

DESCRIPTION

TITLE OF INVENTION: [AN AUTOMATED DINING ITEMSORTING SYSTEM]

TECHNICAL FIELD

[0001] The present disclosure relates generally to the field of automated tray returning system (ATRS), particularly for those ATRS to be used in public dining establishments.

BACKGROUND

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

[0003] In many public dining facilities, such as hawker centers, patrons are encouraged to return their used dining items, typically the used utensils and the trays carrying those utensils, to designated collection points. However, during peak dining hours, these collection points often reach capacity quickly, necessitating manual intervention by cleaning staff to clear the accumulated dining items and transport them to dishwashing areas. This manual process is not only time-consuming but also becomes less efficient during high-traffic periods. Furthermore, the presence of food remains on trays and utensils poses a significant hygiene risk, attracting pests including birds, insects, and rodents, thereby compounding the hygiene challenges within these environments.

[0004] While Automated Tray Returning Systems (ATRS) have been introduced to mitigate these issues, conventional ATRS frequently fall short in their ability to sort utensils of different types or effectively remove food remains. Consequently, the reliance on human labor remains, neither substantially reducing the workforce demand nor adequately addressing the hygiene concerns associated with residual food.

[0005] Even among ATRS that purport to include sorting capabilities, such as outlined in the Chinese patent CN208426068U “AUTOMATIC SORTING AND CLEANING

SYSTEM OF TABLEWARE,” reliance on multiple robotic arms for sorting necessitates significant investment and operational costs. Additionally, maintaining the precision required for sorting by these robotic arms presents ongoing challenges. Similarly, the US patent US10905307B2 “DISHWASHING SYSTEM AND ROBOT DEVICE” describes a system employing a robotic arm for repositioning dishes and tableware. Yet, it does not adequately detail the handling of large volumes of utensils, which vary in size and configuration and may bear substantial amounts of food remains. Inadequate removal of such food residues before the washing process can drastically impair both the efficiency and the quality of the cleaning operation.

[0006] Thus, there exists a need to develop an ATRS equipped with an automated dining item sorting capabilities that are both efficient and effective, alleviating, at least to some extent, some of the aforementioned technical problems.

SUMMARY

[0007] Specifically, to address the above-mentioned technical problems, the present invention specifically uses the following technical solutions:

[0008] Accordingly, in accordance with one aspect of the present invention, there is provided an automated dining item sorting system (ADSS) (100), comprising: a first conveying apparatus (101), comprising a first path (102) operable for dining item to move along; a first sorting station (103) configured to be on the first path (102); wherein the first sorting station (103) comprises a first handling apparatus (103a); a flipping apparatus (105) comprising an upper conveying unit (106), a lower conveying unit (107), a flipping path (108) and a guiding path (109); wherein the first handling apparatus (103a) is operable to move a first type utensil from the first conveying apparatus (101) onto the upper conveying unit (106); the upper conveying unit (106) comprises a plurality of gaps (110), wherein each of the plurality of gaps (110) is configured to have a gap size configured to be able to: retain the first type utensil (114) on the upper conveying unit (106); and, allow a second type utensil (115) carried with the first type utensil to drop off from the upper conveying unit (106) to a second conveying apparatus (201) through a guiding path (109); wherein the guiding path (109) is configured to connect the upper conveying unit (106) and the second conveying

apparatus (201); and, wherein the first type utensil (114) is operable to move from the upper conveying unit (106) to the lower conveying unit (107) through the flipping path (108); the flipping path (108) and a first edge (112) of the upper conveying unit (106) form an entry gap configured to allow the first type utensil (114) to flip off the first edge (112) onto the flipping path (108).

[0009] In some embodiments, the first handling apparatus (103a) is operable to be guided by a first image recognition apparatus configured to recognize the first type utensil.

[0010] In some embodiments, ADSS further comprises a waste collector (202) configured to be placed below the lower conveying unit (107), and the flipping path (108) is configured to extend towards above an opening of the waste collector (202).

[0011] In some embodiments, the first type utensil (114) is large utensil, and the second type utensil (115) is small utensil.

[0012] In some embodiments, the first type utensil (114) comprises plate, bowl, dish, tray, pot and pan.

[0013] In some embodiments, the second type utensil (115) comprises spoon, fork, chopstick, knife, saucers, and serving tong.

[0014] In some embodiments, the first handling apparatus is a six-axis robotic arm.

[0015] In some embodiments, first handling apparatus comprises a first clamping element (300) operable to grip the first type utensil.

[0016] In some embodiments, the clamping element (300) comprises a pair of L-shape clamping holders (301) operable to clamp and hold the first type utensils in-between.

[0017] In some embodiments, the clamping element (300) comprises a plurality of stabilizing elements (302) operable to exert a force to the first type utensil being clamped by the clamping element (300).

[0018] In some embodiments, ADSS further comprising a second sorting station (203) operable to identify and remove unauthorized item , wherein the second sorting

station (203) is located upstream of the first sorting station (103).

[0019] In some embodiments, the unauthorized item comprises non-utensil items, unauthorized utensil, and disposable utensil.

[0020] In some embodiments, the second sorting station (203) is configured to identify and remove halal-related dining item.

[0021] In some embodiments, the second sorting station is coupled with (i) a third image recognition apparatus configured to recognize the unauthorized item, and (ii) a fourth image recognition apparatus configured to recognize the halal-related dining item.

[0022] In some embodiments, the first sorting station (103) further comprises a second handling apparatus (103b) operable to move the second type utensil (115) onto the second conveying apparatus (201).

[0023] In some embodiments, the second handling apparatus (203) is operable to be guided by a second image recognition apparatus configured to recognize the second type utensil.

[0024] In some embodiments, the second handling apparatus is a four-axis robotic arm.

[0025] In some embodiments, second handling apparatus comprises a second clamping element (303) operable to grip the second type utensil.

[0026] In some embodiments, the flipping apparatus (105) comprises a brush apparatus (120) configured to be located above the upper conveying unit (106) and operable to brush the second type utensils off the first type utensils.

[0027] In some embodiments, the brush apparatus (120) comprises a overhead frame located above the upper conveying unit (106) and a plurality of metal chains hanging from the overhead frame.

[0028] In some embodiments, the waste collector (202) is configured to collect food remains that are flipped off the first type utensil (114) on the flipping path (108), and wherein the food remains slide along the flipping path (108) into the waste collector (202).

[0029] In some embodiments, the flipping path (108) is configured to comprise a belt with textured surface or rubber coating.

[0030] In some embodiments, the guiding path (109) is configured to be slide-like structure, guiding the second type utensil (115) that drops off from the upper conveying unit (106) to gradually fall onto the second conveying apparatus (201).

[0031] In some embodiments, the lower conveying unit (107) is configured to comprise a plurality of gaps configured to allow any food remains to pass through the lower conveying unit (107) and to further drop into the waste collector (202).

[0032] In some embodiments, the flipping path (108) and a second edge (113) of the lower conveying unit (107) form a disposal gap (117), configured to allow passage of the food remains but prevent entry of the first type utensil (114).

[0033] In some embodiments, the flipping path (108) comprises a guiding extension (118), configured to extend the flipping path (108) from the disposal gap (117) to a position towards below the lower conveying unit (107) and above the waste collector (202).

[0034] In some embodiments, the first sorting station (103) further comprises a sweeper apparatus (304) positioned downstream of the first handling apparatus (103a), and configured to sweep up the second type utensils together.

[0035] In some embodiments, the sweeper apparatus (304) comprises a pair of dynamic fence structures capable of moving back and forth, and is configured to move in from both the front and rear sides towards the second type utensils.

[0036] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] In the figures, which illustrate, by way of non-limiting examples only, embodiments of the present invention,

[0038] **[Fig. 1]:** illustrates a perspective view of the flipping apparatus (105)

according to various embodiments of the present invention.

[0039] [Fig. 2]: illustrates another perspective view of the flipping apparatus (105) according to various embodiments of the present invention.

[0040] [Fig. 3]: illustrates a top view of a flipping apparatus (105) according to various embodiments of the present invention.

[0041] [Fig. 4]: illustrates a back view of a flipping apparatus (105) according to various embodiments of the present invention.

[0042] [Fig. 5]: illustrates a side view of a flipping apparatus (105) according to various embodiments of the present invention.

[0043] [Fig. 6a]: provides a schematic diagram of a flipping apparatus (105) according to various embodiments of the present invention.

[0044] [Fig. 6b]: provides a schematic diagram of a flipping apparatus (105) according to various embodiments of the present invention.

[0045] [Fig. 7]: illustrates a top view of an automated dining item sorting system (100) according to various embodiments of the present invention.

[0046] [Fig. 8a]: illustrates a perspective view of an automated dining item sorting system (100) according to various embodiments of the present invention.

[0047] [Fig. 8b]: illustrates a perspective view of an automated dining item sorting system (100) according to various embodiments of the present invention.

[0048] [Fig. 9a]: illustrates a perspective view of a first handling apparatus (103a) according to various embodiments of the present invention.

[0049] [Fig. 9b]: illustrates a first clamping element (300) according to various embodiments of the present invention.

[0050] [Fig. 9c]: illustrates a perspective view of a second handling apparatus (103b) according to various embodiments of the present invention.

[0051] [Fig. 9d]: illustrates a perspective view of a second handling apparatus (103b) located at the first sorting station (103) according to various embodiments of the

present invention.

[0052] [Fig. 9e]: illustrates a perspective view of a sweeper apparatus (304) located at the first sorting station (103) according to various embodiments of the present invention.

[0053] [Fig. 9f]: illustrates a perspective view of a first sorting station (103) according to various embodiments of the present invention.

[0054] [Fig. 10]: illustrates, in block diagram, the workflow of an automated dining item sorting system (100) according to various embodiments of the present invention.

DETAILED DESCRIPTION

[0055] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0056] Furthermore, throughout the document, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0057] Furthermore, throughout the document, unless the context requires otherwise, the term “dining item” refer to any item utilized in dining establishments that need to be returned and cleaned after use, including, but not limited to, forks, spoons, knives, saucers, trays, bowls, plates, dishes, cutlery, glassware, as well as any other washable utensils, serving wares, tableware used during dining. Furthermore, through the document, unless the context requires otherwise, the term “unauthorized item” is used to denote any object that is not amenable to the automated washing and cleaning process defined herein. Within the scope of the present invention, the category of unauthorized items encompasses, but is not limited to: (1) non-utensil objects such as stones, bricks, plastic bags, used tissues, serviette and paper, as well as any other items that do not qualify as utensils or dining-related items, which may inadvertently be placed on trays; and (2) disposable dining items designed for single use, which are intended to be discarded rather than cleaned. In addition to the unauthorized items

defined above, some dining items, such as utensils designated for halal use (i.e., halal dining items) and utensils with special configurations and materials, require manual cleaning due to their specific requirements. As such, these dining items also need to be identified and separated from other suitable dining items before the latter are conveyed for autocleaning.

[0058] Unless defined otherwise, all other technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0059] According to various embodiments of the present invention, as illustrated in Fig 1 – Fig 8 (Fig 8a and 8b), there is provided an automated dining item sorting system (ADSS) (100) to be integrated into an ATRS, addressing the technical problems of the conventional ATRS that fails to have efficient sorting function. The ADSS comprises a first conveying apparatus (101) operable for the patrons to place their used dining items on, for example, the dining items typically comprises some used utensils (e.g., dish, bowl, plate, knives, spoons, chopsticks) and a tray carrying these used utensils. The first conveying apparatus (101) is configured to comprise a first path (102) operable for utensil to move along. In some embodiments, the first path (102) comprises a conveyor belt operable to efficiently collect used dining items directly from diners, facilitating their movement towards areas designated for dining item sorting and subsequent washing respectively. Furthermore, in some embodiments, the ADSS (100) is adaptable to incorporate multiple first conveying apparatuses (101). This arrangement increases the number of available return stations for the used dining items, offering greater convenience for patrons and streamlining the utensil return process.

[0060] First Sorting Station (103)

[0061] As illustrated in Fig 7 and Fig 8 (Fig 8a and 8b), the ADSS (100) comprises a first sorting station (103) situated on the first path (102). In some embodiments, the first sorting station (103) includes a first handling apparatus (103a) designed to transfer utensils, specifically larger utensils such as plates, bowls, dishes, trays, pots, and pans, from the first conveying apparatus (101) to the flipping apparatus (105). In other words, at the first sorting system, the first handling apparatus (103a) functions to separate the large utensils from the trays, and to further place it at the flipping apparatus (105) for processing.

[0062] In some embodiments, the first handling apparatus (103a) is guided by a first image recognition device (307a) () that is capable of recognizing various types of dining items, and could be further distinguished to categorize them into small and large utensils. In the context of the present, large utensils or also named as “first type utensils” are essential utensils used to hold and contain food, which are in general larger in size than those utensils used to pick and poke food (named as “second type utensils”).

This arrangement is important for properly and efficiently processing large utensils that are often more complex to handle and clean. For instance, large utensils may accidentally contain or carry smaller utensils (e.g., spoons inside a bowl, chopsticks stuck on the plates) with them, making it challenging to rely solely on image recognition and simple robotic arms for efficient separation. Therefore, rather than relying on advanced, high-tech robotic arms for the precise manipulation and segregation of larger utensils, the present invention employs a dual-phase separation approach. This involves initially utilizing a handling apparatus (e.g., robotic arm) to select and lift the larger utensils (constituting the first phase of separation) from the trays, followed by a subsequent flipping mechanism that further separating the large utensils from the small utensils (constituting the second phase of separation).

[0063] Additionally, when large and small utensils are washed together without prior sorting, they might not be cleaned as effectively since different sizes may require different washing mechanisms. Also, large utensils often carry significant quantities of food remains, necessitating thorough processing before being sent for washing. Thus, the dual-phase separation approach for the large utensils helps achieve the efficient removal of not just the small utensils but food remains as well. In some embodiments, the first sorting station (103) also includes a second handling apparatus (103b) configured to transfer smaller utensils (e.g., spoons, forks, chopsticks, knives, and serving tongs) to a second conveying apparatus (201), which is specifically configured to transport small utensils to the washing area. Typically, small utensils are dispersed, some resting openly on trays, easily detectable by imaging recognition systems, while others may be ensconced within larger utensils, rendering them less accessible to straightforward identification by such devices. To address this, in some embodiments, the second handling apparatus (103b) is adeptly designed to specifically target and retrieve small utensils situated openly on the trays. In some embodiments, the operation of the second handling apparatus (103b) is guided by a second image recognition

device (307b), designed to accurately identify and pinpoint the positions of small utensils. This device then precisely guides the second handling apparatus (103b) in targeting and retrieving the small utensils (referred to as second type utensils), ensuring high precision in their collection.

[0064] In some embodiments, as illustrated in Fig 9e and 9f, the first sorting station (103) is equipped with a sweeper apparatus (304) positioned downstream of the first handling apparatus (103a). After the first handling apparatus (103a) has relocated the large utensils (i.e., the first type utensils) to the flipping apparatus (105), small utensils, such as chopsticks, forks, and saucers, may remain scattered on the tray, especially near its edges, partly due to the movements of the first handling apparatus (103a). To address this, the sweeper apparatus (304), potentially designed as a pair of dynamic fence structures capable of moving back and forth, is configured to move in from both the front and rear sides towards the tray. This action sweeps the small utensils from the tray's periphery to its centre, thereby repositioning them for more efficient pickup by the second handling apparatus (103b). Essentially, the sweeper apparatus (304) ensures that the small utensils are centralized on the tray, thereby simplifying their detection and retrieval by the second handling apparatus (103b). This process is further refined by enhancing the accuracy of the image recognition device (307b), which guides the second clamping element (303) of the second handling apparatus (103b) to efficiently identify and capture the small utensils.

[0065] In summary, when the first handling apparatus (103a) and the second handling apparatus (103b) operate together, they can separate large from small utensils. Additionally, by transferring large utensils to the flipping apparatus (105) and small utensils to the second conveying apparatus (201), they also automate the separation of utensils from trays. This allows the trays to continue from the first path (102) on the first conveying apparatus (101) into a third conveying apparatus (206), wherein the third conveying apparatus (206) transports the trays (with utensils and unauthorized items removed) to the washing area with a cleaning program specifically designed for trays.

[0066] In some embodiments, the first handling apparatus (103a) and the second handling apparatus (103b) are robotic arms, adapted for handling different types of utensils. For instance, the first handling apparatus (103a) might be a six-axis robotic arm, offering greater flexibility in movement, thus efficiently handling large utensils

(114), which can be more challenging.

[0067] On the other hand, as illustrated in Fig 9c – 9f, the second handling apparatus (103b) could be a four-axis robotic arm, offering less flexibility but more suited for high-speed, repetitive tasks, such as transporting small utensils (115), including chopsticks, spoons, knives, and forks. More specifically, certain embodiments equip the second handling apparatus (103b) with multiple second clamping elements (303) (e.g., four, in some designs) arrayed around a central axis. These second clamping elements (303) are designed to securely grip smaller utensils, such as spoons, chopsticks, and knives, especially those resting openly on trays. Unlike the more complex clamping mechanism of the first clamping element (300) used by the first handling apparatus (103a), which is tailored for larger utensils, the second clamping elements (303) of the second handling apparatus (103b) could be made simpler in design. In some embodiments, each second clamping element (303) is configured to comprise two opposing plates. To engage small utensils, these plates can diverge, encircling the utensil before converging to ensure a firm grip. Given that the second handling apparatus (103b) may incorporate several of these second clamping elements (303), it is capable of transporting a greater volume of utensils in a single motion from the first conveying apparatus (101) to the second conveying apparatus (201). This multi-utensil transport capability significantly enhances the operational throughput of the second handling apparatus (103b) and, by extension, the overall efficiency of the sorting process at the first sorting station (103).

[0068] Together, at the first sorting station (103), these robotic arms work synergistically to separate large utensils (114), small utensils (115), and trays into different locations for further processing.

[0069] As shown in Fig 9a and 9b, some embodiments include robotic arms equipped with a first clamping element (300), designed to grip and hold utensils securely. The clamping element (300) may feature a pair of L-shaped clamping holders (301) that can move apart or together to accommodate and securely grasp the utensil, in particular the large ones. Once the large utensil is positioned between the L-shaped plates, the pair of the L-shaped clamping holders (301) can close together to firmly hold the utensil, enabling the robotic arm to move the utensil safely and stably from one location to another. Additionally, the first clamping element (300) may incorporate a plurality of stabilizing elements (302) (e.g., cylindrical rubber strips), which can be

inserted into the utensils gripped by the first clamping element (300) to apply pressure to restrict the movement of the utensils during transport by the robotic arms.

[0070] In some embodiments, these robotic arms are equipped with image recognition devices operable to identify the various types of utensils, and accordingly functions to guide the robotic arms to grip the specific utensils.

[0071] Second Sorting Station (203)

[0072] The ADSS (100) further includes a second sorting station (203) designed to identify and remove unauthorized items (including non-utensil items and unsuitable utensils) mixed with the utensils before their advancement towards automatic processing. The essential role of the second sorting station (203) is to perform an initial sorting of the used utensils placed on the first conveying apparatus (101). This happens before the first conveying apparatus (101) transfers the utensils to the first sorting station (103). At the second sorting station (203), utensils appropriate for automated sorting and cleaning are distinguished from those that are unsuitable for such processes (e.g., halal utensils) and non-utensil items mistakenly placed on the first conveying apparatus (101) as patrons return the trays to the ATRS.

[0073] In some embodiments, the second sorting station (203) integrates one or more third image recognition devices capable of differentiating non-utensil items from the reusable utensils that require cleaning. Items identified as non-utensils, which may include objects (e.g., stones, bricks, plastic bags) accidentally placed on the first conveying apparatus, are then expelled by an activated conveyor diverter (306) or a mechanical pusher (305) directly into a waste bin. This arrangement helps prevent the entry of non-utensil items, with their diverse configurations and properties, into the ADSS (100), thereby averting potential disruptions to its normal operations. For example, small stones and plastic bags introduced into the ADSS may become ensnared in mechanical components, leading to unforeseen disruptions and potential damage. The third image recognition device can employ various techniques for this purpose, leveraging the largely standardized shapes and sizes of conventional utensils to facilitate accurate and efficient recognition of non-utensil items.

[0074] In some embodiments, the third image recognition device is further configured to determine whether utensils are correctly positioned on a tray or a large dish. This

capability is critical for ensuring that small utensils, such as spoons, knives, and chopsticks, are securely placed on the tray or large dish before entering the ADSS. Without proper placement, there is a risk that these small dining items could slip through gaps within the ADSS's mechanical components, leading to unexpected disruptions and potential damage to the system.

[0075] In some embodiments, the third image recognition device situated at the second sorting station (203) is adeptly programmed to distinguish disposable utensils from their non-disposable counterparts. Upon identifying these disposable items, the system, for instance, activates a mechanical pusher (305). This mechanical pusher is specifically designed to expel the identified disposable utensils directly into a designated waste receptacle. To accomplish this, the third image recognition device can utilize a variety of recognition techniques, e.g., for example, by analysing the distinct visual properties inherent to materials commonly employed in the manufacture of disposable dining items, such as plastics and paper. Removing such disposable utensils not only reduces cleaning costs associated with processing unnecessary items but also mitigates the risk of system disruptions caused by materials, such as certain types of paper, that are unsuitable for washing. In some embodiments, a fourth image recognition device is situated at the second sorting station (203) to segregate halal from non-halal utensils. This can be effectively executed in settings like Singapore hawker centers, where trays designated for halal stalls may feature a unique color (e.g., green). Consequently, utensils found on these green trays are identified as halal utensils and are directed via a conveyor diverter (306) towards a separate conveying belt (e.g., halal conveyor belt) for manual processing. In some embodiments of the invention, the conveyor diverter (306) is a sorting pneumatic valve conveyor diverter.

[0076] In some embodiments, the third image recognition device and the fourth image recognition devices are separate devices, each operable to perform their designated tasks – distinguishing unauthorized item or halal dining items. However, in some other embodiments, the third image recognition device and the fourth image recognition device are the same image recognition device configured and operable to perform multiple functions.

[0077] In some embodiments, the second sorting station (203) simplifies the process by integrating a single-step image recognition system, as opposed to a two-

phase sorting approach that initially separates unauthorized items from dining items and subsequently sorts halal from non-halal items. This streamlined method employs image recognition to categorize approved dining items, including non-halal utensils that conform to standard configurations, apart from unauthorized items (such as non-utensil objects, utensils with non-standard configurations, and disposable items like plastic or paper cups) and halal utensils. Once these distinctions are made, the Automated Dining Service System (ADSS) (100) engages a mechanical pusher (305) to expel unauthorized items directly, while halal dining items are rerouted via a conveyor diverter (306) to a manual handling belt (205) for specialized processing.

[0078] The dining items deemed suitable for automatic processing, after passing through the second sorting station (203), are subsequently transported by the first conveying apparatus (101) to the first sorting station (103).

[0079] This setup enhances the efficiency of the handling apparatuses at the first sorting station (103) by allowing their image recognition systems to concentrate on identifying utensil types (e.g., large vs small utensils) without the complication of detecting non-utensil items. In essence, it simplifies the image recognition process at the first sorting station (103), leading to improved operational efficiency of the handling mechanisms, such as robotic arms.

[0080] In some embodiments, alternatives to the conveyor diverter (306) or mechanical pusher (305) are utilized to sort out unauthorized articles and halal utensils from among the dining items awaiting autocleaning. Specifically, robotic arms outfitted with clamping mechanisms are deployed to accurately identify and securely capture certain dining items, such as halal dining items, which are non-disposable and necessitate further cleaning. Once identified, these items are conveyed to the manual handling belt (205), where they undergo processing in a specially designated manual processing area.

[0081] Flipping Apparatus (105)

[0082] As illustrated in Fig 1 – Fig 6 according to various embodiments of the invention, the ADSS (100) comprises a flipping apparatus (105). The flipping apparatus (105) comprises an upper conveying unit (106), a lower conveying unit (107), a flipping path (108) (also known as flipping chute) and a guiding path (109) (also known as

inclined chute).

[0083] The upper conveying unit (106), situated above the lower conveying unit (107), features a flipping path (108) that extends from beneath a first edge (112) of the upper conveying unit to beneath a second edge (113) of the lower conveying unit. This path is designed to receive utensils from the upper conveying unit (106) and direct them to the lower conveying unit (107).

[0084] The upper conveying unit (106) is equipped to handle utensils delivered by the first handling apparatus (103a) on its upper surface. The upper conveying unit (106) comprises a plurality of gaps (110), each sized to retain larger utensils (e.g., plates, bowls, dishes, trays, pots, and pans), referred to as a first type of utensil (114), while allowing smaller utensils (e.g., spoons, forks, chopsticks, knives, saucers, and serving tongs), termed as a second type of utensil (115), to drop through to a second conveying apparatus (201) via the guiding path (109). This design ensures that while large utensils are captured and conveyed appropriately, smaller utensils can be separated efficiently due to the specifically configured gap sizes.

[0085] In some embodiments, the flipping apparatus (105) includes a brush apparatus (120) designed to engage and displace smaller utensils (i.e., second type utensils), such as spoons or forks, that are positioned or stacked on top of the larger utensils (i.e., first type utensils). In operation, as the upper conveying unit (106) progresses, it transports the larger utensils across the brush apparatus (120). The brush apparatus (120) is configured to dislodge the smaller utensils from their perched positions on the larger ones, ensuring their deposition onto the upper surface of the conveying unit (106). Given that the upper conveying unit (106) comprises gaps (110), these dislodged utensils are then allowed to descend through these gaps (110), effectively separating them from the conveyor's surface and facilitating their onward movement to the second conveying apparatus (201). In some embodiments, the brush apparatus (120) features an overhead frame positioned above the upper conveying unit (106), from which a multitude of metal chains are suspended. As the first type utensils (114) pass beneath the brush apparatus (120), these dangling metal chains serve to dislodge any smaller utensils that are perched atop the larger utensils (for instance, chopsticks resting on a bowl) ensuring they are deposited onto the upper conveying unit (106).

[0086] The guiding path (109) is positioned between the upper conveying unit (106) and the lower conveying unit (107), i.e., beneath the upper conveying unit (106) to receive small utensils (115) falling off from the upper conveying unit (106) through the plurality of gaps (110) on the upper conveying unit (106), and at the same time, above the lower conveying unit (107) so that the small utensils (115) are not allowed to fall onto the lower conveying unit (107). The guiding path (109) is configured to extend from beneath the upper conveying unit (106) to the second conveying apparatus (201) operable to direct the small utensils (115) to the designated washing area. In some embodiments, the guiding path (109) is configured to have a slide-like structure that allows the small utensils (115) falling onto the guiding path (109) to smoothly slide onto the second conveying apparatus (201).

[0087] As illustrated in Fig 6, the flipping path (108) and a first edge (112) of the upper conveying unit (106) form an entry gap (116). The large utensils (114) move on the upper conveying unit (106) towards its first edge (112) and then flip off the first edge (112) onto the flipping path (108). To achieve this, the entry gap (116) is configured to have a width sufficiently large for the large utensils to pass through. When the large utensils, such as bowls, plates, pots, and pans, flip off from the first edge (112) onto the flipping path (108), food remains carried by these large utensils will then be disposed of onto the flipping path (108). In other words, the flipping of the large utensils (114) facilitates the removal of food remains from these large utensils (114).

[0088] In some embodiments, as illustrated in Fig 6a, where the flipping path (108) is directly connected to the lower conveying unit (107), both the large utensils (114) and the food remains transition onto the lower conveying unit (107) together. The lower conveying unit (107) is outfitted with a series of gaps, designed such that their dimensions are inadequate for allowing the large utensils (114) to pass through, while adequately permitting the passage of food remains. As a result, when the food remains are conveyed onto the lower conveying unit (107), they proceed to fall through these gaps into the waste collector (202) situated beneath. Additionally, as the large utensils (114) are inverted upon the flipping path (108), any encapsulated food, sauces, and liquids are allowed to drip through the gaps present in the lower conveying unit (107) directly into the waste collector (202) located below.

[0089] In some embodiments, as illustrated in Fig 6b, the flipping path (108) and a

second edge (113) of the lower conveying unit (107) form a disposal gap (117), right before the first type utensils (114) move onto the lower conveying unit (107). This disposal gap (117) is configured to allow passage of the food remains but prevent entry of the first type utensil (114). For instance, the disposal gap (117) is dimensioned to be narrower than the average size of the first type utensils (114), ensuring that food remains detached from these utensils on the flipping path (108) can navigate through the disposal gap (117) into the waste collector (202). This design proves particularly beneficial during periods of high activity, such as peak dining hours, when a substantial influx of used dining items enters the ADSS. By facilitating the direct removal of food remains into the waste collector (202), the disposal gap (117) effectively reduces the burden on the lower conveying unit (107), minimizing the volume of food remains that need to be filtered through its gaps. Otherwise, the gaps on the lower conveying unit (107) could be obstructed with food remains, negatively impacting the efficiency of the ADSS.

[0090] As described above, the size of the disposal gap (117) is configured to be smaller than the dimensions of the typical large utensils (114), thus stopping the movement of the large utensils (114) along the flipping path (108) and instead directing the large utensils (114) to move onto the lower conveying unit (107). The lower conveying unit (107) then moves the large utensils (114) away from the second edge (113) of the lower conveying unit (107) and eventually onto the conveying belt (i.e., the fourth conveying apparatus (207)) specifically designed for bringing the large utensils (114) to the washing area.

[0091] In some embodiments, as illustrated in Fig 6b, the flipping path (108) includes a guiding extension (118), designed to extend the flipping path (108) from the disposal gap (117) to a location beneath the lower conveying unit (107) yet above the waste collector (202). This configuration effectively channels both food remains and possibly some smaller utensils directly into the waste collector (202), ensuring a clean and orderly transfer without the risk of spillage. In some embodiments, the waste collector (202) further comprises a filter element (119) configured to segregate food remains from any small utensils that accompany them. For instance, when food remains and a spoon that was lodged in a large bowl are flipped onto the flipping path (108) and subsequently fall into the waste collector (202), the filter element (119) provides additional technical benefits. This filter element (119) may be structured as a perforated plate, equipped

with numerous holes sized to permit the passage of food remains while retaining the spoon above. This design simplifies the retrieval of small utensils, facilitating their removal for manual processing and eliminating the need to manually sort through food remains within the waste collector (202) to extract them.

[0092] In some embodiments, the flipping path (108) is designed to include a belt with a textured surface or rubber coating to increase the friction of the belt, so that large utensils flipping onto the belt will move gradually along the flipping path (108). This feature helps to prevent clashes of utensils on the flipping path (108).

[0093] In some embodiments, the lower conveying unit (107) is configured to comprise a plurality of gaps specifically designed to allow any food remains carried by the large utensils to pass through these disposal gaps and drop directly into the waste collector (202). This arrangement further facilitates the removal of food remains from the large utensils, particularly because the large utensils on the lower conveying unit (107) are flipped with their openings facing downwards. Thus, large utensils (114) exiting the flipping apparatus (105) have their food remains significantly reduced, thereby enhancing the efficiency of washing these large utensils in the washing area. Finally, large utensils (114) with small utensils (115) and food remains removed are then transported by a fourth conveying apparatus (207) to the washing area.

[0094] Fig 7 and Fig 8 (Fig 8a and 8b) illustrate a specific embodiment of the ADSS, comprising two first conveying apparatuses (101), which allow patrons to return used dining items at two separate locations. This ADSS also comprises two second sorting stations (203), each outfitted with a fourth image recognition device (marked as number 1 circled in Fig 7) designed to differentiate between authorized dining items eligible for autocleaning and unauthorized items that are to be excluded from entering the ATRS. Additionally, the ADSS incorporates a third image recognition device (marked as number 2 circled in Fig 7), tasked with identifying dining items that are appropriate for autocleaning versus those that require manual handling due to their unsuitability for the automated process, such as halal dining items designated for manual cleaning.

[0095] Additionally, the system further incorporates a first image recognition device (307a) at the first sorting station (103) (see Fig 7 (circled number 2) and Fig 8b). The first image recognition device assists the first handling apparatus (103a), a six-axis robotic arm (Fig 9a), in picking up and moving large utensils. In this specific

embodiment as illustrated by Fig 7 and Fig 8a – 8b, the first image recognition device and the third image recognition device are integrated into a single image recognition device (307a).

[0096] Additionally, the system further incorporates a second image recognition device (307b) at the first sorting station (103) (see Fig 7 (circled number 3) and Fig 9f), which aids the second handling apparatus (103b), a four-axis robotic arm (Fig 9c), in capturing and moving smaller utensils.

[0097] Large utensils handled by the first handling apparatus (103a) are then transferred to the flipping apparatus (105) for additional processing, which includes the removal of any smaller utensils and food remains adhering to them. After processing, these large utensils are conveyed to the washing area via the fourth conveying apparatus (207), which is specifically designed to transport large utensils (114) to an area designated for washing such items.

[0098] Regarding the handling of small utensils (115), as illustrated in Fig 9c – 9f, a portion is directly transferred by the second handling apparatus (103b) to the second conveying apparatus (201), while others are dislodged from large utensils (114) by the flipping apparatus (105), specifically, those small utensils that had been stuck among the larger ones. The second conveying apparatus (201) is then operable to convey these small utensils to the washing area for thorough cleaning.

[0099] Regarding the handling of the trays, after the removal of unauthorized utensils, non-utensil items, and the separation of both large and small utensils, they are moved to the washing area for cleansing by the third conveying apparatus (206). This ensures that trays are also subject to a dedicated cleaning process.

[0100] In summary, as depicted in the embodiment shown in Fig 7 and Fig 8 (Fig 8a and 8b), the ADSS categorizes dining items into trays, small utensils, and large utensils for targeted washing processes. This stratification significantly enhances the system's cleaning efficiency and effectiveness by allowing the implementation of specialized washing programs. These programs are tailored to address the specific cleaning requirements of each category of dining item, utilizing the appropriate resources and techniques needed for optimal cleanliness.

It should be mentioned that although the separation of utensils from trays and the

subsequent sorting into large and small categories could theoretically be executed by advanced robotic mechanisms as proposed by some existing technologies, employing such sophisticated equipment for tasks like extracting spoons and chopsticks from bowls and plates is not economically viable. Furthermore, these high-tech robotic solutions often suffer from durability issues and necessitate meticulous maintenance, escalating operational costs and rendering them impractical for widespread use at public dining establishments. In contrast, the present invention introduces a cost-efficient system that intelligently integrates sorting mechanisms with relatively straightforward handling apparatuses and a two-tier flipping system. This present invention achieves, at least to some extent, efficient segregation of dining items and removal of food waste using relatively straightforward and robust mechanical components, which could be widely implemented and operated at public dining establishments such as hawker centres, food courts and food stalls.

[0101] Workflow of the ADSS

[0102] As illustrated in Fig 10, in operation, trays carrying utensils are placed onto the first conveying apparatus (101). Upon detecting the presence of trays by the ADSS (e.g., via a sensor), the first conveying apparatus (101) commences operation to move the trays along the first path (102) of the first conveying apparatus (101).

[0103] In some embodiments, the trays first passing through the second sorting station (203), which is coupled with one or more third image recognition devices (e.g., AI camera or any other types of digital camera with image recognition functionalities) operable to identify unauthorized items (such as non-utensil articles, disposable utensil articles). The unauthorized items, once identified by the cameras, are then removed from the utensils and moved away for manual handling or even direct disposal. In some embodiments, the second sorting station (203) is also equipped with image recognition devices to identify halal-related dining items, which, upon identification, could be directed towards the manual processing belt for manual handling.

[0104] The remaining utensils are then moved to the first sorting station (103), wherein the first handling apparatus (103a) and the second handling apparatus (103b) are activated to grip large and small utensils respectively. The first handling apparatus (103a) (e.g., a six-axis robotic arm) is triggered to identify (e.g., through an AI camera) and move the large utensils from the first path (102) onto the upper conveying unit (106).

After the operation of the first handling apparatus (103a), the remaining dining items (e.g., the small utensils) are then subjected to the operation of the sweeper apparatus (304). This apparatus consists of a pair of dynamic fence structures capable of moving back and forth and is configured to converge from both the front and rear sides towards the tray carrying the small utensils. The sweeper apparatus (304) then proceeds to sweep the scattered utensils on the tray towards the center of the tray, thus preparing these remaining utensils for recognition and pickup by the second handling apparatus (103b).

[0105] While the second handling apparatus (e.g., a four-axis robotic arm) is triggered to identify (e.g., through an AI camera) and move the small utensils from the first path (102) onto the second conveying apparatus (201).

[0106] Utensils placed by the first handling apparatus (103a) onto the upper conveying unit (106) is equipped with gaps that allow smaller utensils, such as spoons, chopsticks, and forks (115), to be segregated from the larger utensils. These smaller utensils then descend through the gaps onto a guiding path (109), facilitating the movement of the small utensils gradually and smoothly onto the second conveying apparatus (201). Thus, the second conveying apparatus (201) gathers the small utensils from both the second handling apparatus (103b) and the flipping apparatus (105), and transports these small utensils to the washing area (e.g., a Central Dishwashing Unit).

[0107] Subsequent to the sorting of small utensils, the remaining larger utensils, such as bowls and plates, are transitioned from the upper conveying unit (106) into the flipping path (108) (also known as flipping chute) by the rotation of the upper conveying unit. When the large utensils (114) move onto the flipping path (108), the large utensils (114) are reoriented and flipped onto the flipping path (108). Any food remains carried by these large utensils (114) are then dislodged from the large utensils, dropped onto the flipping path (108), and moved along the flipping path (108) into the waste collector (202).

[0108] The process continues as the lower conveying unit then guides these large utensils onto another conveyor specifically designed for the handling of larger utensils, propelling them towards the washing area (e.g., CDW) for thorough washing. This systematic approach ensures the efficient separation, sorting, and cleaning of utensils, highlighting the ADSS's capability to streamline the operation of ATRS. Clear to any

skilled person, while the present invention is of particular application in public dining establishments, the present invention can also be implemented and utilized in private or even household dining establishments with sufficient space.

It should be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the invention. As would be understood by a person skilled in the art, each embodiment may be used in combination with other embodiment or several embodiments. For instance, in certain embodiments, the functionality of the first image recognition device may be amalgamated with that of the third or fourth image recognition devices into a singular unit capable of executing multiple tasks. Specifically, while the third and fourth image recognition devices are tasked with identifying unauthorized items and halal dining items, they can concurrently detect the presence, configurations, and sizes of large utensils. This collected information can be utilized to inform and direct the operations of the first handling apparatus (103a), effectively allowing it to serve the role of the first image recognition device. Moreover, even in configurations where multiple image recognition devices remain distinct, establishing data communication between them enables the sharing of identification results (such as the detection of large and small utensils) from devices positioned upstream to those downstream within the ADSS, thereby enhancing the system's overall operational efficiency. Moreover, the placement of image recognition devices can be flexibly adjusted and tailored to meet the specific requirements of the ADSS and ATRS implementation, provided that the image recognition devices can effectively capture and recognize the images of the dining items.

REFERENCE

100 automated dining item sorting system

101 first conveying apparatus

102 first path

103 first sorting station

103a first handling apparatus

103b second handling apparatus

105 flipping apparatus

106 upper conveying unit

107 lower conveying unit

108 flipping path
109 guiding path
110 plurality of gaps
112 first edge
113 second edge
114 first type utensil
115 second type utensil
116 entry gap
117 disposal gap
118 guiding extension
119 filter element
120 brush apparatus
201 second conveying apparatus
202 waste collector
203 second sorting station
205 manual processing belt
206 third conveying apparatus
207 fourth conveying apparatus
300 first clamping element
301 L clamping holder
302 stabilizing element
303 second clamping element
304 sweeper apparatus
305 pusher
306 conveyor diverter
307a first image recognition device
307b second image recognition device

Claims

Claim 1. An automated dining item sorting system (100), comprising:

a first conveying apparatus (101), comprising a first path (102) operable for dining item to move along;

a first sorting station (103) configured to be on the first path (102); wherein the first sorting station (103) comprises a first handling apparatus (103a);

a flipping apparatus (105) comprising an upper conveying unit (106), a lower conveying unit (107), a flipping path (108) and a guiding path (109);

wherein the first handling apparatus (103a) is operable to move a first type utensil from the first conveying apparatus (101) onto the upper conveying unit (106); the upper conveying unit (106) comprises a plurality of gaps (110), wherein each of the plurality of gaps (110) is configured to have a gap size configured to be able to:

retain the first type utensil (114) on the upper conveying unit (106); and,

allow a second type utensil (115) carried with the first type utensil to drop off from the upper conveying unit (106) to a second conveying apparatus (201) through a guiding path (109); wherein the guiding path (109) is configured to connect the upper conveying unit (106) and the second conveying apparatus (201); and,

wherein the first type utensil (114) is operable to move from the upper conveying unit (106) to the lower conveying unit (107) through the flipping path (108);

the flipping path (108) and a first edge (112) of the upper conveying unit (106) form an entry gap configured to allow the first type utensil (114) to flip off the first edge (112) onto the flipping path (108).

Claim 2. The automated dining item sorting system according to Claim 1, wherein the first handling apparatus (103a) is operable to be guided by a first image recognition apparatus configured to recognize the first type utensil.

Claim 3. The automated dining item sorting system according to Claim 1 or Claim 2, wherein further comprising a waste collector (202) configured to be placed below the lower conveying unit (107), and the flipping path (108) is configured to extend towards above an opening of the waste collector (202).

Claim 4. The automated dining item sorting system according to any one of the preceding claims, wherein the first type utensil (114) is large utensil, and the second type utensil (115) is small utensil.

Claim 5. The automated dining item sorting system according to any one of the preceding claims, wherein the first type utensil (114) comprises plate, bowl, dish, tray, pot and pan.

Claim 6. The automated dining item sorting system according to any one of the preceding claims, wherein the second type utensil (115) comprises spoon, fork, chopstick, knife, saucers, and serving tong.

Claim 7. The automated dining item sorting system according to any one of the preceding claims, wherein the first handling apparatus is a six-axis robotic arm.

Claim 8. The automated dining item sorting system according to any one of preceding claims, wherein first handling apparatus comprises a first clamping element (300) operable to grip the first type utensil.

Claim 9. The automated dining item sorting system according to Claim 8, wherein the clamping element (300) comprises a pair of L-shape clamping holders (301) operable to clamp and hold the first type utensils in-between.

Claim 10. The automated dining item sorting system according to Claim 8 or Claim 9, wherein the clamping element (300) comprises a plurality of stabilizing elements (302) operable to exert a force to the first type utensil being clamped by the clamping element (300).

Claim 11. The automated dining item sorting system according to any one of the preceding claims, wherein further comprising a second sorting station (203) operable to identify and remove unauthorized item , wherein the second sorting station (203) is located upstream of the first sorting station (103).

Claim 12. The automated dining item sorting system according to Claim 11, wherein the unauthorized item comprises non-utensil items, unauthorized utensil, and disposable utensil.

Claim 13. The automated dining item sorting system according to Claim 11 or Claim 12, wherein the second sorting station (203) is configured to identify and remove halal-related dining item.

Claim 14. The automated dining item sorting system according to any one of Claims 11 – 13, wherein the second sorting station is coupled with (i) a third image recognition apparatus configured to recognize the unauthorized item, and (ii) a fourth image recognition apparatus configured to recognize the halal-related dining item.

Claim 15. The automated dining item sorting system according to any one of the preceding claims, wherein the first sorting station (103) further comprises a second handling apparatus (103b) operable to move the second type utensil (115) onto the second conveying apparatus (201).

Claim 16. The automated dining item sorting system according to Claim 15, wherein the second handling apparatus (203) is operable to be guided by a second image recognition apparatus configured to recognize the second type utensil.

Claim 17. The automated dining item sorting system according to Claim 15 or Claim 16, wherein the second handling apparatus is a four-axis robotic arm.

Claim 18. The automated dining item sorting system according to any one of Claims 15 – 17, wherein second handling apparatus comprises a second clamping element (303) operable to grip the second type utensil.

Claim 18. The automated dining item sorting system according to any one of the preceding claims, where the flipping apparatus (105) comprises a brush apparatus (120) configured to be located above the upper conveying unit (106) and operable to brush the second type utensils off the first type utensils.

Claim 19. The automated dining item sorting system according to Claim 18, wherein the brush apparatus (120) comprises a overhead frame located above the upper conveying unit (106) and a plurality of metal chains hanging from the overhead frame.

Claim 20. The automated dining item sorting system according to Claim 2, wherein the waste collector (202) is configured to collect food remains that are flipped off the first type utensil (114) on the flipping path (108), and wherein the food remains slide along the flipping path (108) into the waste collector (202).

Claim 21. The automated dining item sorting system according to any one of preceding claims, wherein the flipping path (108) is configured to comprise a belt with textured surface or rubber coating.

Claim 22. The automated dining item sorting system according to any one of preceding claims, wherein the guiding path (109) is configured to be slide-like structure, guiding the second type utensil (115) that drops off from the upper conveying unit (106) to gradually fall onto the second conveying apparatus (201).

Claim 23. The automated dining item sorting system according to anyone of the preceding claims, wherein the lower conveying unit (107) is configured to comprise a plurality of gaps configured to allow any food remains to pass through the lower conveying unit (107) and to further drop into the waste collector (202).

Claim 24. The automated dining item sorting system according to anyone of the preceding claims, wherein the flipping path (108) and a second edge (113) of the lower conveying unit (107) form a disposal gap (117), configured to allow passage of the food remains but prevent entry of the first type utensil (114).

Claim 25. The automated dining item sorting system according to Claim 22, wherein the flipping path (108) comprises a guiding extension (118), configured to extend the flipping path (108) from the disposal gap (117) to a position towards below the lower conveying unit (107) and above the waste collector (202).

Claim 26. The automated dining item sorting system according to anyone of the preceding claims, wherein the first sorting station (103) further comprises a sweeper apparatus (304) positioned downstream of the first handling apparatus (103a), and configured to sweep up the second type utensils together.

Claim 27. The automated dining item sorting system according to Claim 26, wherein the sweeper apparatus (304) comprises a pair of dynamic fence structures capable of moving back and forth, and is configured to move in from both the front and rear sides towards the second type utensils.