

Beverage preparation station

FIELD

5 The present invention relates to a beverage preparation station which automates the preparation of a beverage through the use of robotics.

BACKGROUND

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Western approaches to making a cup of coffee favours using equipment such as an espresso machine, an aeropress, a percolator, a French press to extract the full flavour of the Arabica coffee beans that are used. However, these approaches are not particularly suited for making traditional coffee enjoyed in Southeast Asian countries like Singapore, Malaysia and Brunei, made generally
15 from robusta beans roasted with butter or margarine along with sugar.

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The approach used for making traditional coffee in such Southeast Asian countries involve brewing coffee powder in a sock filter, which serves as an infuser that is placed within a long-spouted pot. To serve, the concentrated brew is mixed with milk, sugar and diluted with water as needed before being served in a cup. The coffee maker needs to calibrate the grind of the coffee powder, the
20 water temperature, deciding when to replace the sock filter when the filtration is no longer optimal and an amount of air to introduce into the coffee. Experience is required to make the necessary calibrations to consistently make a good cup of coffee, one that is acceptable for even the recreational customer with no strong taste preference.

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The present invention is directed at a beverage station that seeks to make a cup of coffee or
25 tea that can suit individual preference.

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SUMMARY OF THE INVENTION

According to a one aspect of the present invention, there is provided a coffee and/or tea
30 preparation station comprising: a robotic arm arrangement; a control unit to operate the robotic arm arrangement to prepare coffee and/or tea steeped from its base, wherein the control unit is configured to: actuate the robotic arm arrangement to perform a motion sequence that effects transfer of content between a mixing canister and a filtering canister, wherein the mixing canister initially contains the base, and wherein the filtering canister comprises a filter to separate the base received from the
35 mixing canister during the transfer, so that the filtering canister contains filtered coffee and/or tea and the base trapped by the filter.

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BRIEF DESCRIPTION OF THE DRAWINGS

Representative embodiments of the present invention are herein described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a top view of a beverage preparation station in accordance with one embodiment of the present invention.

Figure 2 illustrates a first part of a brewing phase to prepare a beverage from its base.

Figure 3 illustrates a second part of the brewing phase.

Figure 4 illustrates a third part of the brewing phase.

Figure 5 provides a summary of the processes involved in the brewing phase.

Figure 6 shows a serving phase in the preparation of the beverage.

Figure 7 provides a summary of the processes involved in the serving phase.

Figure 8 shows a perspective view of a washing station of the beverage preparation station of Figure 1.

Figures 9A and 9B are perspective views of the collection counter of the beverage preparation station of Figure 1.

Figure 10 is a perspective view of the mechanism for the swivelling bottom of Figures 9A and 9B.

Figure 11 shows a belt conveyor mechanism approach to effect transfer of content between two canisters.

Figure 12 is a perspective view of a beverage preparation station in accordance with another implementation.

DETAILED DESCRIPTION

In the following description, various embodiments are described with reference to the drawings, where like reference characters generally refer to the same parts throughout the different views.

The present application, in a broad overview, relates to a beverage preparation station which is a system that facilitates preparing a beverage, preferably coffee and/or tea, from its base. The term "and/or" in the context of "coffee and/or tea" means coffee, tea or both. Further, "beverage" is to be understood to refer to "coffee and/or tea", with both terms being used interchangeably.

The beverage preparation station is configured for preparation of coffee and/or tea through infusion or steeping. Examples of the base include, but are not limited to any one or more of coffee beans, coffee powder, tea powder and tea leaves. Any suitable fluid is used for the infusion or

steeping, such as hot water or hot flavoured liquid (e.g. hot tea or hot coffee, in the scenario where consumer preference is a beverage that is a combination of hot tea and coffee).

The preparation is facilitated by a movement mechanism working in tandem with canisters used to contain the base from which the coffee and/or tea is made and the fluid, for extracting the flavour from the base. The movement mechanism refers to any suitable combination of mechanical devices, such as one or more of a robotic arm arrangement and conveyor mechanisms. For example, the movement mechanism may be implemented using a combination of robotic arms interacting with vertical and horizontal belt conveyors. Alternatively, the movement mechanism may be implemented by solely using robotic arms; or by solely using belt conveyors.

The robotic arm arrangement refers to an implementation of one or more robotic arms. When two or more robotic arms are used, one implementation may have each of the robotic arms work independently, such as when each robotic arm is responsible for a specific phase in the preparation of the beverage (e.g. a brewing phase where a beverage concentrate is made from its base, which involves steeping the beverage base in water; and a serving phase, which involves adding condiments into the beverage concentrate to taste, such as sugar and/or milk). In another implementation, the two or more robotic arms may interact. For example, one of the robotic arms may grip a canister and empty its contents into another canister that is gripped by the other robotic arm. Each of the one or more robotic arms has a layout that may comprise a plurality of members, each coupled to another member by a respective joint. Each joint allows the coupled member to have one or more of the following motions: yaw, pitch and roll. The interconnection provides each robotic arm with several degrees of freedom, allowing movement along and/or about multiple axes, so that the arm exhibits anthropomorphic articulation. One end of each robotic arm is connected to a base, with an end effector at the other end.

The beverage preparation station has a control unit to operate the movement mechanism, for example, by controlling the movement of the robotic arm arrangement when preparing a beverage from its base. The control unit may include at least one memory to store programming code that effects the movement required of the robotic arm to prepare the beverage and one or more processors that execute the programming code. The executed programming code has the control unit actuate the robotic arm arrangement to perform a sequence of movements during a brewing phase of the beverage preparation, where a concentrate is extracted from the beverage base (such as coffee or tea powder); and another sequence of movements that prepares the beverage from the concentrate. The programming code defines the trajectories of the robotic arm arrangement to prepare the beverage. An optimisation algorithm may be programmed to give the spatial x, y, z, positions for the robotic arm arrangement at each phase of the beverage preparation and automatically defines the relevant trajectory, which comprises linear segments, along which the robotic arm arrangement moves, for example to minimise the time taken to prepare the beverage.

The control unit may execute a learning algorithm adapted to process input received from one or more sensors (including but not limited to optical based ones) that track the movement of the robotic arm arrangement. The learning algorithm can learn which paths are best while the robotic arm arrangement is in operation and works in conjunction with the optimisation algorithm to provide real-time trajectory correction for the robotic arm arrangement movement. The control unit may operate entirely based on such a learning algorithm or may incorporate portions of such a learning algorithm. In another implementation, the control unit may receive instructions to operate the robotic arm arrangement remotely, e.g. from a cloud, i.e. the programming code need not necessarily reside on the control unit's local memory.

The preparation of the concentrate involves transfer of content between a mixing canister and a filtering canister, the content being primarily the beverage (more specifically the beverage concentrate). When a robotic arm arrangement is used for this preparation, one or more robotic arms pour the beverage from the mixing canister into the filtering canister during the transfer from the mixing canister into the filtering canister. Similarly, the robotic arm arrangement pours the beverage from the filtering canister into the mixing canister during the transfer from the filtering canister into the mixing canister. As such, the transfer causes the content to alternate between the mixing canister and the filtering canister, whilst introducing air into the brewing/pouring process, changing the taste variable.

When belt conveyors are used for the preparation of the coffee or tea concentrate, a vertical lift conveyor lifts the mixing canister above the filtering canister. A valve at the bottom of the mixing canister is opened to allow its content to fall into an opening of the filtering canister during the transfer from the mixing canister into the filtering canister. The vertical lift conveyor lifts the filtering canister above the mixing canister during the transfer from the filtering canister into the mixing canister. A valve at the bottom of the filtering canister is opened to allow its content to fall into an opening of the mixing canister.

The transfer is important in consideration of the function that the mixing canister and the filtering canister each serve during the brewing phase. The mixing canister serves as the initial repository for a mixture of the beverage base and liquid to steep the beverage base to make the beverage. However, it is undesirable to use the beverage from the mixing canister as a concentrate because of the presence of residue from the undissolved beverage base.

The filtering canister serves to remove the undissolved beverage base. This is achieved using its filter to separate the beverage base received from the mixing canister during the transfer. The filtering canister contains filtered beverage and the beverage base trapped by the filter. The filtered beverage in the filtering canister, which is free from the beverage base, can thus be used for the beverage concentrate.

The transfer of content between the mixing canister and the filtering canister may then be reiterated. That is, the content in the filtering canister is returned (less sediment trapped by its filter)

to the mixing canister, with the mixing canister pouring its content back into the filtering canister. This cycle is reiterated depending on one or more factors (such as grind of the base, desired coffee and/or tea strength, temperature of the steeping fluid, yield), ending with the filtering canister containing the filtered coffee and/or tea. Starting from the mixing canister, a minimum cycle sees the
5 mixing canister transferring its content into the filtering canister once.

One purpose of the transfer between the mixing canister and the filtering canister is to provide beverage concentrate largely free from its beverage base, which is present in the filtering canister. Another purpose is that it allows for recirculation, where the filtered beverage from the filtering canister is used to flush beverage base that remains in the mixing canister from an earlier transfer. In
10 addition, the recirculation lengthens the infusion time for the beverage base. A further purpose introduces air into the coffee or tea, which enhances the flavour of the coffee or tea concentrate.

It will be appreciated that the filtering canister and the mixing canister are coined terms used to convey a function that each serves when brewing a beverage from its base. The canister to initially contain the beverage base and steeping liquid is the "mixing canister". The canister that can remove
15 the beverage base is the "filtering canister". The canister for the filtering canister and the mixing canister may thus be any type of storage means with an open top and a spout.

The operation of the beverage preparation station is described in greater detail below.

Figure 1 is a top view 102 of a beverage preparation station 100 in accordance with one embodiment of the present invention. The beverage preparation station 100 has the following
20 components: a robotic arm arrangement 104, an ingredient station 106, a condiment station 110, a collection counter 112, a washing station 114, a filter rack (not shown) and a beverage storage (not shown). The functioning of each of these components is described below with reference to Figures 2 to 10.

The robotic arm arrangement 104 is involved in the various phases of preparing a beverage
25 from a base, preferably coffee and/or tea from its base. A control unit 120 controls the movement of the robotic arm arrangement 104 during each of these phases. Figure 1 shows that there are two robotic arms 102 and 103. However, it will be appreciated that other configurations (not shown) are possible, such as only one robotic arm or more than two robotic arms.

Figure 2 to 5 illustrate the operation of the robotic arm arrangement 104 during the brewing
30 phase, which results in the making of beverage concentrate from a beverage base.

Figure 2 illustrates a first part of the brewing phase, where the robotic arm arrangement 104 facilitates collecting the beverage base and fluid to steep the beverage base. In step 202, an end effector of the robotic arm 103 collects an empty canister, which will be used to hold a mixture of the beverage base and fluid. This canister is subsequently referred to as mixing canister 201. The mixing
35 canister 201 may be drawn from the washing station 114, although the robotic arm 103 may also draw the mixing canister from another storage location, under the direction of the control unit 120.

The robotic arm 103 is then actuated to position the mixing canister 103 at the ingredient station 106. The ingredient station 106 dispenses beverage base and fluid to steep the beverage base into the mixing canister 103. In Figure 2, the beverage base is stored in a powder repository 205, while the fluid is from a tap 208. As such, the robotic arm 103 actuates the mixing canister 103 in
5 step 204 to the powder repository 205 to collect the beverage base. The powder repository 205 may be in communication with a cloud that decides an amount of base to dispense. This amount may also be controlled by any one or more of a user interface located on the beverage preparation station 100, a remote computing device (such as a smart phone) or a remote ordering kiosk. The robotic arm 103 then manoeuvres the mixing canister 201 in step 206 to be in proximity to the tap 208 to collect the
10 fluid. The fluid may be hot water into which the flavour of the beverage base is extracted or the fluid may be flavoured water, such as hot tea or coffee.

The control unit 120 is configured to cause the dispensed beverage base and the dispensed fluid in the mixing canister 201 to be stirred. Such stirring is achieved in Figure 2 by having the robotic arm 103 actuate the robotic arm arrangement to stir the dispensed beverage base and the
15 dispensed fluid using a stirrer. In step 210, the robotic arm 103 rests the mixing canister 201 on a suitable space of the beverage preparation station 100. This resting space may be predefined, its co-ordinates being programmed into the control unit 120. Alternatively, a suitable sensor (such as an optical sensor like a camera) may detect a portion with sufficient area to place the mixing canister 201 and designate it as the resting space. For example, in Figure 2, the washing station 114 may have a
20 bay which serves as the resting space. After releasing the mixing canister 201, the robotic arm 103 is actuated in step 212 to retrieve a stirrer from storage, such as from being immersed in a water bath. The robotic arm 103 then dips the stirrer into the mixture of the dispensed beverage base and the dispensed fluid in the mixing canister 201 and executes a circular motion, which causes the mixture to be stirred. This stirring helps to further extract the flavour of the beverage base into the fluid, so that
25 the mixing canister 201 contains beverage concentrate and the beverage base.

In an alternative configuration (not shown), the beverage preparation station 100 may have a dedicated mechanism, such as a vibrator, to perform the stirring. The robotic arm 103 may then, under direction by the control unit 120, place the mixing canister 201 in step 210 onto the vibrator to perform the stirring, after collection of the dispensed beverage base and the dispensed fluid from the
30 ingredient station 106.

After the mixture in the mixing canister 201 is stirred, the robotic arm 103 returns the stirrer to storage in step 214. The robotic arm 103 is then available for use in a second part of the brewing phase, described with reference to Figure 3.

Figure 3 illustrates a second part of the brewing phase, where the robotic arm arrangement
35 104 facilitates preparing a canister to receive the content of the mixing canister 201; and filter the received content so as to remove the beverage base. The robotic arm arrangement 104 introduces a

filter before this canister receives beverage from the mixing canister 201 and removes the filter after the beverage is made.

In step 302, an end effector of the robotic arm 102 collects an empty canister, which will be used to filter content poured from the mixing canister 201. This canister is subsequently referred to as filtering canister 340. The filtering canister 340 may be drawn from the washing station 114, although the robotic arm 102 may also draw the mixing canister from another storage location, under the direction of the control unit 120. The robotic arm 102 rests the filtering canister 340 on a suitable space of the beverage preparation station 100. This resting space may be predefined, its co-ordinates being programmed into the control unit 120. Alternatively, a suitable sensor (such as an optical sensor like a camera) may detect a portion with sufficient area to place the filtering canister 340 and designate it as the resting space. For instance, the washing station 114 may have a bay which serves as the resting space. In another implementation, the control unit 120 may have the robotic arm 103 collect and site the filtering canister 340 for receiving content from the mixing canister 201, as opposed to the robotic arm 102.

In step 304, the robotic arm 103 retrieves a filter from a filter rack, under direction by the control unit 120. The robotic arm 103 then manoeuvres the filter in step 306 to be inserted into the filtering canister 340, positioned as described in the step 302. After insertion, the filter covers the opening of the filtering canister 340, through which content from the mixing canister 201 is received. The robotic arm 103 may first wet the filter (e.g. by dipping into a water tank or spraying the filter with water) before placement into the filtering canister 340, since this facilitates the insertion of the filter. The robotic arm 103 releases the filter after insertion. In addition, either of the robotic arms 103, 102 may be actuated by the control unit 120 to replace the filter, for example after the beverage is made.

Figure 4 illustrates a third part of the brewing phase, where the robotic arm arrangement 104 facilitates transferring of content between the mixing canister 201 and the filtering canister 340. During this part of the brewing phase, the control unit 120 actuates the robotic arm arrangement 104 to perform a sequence that effects transfer of content between the mixing canister 201 and the filtering canister 340. With reference to Figure 2 and its accompanying description, the mixing canister 201 initially contains a mixture of the beverage base and fluid to steep the beverage base to make the beverage.

In step 402, the robotic arm 103 grips the mixing canister 201 from its resting space at the beverage preparation station 100. From the above description of the first part of the brewing phase, the robotic arm 103 would thus retrieve the mixing canister 201 from a bay of the washing station 114 and manoeuvre a spout of the mixing canister 201 to be adjacent to an opening of the filtering canister 340. The robotic arm 103 then pours the content from the mixing canister 201 into the filtering canister 340 during the transfer from the mixing canister 201 into the filtering canister 340, the content being beverage concentrate and the beverage base. The robotic arm 103 then returns the

mixing canister 201 to its resting place, the mixing canister 201 empty save for the beverage base that does not get carried into the filtering canister 340 by the content pour.

From Figure 3 and its accompanying description, the filtering canister 340 has a filter. The filter separates the beverage base received from the mixing canister 201 during the transfer of the step 402. Step 402 thus results in the filtering canister 340 containing filtered beverage and the beverage base trapped by the filter.

In step 404, the robotic arm 103 grips the filtering canister 340 from its resting space at the beverage preparation station 100. From the above description of the second part of the brewing phase, the robotic arm 103 would thus retrieve the filtering canister 340 from a bay of the washing station 114 and manoeuvre a spout of the filtering canister 340 to be adjacent to an opening of the mixing canister 201. The robotic arm 103 then pours the content from the filtering canister 340 into the mixing canister 201 during the transfer from the filtering canister 340 into the mixing canister 201, the content being filtered beverage without the beverage base. The beverage base is not carried into the mixing canister 201 during the content pour because it is trapped by the filter in the filtering canister 340. The robotic arm 103 then returns the filtering canister 340 to its resting place, the filtering canister 340 empty save for the filter with the trapped beverage base. It will be appreciated that the control unit 120 can alternatively actuate the robotic arm 102 to perform the steps 402 and 404, instead of the robotic arm 103.

The control unit 120 is configured to actuate the robotic arm arrangement 104 (i.e. either of the robotic arms 102, 103) to reiterate the steps 402 and 404, i.e. repeat the transfer between the mixing canister 201 and the filtering canister 340, with the iteration ending with the filtering canister 340 containing the filtered beverage. In one implementation, the number of performed reiterations may be pre-programmed into the control unit 120. In another implementation, the number of reiterations depends on one or more factors (such as grind of the base, desired coffee and/or tea strength, temperature of the steeping fluid, yield), which may be decided by a learning algorithm fed with values for each of these factors. Each subsequent iteration is expected to result in the content pour from the mixing canister 201 into the filtering canister 340 in the step 402 carrying less of the beverage base.

The transfer between the mixing canister 201 and the filtering canister 340 serves to extract more flavour of the beverage base into the beverage concentrate. In addition, the transfer flushes beverage base that remains in the mixing canister 201 to be trapped onto the filter of the filtering canister 340.

Figure 5 provides a summary of the processes involved in the brewing phase. The steps 202, 204, 206, 212, 302, 304 and 306 already described in Figures 2 to 4 are not further elaborated. From Figure 5, the robotic arm arrangement 104 tilts the mixing canister 201 towards the filtering canister 340 in the step 402 when pouring the content into the filtering canister 340. The robotic arm

arrangement 104 tilts the filtering canister 340 towards the mixing canister 201 in the step 404 when pouring the content into the mixing canister 201.

During step 402, the transfer from the mixing canister 201 into the filtering canister 340, the control unit 120 configures the robotic arm arrangement 104 to perform a movement sequence that comprises: an initial stage where the mixing canister 201 is tilted such that its spout is placed adjacent to an opening of the filtering canister 340. This is followed by a subsequent stage where the mixing canister 201 is tilted such that its spout is shifted further away from the opening of the filtering canister 340. This shifting of the spout, which is optional, creates a pulling motion that oxygenates the beverage concentrate, which is believed to enhance the flavour of the beverage concentrate.

In addition, during the transfer from the mixing canister 201 into the filtering canister 340, the control unit 120 configures the robotic arm arrangement 104 to swirl the mixing canister 201 before pouring its content into the filtering canister 340. The swirling motion is found to reduce blockage caused by the beverage base accumulating at an entrance of the spout of the mixing canister 201, the entrance being located at the bottom of the inner wall of the mixing canister 201.

While the robotic arm arrangement 104 has two robotic arms 102 and 103, Figures 1 to 5 illustrate that only one robotic arm 103 is used during the transfer of the steps 402 and 404, which interchanges between gripping the mixing canister 201 and the filtering canister 340. As the robotic arm 103 pours the content from one canister (e.g. the mixing canister 201), the other canister (i.e. the filtering canister 340) remains stationary on its resting surface at the beverage preparation station 100, without being held by the other robotic arm 102. However, another implementation (not shown) involves both robotic arms 102 and 103 in the transfer. One robotic arm grips the mixing canister 201 while the other robotic arm grips the filtering canister 340 when effecting the transfer.

In an implementation (not shown) where the robotic arm arrangement has only one robotic arm, the sole robotic arm also interchanges between gripping the mixing canister 201 and the filtering canister 340 when effecting the transfer of the steps 402 and 404.

Returning to Figure 4, the filtering canister 340 contains the filtered beverage concentrate, along with the beverage base trapped on its filter, after the steps 402 and 404 are reiterated and completed. Either of the robot arms 102 and 103 removes the filter from the filtering canister 340 before bringing the filtering canister 340 to a staging area 405. The staging area 405 may have a heating base on which the filtering canister 340 is placed, to keep the filtered beverage hot. The beverage can thus be made from the beverage concentrate in the filtering canister 340. Alternatively, the filter can be removed after the filtering canister 340 is located at the staging area 405 or removed after all the beverage concentrated in the filtering canister 340 is consumed.

The beverage preparation station 100 may also have a beverage storage (not shown). Under direction by the control unit 120, either of the robot arms 102 and 103 moves the filtering canister 340 adjacent to the beverage storage to empty the filtered beverage therein. The beverage storage may be a thermal storage with heat insulation to keep the filtered beverage warm. The beverage preparation

station 100 may use an implementation of either the heating base or the beverage storage. The beverage storage may have a cover mechanism that opens to receive the filtered beverage and closes after the filtering canister 340 is emptied. Either of the robot arms 102 and 103 may remove the filter from the filtering canister 340 before or after the pouring of the filtered beverage into the beverage storage. With the filter removed, the filtering canister 340 can then be moved to the washing station 114 to be cleaned (which is described later with respect to Figure 8). The duration over which the coffee and/or tea is stored may be monitored. The beverage storage is emptied after a shelf life is past, to receive a fresh batch of filtered coffee and/or tea from the filtering canister 340.

The filtered beverage obtained at the end of the third part of the brewing phase as per the accompanying description for Figure 4 is also referred to as beverage concentrate, from which the beverage is made through dilution or the addition of condiments to taste. This filtered beverage is stored in the filtering canister 340 on the heating base of the staging area 405, in the beverage storage implementation; or in both. The making of the beverage from its concentrate is described in Figure 6.

Figure 6 shows a serving phase in the preparation of the beverage. During this serving phase, either of the robotic arms 102, 103 is actuated to position a cup to collect dispensed condiments from the condiment station 110 of the beverage preparation station 100. Examples of condiments include sugar, creamer, milk or flavourings. In addition, the condiment station 110 may have a water dispenser 709 to dilute the beverage. The type and amount of condiments, along with amount of water, dispensed vary according to taste. The beverage preparation station 110 may have a user interface configured to receive input for a mix for the condiments and communicate the mix to the condiment station 110. In addition or alternatively, the condiment station 110 may receive the mix for the condiments from a remote computing device, such as a smart phone or remote ordering kiosk. The user interface, along with the other means for receiving the mix (remote computing device, remote ordering kiosk), may be the same as those used to control an amount of base powder, as described above in Figure 2 with respect to the powder repository 205. The mix may be made on an application residing in the remote computing device, which provides an icon or text for each of the condiments available in the condiment station 110 and an icon to select the thickness of the beverage (which translates to the amount of water used to dilute the beverage concentrate). The dispensed condiments and water then depends on which text or icons are selected, along with their respective amount.

The robotic arm 102 is used during the serving phase for being closer to the condiment station 110 compared to the robotic arm 103. In step 602, the robotic arm 103 obtains an empty cup, such as a paper cup, from a cup dispenser. In steps 604 and 606, the robotic arm 102 actuates the cup to the condiment station 110 to collect one or more of the condiments: sugar, creamer, milk, or any other flavouring. After the condiments are collected, the robotic arm 102 rests the cup in step 608 on a suitable space at the beverage preparation station 100, such as adjacent to the condiment station 110. The robotic arm 102 lifts the filtering canister 340 in step 610 from the staging area 405 to pour its

beverage concentrate into the cup. The robotic arm 102 returns the filtering canister 340 to the staging area 405 so that it is free to grip the cup, with the mixture of condiments and the beverage concentrate, and move the cup in step 612 to the water dispenser 609. Although not shown, the robotic arm 102 may move the cup to an ice dispenser 611, if an iced beverage is desired. The robotic arm 102 finally moves the cup, with the beverage made to taste, in step 614 to a collection zone for collection.

Where the beverage concentrate is kept in the beverage storage, the robotic arm 102 follows the steps 602 to 606, i.e. retrieves an empty cup and positions the cup at the condiment station 110 to collect the dispensed condiments. The robotic arm 102 then positions (not shown) the cup at the beverage station to collect the beverage concentrate. The robotic arm 102 moves the cup, with the beverage made to taste, to a collection zone for collection.

Figure 7 provides a summary of the processes involved in the serving phase. The steps 602, 604, 606, 610, 612 and 614 already described in Figure 6 are not further elaborated. Figure 7 shows that after the hot water is added in step 612, the robotic arm 102 may stir the mixture in the cup in step 702 and cover the cup in step 704. The robotic arm 102 then brings the cup to the collection zone in the step 614.

Figure 8 shows a perspective view of the washing station 114. When the filtering canister 340 and the mixing canister 201 are empty (such as after the beverage is made), they are brought by the robotic arm arrangement 104 to the washing station 114 to be cleaned and ready for the preparation of another round of beverage. The washing station 114 has at least one nozzle 804 which emits a jet of water to rinse the filtering canister 340 and the mixing canister 201. When the canisters 340 and 201 are returned to the washing station 114 by robotic arm arrangement 104, they are inverted so that each of their openings faces the exit of the nozzle 804. The rinsing of the filtering canister 340 and the mixing canister 201 does not necessarily have to occur simultaneously, i.e. the washing station 114 may be configured to clean whichever of the canisters 340 and 201 that are first returned.

Returning to Figure 1, the collection counter 112 is where the robotic arm arrangement 104 places the cup with the prepared beverage (i.e. the filtered beverage with the dispensed condiments). The collection counter 112 may have one or more collection zones, wherein the control unit 120 is configured to actuate the robotic arm arrangement 104 to place the cup at an assigned collection zone. The collection counter 112 further comprises at least one sensor to monitor availability of the one or more collection zones, from which the assigned collection zone is selected.

Figures 9A and 9B are perspective views of one collection zone of the collection counter 112, in accordance with one embodiment of the invention. The collection counter 112 has a swivelling bottom 904 onto which the cup 902 containing the beverage is placed after the step 614 from Figure 6. The swivelling bottom 904 has a panel 908 that is dimensioned to fit a cutaway of a perimeter barrier 906, the perimeter barrier 906 being erected to block access to the robotic arm arrangement 104

during their operation, so as to prevent injury. Activation of the swivelling bottom 904 causes the cup 902 to be rotated outside of the perimeter barrier 906 where it can be retrieved.

Figure 10 is a perspective view of the mechanism 1002 for the swivelling bottom 904 of Figures 9A and 9B. Essentially, the mechanism 1002 has a rotor 1004 that is rotated by a conveyor belt 1006. However, it will be appreciated that any other suitable mechanism may be used.

Other implementations of the collection counter 112, to which the robotic arm arrangement 104 places the cup with the filtered beverage and the dispensed condiments are possible. For example (not shown), each of the collection zones of the collection counter may further include a display that shows a queue number for the beverage that is being served. When a collection zone is detected to be available (such as after a cup is removed) and assigned to place a beverage that the robotic arm arrangement 104 is holding, the display will update to show the queue number for the upcoming beverage.

Figure 11 shows a belt conveyor mechanism 1100, used as an alternative to the robotic arm arrangement 104 described in Figures 1 to 10, to effect transfer of content between a mixing canister 1101 and a filtering canister 1140.

The belt conveyor mechanism 1100 comprises a vertical lift conveyor 1102 having a member 1106 that engages either the mixing canister 1101 or the filtering canister 1140, with Figure 11 showing the filtering canister 1140 being engaged. The member 1106 of the vertical lift conveyor 1102 engages and raises the filtering canister 1140 when its content is ready to be transferred to the mixing canister 1101, as shown in Figure 11. A turntable 1104 then rotates the mixing canister 1101 to be below the filtering canister 1140. With the mixing canister 1101 below the filtering canister 1140, a valve at the bottom of the filtering canister 1140 is opened to allow its content to fall into an opening of mixing canister 1101 during the transfer from the filtering canister 1140 into the mixing canister 1101. After the filtering canister 1140 is emptied, the turntable 1104 rotates the mixing canister 1101 away so that the vertical lift conveyor 1102 can lower the filtering canister 1140 for the member 1106 to release it onto the turntable 1104. The turntable 1104 then rotates, to allow for the mixing canister 1101 to be engaged and raised by the member 1106 of the vertical lift conveyor 1102. With the mixing canister 1101 raised, the turntable 1104 rotates the filtering canister 1140 to be below the mixing canister 1101. A valve at the bottom of the mixing canister 1101 is opened to allow its content to fall into an opening of the filtering canister 1140 during the transfer from the mixing canister 1101 into the filtering canister 1140. This cycle then reiterated, as per the approach adopted by the robotic arm arrangement 104. The turntable 1104 rotates either clockwise or anti-clockwise when positioning one of the two canisters 1101, 1140 below the other.

Figure 12 is a perspective view of a beverage preparation station 1200 in accordance with another implementation. Similar to the beverage preparation station 100 of Figure 1, the beverage preparation station 1200 has a robotic arm arrangement 104, an ingredient station 106, a condiment

station 110, a collection counter 112, a washing station 114, a filter rack 1240. and a beverage storage 1242. As such, only the differences are briefly mentioned below.

In contrast to the beverage preparation station 100 of Figure 1, the beverage preparation station 1200 does not have a staging area 405 and uses the beverage storage 1242 to store filtered coffee and/or tea. In addition, the collection counter 112 does not use the swivelling mechanism shown in Figures 9A, 9B and 10. Rather, each of the collection zones of the collection counter 112 has a display that shows a queue number for the beverage that is being served. When a collection zone is detected to be available (such as after a cup is removed) and assigned to place a beverage that the robotic arm arrangement 104 is holding, the display will update to show the queue number for the upcoming beverage.

Each of the robotic arms 103 and 102 of the robotic arm arrangement 104 may be designated to be responsible for a particular phase of beverage preparation. The robotic arm 103 may be designated as a first robotic arm responsible for preparing the filtered beverage. As described in Figure 4, the first robotic arm interchanges between engaging the mixing canister 340 and the filtering canister 201 when effecting the transfer of the content between these two canisters 340 and 201. The robotic arm 102 may be designated as a second robotic arm responsible for engaging the cup into which the beverage made to taste from the filtered beverage is collected, as described in Figure 6. The designation of the first robotic arm or the second robotic arm for the robotic arm arrangement 104 may depend on the proximity of its robotic arms to the components of the beverage preparation station 100 that are used in each phase of the beverage preparation.

In the application, unless specified otherwise, the terms "comprising", "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

While this invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes can be made and equivalents may be substituted for elements thereof, without departing from the spirit and scope of the invention. In addition, modification may be made to adapt the teachings of the invention to particular situations and materials, without departing from the essential scope of the invention. Thus, the invention is not limited to the particular examples that are disclosed in this specification, but encompasses all embodiments falling within the scope of the appended claims.

CLAIMS

1. A coffee and/or tea preparation station comprising:
 - a robotic arm arrangement;
 - 5 a control unit to operate the robotic arm arrangement to prepare coffee and/or tea steeped from its base, wherein the control unit is configured to:
 - actuate the robotic arm arrangement to perform a motion sequence that effects transfer of content between a mixing canister and a filtering canister,
 - wherein the mixing canister initially contains the base, and
 - 10 wherein the filtering canister comprises a filter to separate the base received from the mixing canister during the transfer, so that the filtering canister contains filtered coffee and/or tea and the base trapped by the filter.
2. The coffee and/or tea preparation station of claim 1, wherein the robotic arm arrangement tilts
15 the mixing canister towards the filtering canister during the transfer from the mixing canister into the filtering canister, and tilts the filtering canister towards the mixing canister during the transfer from the filtering canister into the mixing canister.
3. The coffee and/or tea preparation station of claim 2, wherein during the transfer from the
20 mixing canister into the filtering canister, the motion sequence that the control unit configures the robotic arm arrangement to perform comprises tilting the mixing canister such that its spout is placed adjacent to an opening of the filtering canister.
4. The coffee and/or tea preparation station of claim 3, wherein the motion sequence further
25 comprises subsequently shifting the mixing canister such that its spout is further away from the opening of the filtering canister.
5. The coffee and/or tea preparation station of any one of the preceding claims, wherein during
the transfer between the mixing canister and the filtering canister, the motion sequence that
30 the control unit configures the robotic arm arrangement to perform comprises swirling the mixing canister.
6. The coffee and/or tea preparation station of any one of the preceding claims, wherein the
35 control unit is configured to reiterate the transfer and end with the filtering canister containing the filtered coffee and/or tea.

7. The coffee and/or tea preparation station of any one of the preceding claims, further comprising
an ingredient station to dispense the base and liquid to steep the base, wherein the control unit is further configured to:
- 5 actuate the robotic arm arrangement to position the mixing canister, when empty, at the ingredient station to collect the dispensed base and the dispensed liquid.
8. The coffee and/or tea preparation station of claim 7, wherein the control unit is further configured to cause the dispensed base and the dispensed liquid in the mixing canister to be stirred.
- 10
9. The coffee and/or tea preparation station of claim 8, wherein the control unit is further configured to actuate the robotic arm arrangement to stir the dispensed base and the dispensed liquid using a stirrer.
- 15
10. The coffee and/or tea preparation station of claim 8, further comprising
a vibrator to perform the stirring, on which the mixing canister is placed by the robotic arm arrangement under direction by the control unit, after collection of the dispensed base and the dispensed liquid.
- 20
11. The coffee and/or tea preparation station of any one of the preceding claims, wherein the control unit is further configured to actuate the robotic arm arrangement to replace the filter of the filtering canister.
- 25
12. The coffee and/or tea preparation station of claim 11, wherein the robotic arm arrangement introduces the filter before the filtering canister receives the content from the mixing canister and removes the filter after the coffee and/or tea is made.
- 30
13. The coffee and/or tea preparation station of claim 11 or 12, further comprising:
a filter rack from which the robotic arm arrangement obtains the filter, under direction by the control unit.
- 35
14. The coffee and/or tea preparation station of any one of the preceding claims, further comprising
a beverage storage into which the robotic arm arrangement empties the filtered coffee and/or tea from the filtering canister, under direction by the control unit.

15. The coffee and/or tea preparation station of claim 14, further comprising:
a condiment station to dispense condiments, wherein the control unit is further configured to actuate the robotic arm arrangement to position a cup at the condiment station to collect the dispensed condiments.
- 5
16. The coffee and/or tea preparation station of claim 15, wherein the control unit is further configured to actuate the robotic arm arrangement to position the cup at the beverage storage to collect the filtered coffee and/or tea.
- 10 17. The coffee and/or tea preparation station of claim 15 or 16, further comprising:
a user interface configured to receive input for a mix for the condiments and communicate the mix to the condiment station.
- 15 18. The coffee and/or tea preparation station of any one of the claims 15 to 17, wherein the condiment station is configured to receive a mix for the condiments from a remote computing device.
19. The coffee and/or tea preparation station of any one of the claims 15 to 18, further comprising:
a collection counter to which the robotic arm arrangement places the cup with the filtered coffee and/or tea and the dispensed condiments, under direction by the control unit.
- 20
20. The coffee and/or tea preparation station of claim 19, wherein the collection counter comprises one or more collection zones, wherein the control unit is configured to:
actuate the robotic arm arrangement to place the container at an assigned collection zone.
- 25
21. The coffee and/or tea preparation station of claim 20, wherein the collection counter further comprises at least one sensor to monitor availability of the one or more collection zones, from which the assigned collection zone is selected.
- 30
22. The coffee and/or tea preparation station of any one of the preceding claims, further comprising:
a washing station to which the robotic arm arrangement returns the filtering canister and the mixing canister after the coffee and/or tea is made, wherein the washing station is configured to rinse the returned filtering canister and mixing canister.
- 35

23. The coffee and/or tea preparation station of any one of the preceding claims, wherein the robotic arm arrangement comprises one robotic arm; the robotic arm interchanging between engaging the mixing canister and the filtering canister when effecting the transfer.

5 24. The coffee and/or tea preparation station of any one of the claims 1 to 22, wherein the robotic arm arrangement comprises:

a first robotic arm; and

a second robotic arm, wherein the first robotic arm engages the mixing canister while the second robotic arm engages the filtering canister when effecting the transfer.

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25. The coffee and/or tea preparation station of any one of the claims 15 to 22, wherein the robotic arm arrangement comprises

a first robotic arm responsible for preparing the filtered coffee and/or tea, the first robotic arm interchanging between engaging the mixing canister and the filtering canister when effecting the transfer; and

15

a second robotic arm responsible for engaging the cup into which the filtered coffee and/or tea is collected.