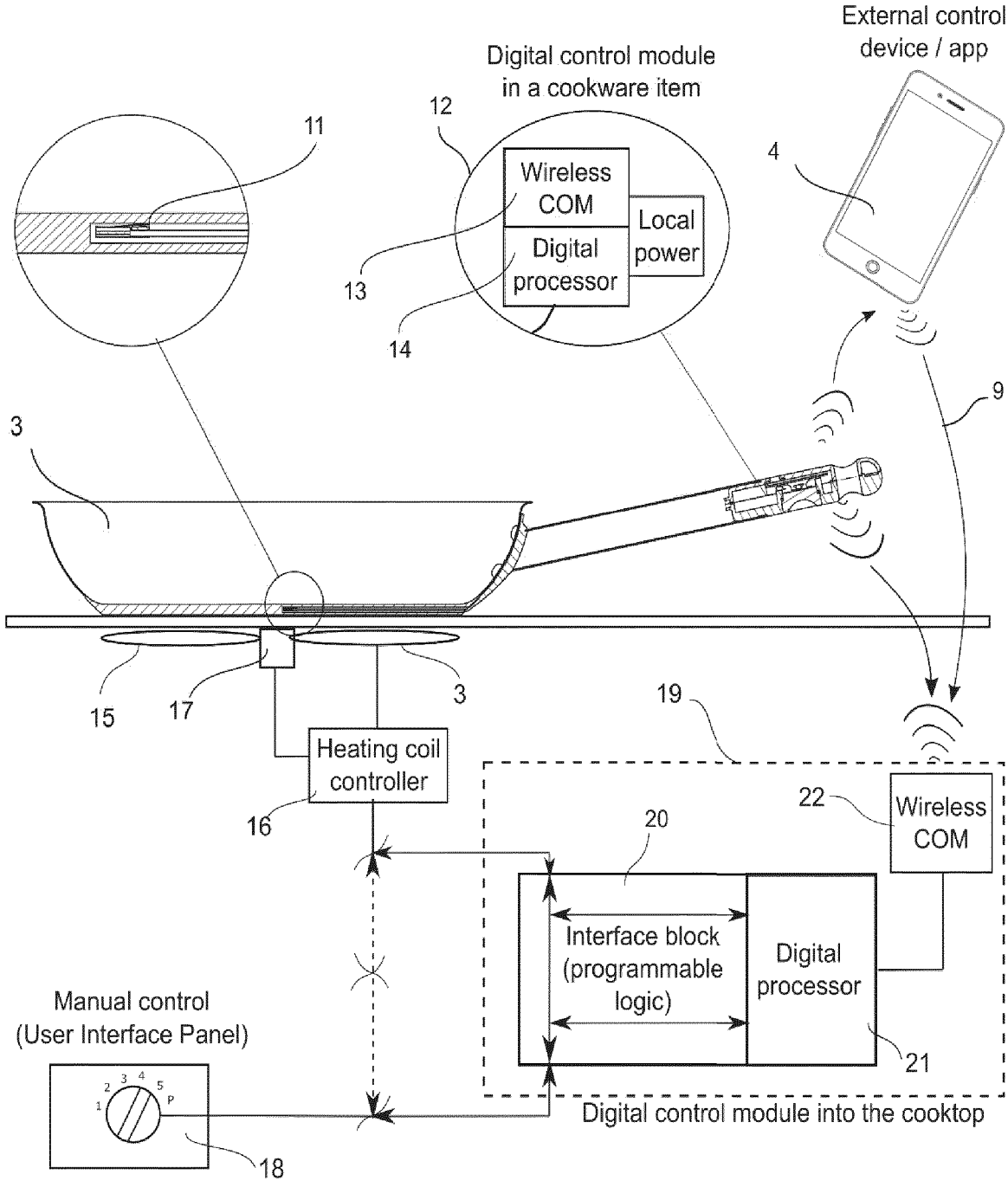
External control device / app
Digital control module in a cookware item
12
11
Wireless COM
Local power
Digital processor
13
14
4
9
3
3
15
17
3
19
Heating coil controller
16
22
Wireless COM
20
Interface block (programmable logic)
Digital processor
21
Manual control (User Interface Panel)
1
2
3
4
5
P
18
Digital control module into the cooktop

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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