CLAIMS

What is claimed is:

1. A system for automatic kitting of items comprising:

a robotic device comprising an arm with a robotic gripper at one end;

a first imaging device focused on a device conveying kitted items;

a computing device coupled to the first imaging device and configured to process image data from the first imaging device, wherein the computing device includes item arrangement verification software configured to determine whether each item desired to be in the kitted items is present or absent in the kitted items in response to the processed image data from the first imaging device and generates data based on whether an item desired to be in the kitted items is absent from the kitted items; and

a controller coupled to the computing device to receive the data from the computer representing whether an item desired to be in the kitted items is absent from the kitted items, the controller further coupled to the robotic device for providing instructions to the robotic device to control movement of the arm and the robotic gripper, wherein at least some of the instructions provided to the robotic device are generated in response to the item desired to be in the kitted items being absent from the kitted items.

2. The system in accordance with Claim 1 wherein the at least some of the instructions provided to the robotic device by the controller comprise one or more instructions to pick an item corresponding to the item desired to be in the kitted items which is absent from the kitted items and place the picked item into the kitted items.

3. The system in accordance with Claim 1 or Claim 2 wherein the computing device further includes object detection software configured to determine a type of each item in the kitted items and a position of that item in the kitted items in response to the processed image data from the first imaging device, and wherein the object detection software provides the type and position of each item present in the kitted items to the item arrangement verification software to determine whether each item desired to be in the kitted items is absent from the kitted items.

4. The system in accordance with Claim 3 wherein the item arrangement verification software is further configured to flag the kitted items for manual postprocessing in response to determining that an item in the kitted items is not positioned correctly.

5. The system in accordance with any of the preceding claims wherein the system is a meal assembly system for automatic kitting of food items.

6. The system in accordance with any of the preceding claims further comprising a second imaging device coupled to the computing device and focused on a device conveying items to be kitted.

7. The system in accordance with Claim 6 wherein the items on the device conveying items to be kitted are conveyed in trays, and wherein the second imaging device comprises depth sensing capability to enable the robotic gripper and arm to pick an item from the trays.

8. The system in accordance with Claim 6 or Claim 7 wherein the computing device is further configured to generate image data corresponding to predefined poses related to a type of item in response to a plurality of backgrounds and a plurality of poses of the item.

9. The system in accordance with Claim 8 wherein the computing device is further configured to determine whether each item to be kitted is posed in accordance with one of the predefined poses corresponding to a location and a type of the item based on the type and the location received from the second imaging device.

10. The system in accordance with Claim 9 wherein the computing device is configured to determine whether each item in the kitted items is posed in accordance with one of the predefined poses based on a small bounding box related to the location and the type of the item.

11. The system in accordance with Claim 10 wherein the computing system is further configured to determine the small bounding box related to the location and the type of the item based on an original bounding box defined by a correct pose of the type of the item at the location which has been shrunk based on an adjustable tolerance factor.

12. The system in accordance with Claim 11 wherein the generated image data further comprises labelled data, the labelled data comprising a range of orientation (ROO) for providing a rough direction to enable fast determination whether each item in items to be kitted is posed in accordance with the predefined pose corresponding to the item to be kitted.

13. The system in accordance with Claim 12 wherein the labelled data further comprises center point information and width and length information.

14. The system in accordance with Claim 12 or Claim 13 wherein the object detection software is configured to determine the type of each item in the kitted items and the position of that item in the kitted items by building a convolutional neural network (CNN) object detector model to classify the items in response to the processed image data from the second imaging device.

15. The system in accordance with Claim 14 wherein the object detection software is further configured to determine the pose of the item in the device conveying the items to be kitted in response to category and bounding box information and range of orientation (ROO) information received from the classification by the CNN object detector model.

16. The system in accordance with Claim 15 wherein the pose is a six-dimensional (6D) pose, and wherein the object detection software is configured to determine the 6D pose of the item in the kitted items further in response to depth map information.

17. A robotic method for automatic kitting of items comprising:

imaging kitted items to generate first image data;

determining whether each item desired to be in the kitted items is present or absent in the kitted items in response to the first image data;

generating data based on whether an item desired to be in the kitted items is absent from the kitted items;

generating robotic control instructions in response to the item desired to be in the kitted items being absent from the kitted items; and

providing the robotic control instructions to a robotic device to control movement of an arm and a robotic gripper of the robotic device, wherein the robotic control instructions comprise one or more instructions to pick an item corresponding to the item desired to be in the kitted items which is absent from the kitted items and place the picked item into the kitted items.

18. The method in accordance with Claim 17 wherein determining whether each item desired to be in the kitted items is present or absent in the kitted items comprises determining a type of each item in the kitted items and a position of that item in the kitted items in response to the first image data, and

wherein generating data based on whether an item desired to be in the kitted items is absent from the kitted items comprises generating data based on whether an item desired to be in the kitted items is absent from the kitted items in response to the type and the position of each item present in the first image data.

19. The method in accordance with Claim 18 further comprising flagging the kitted items for manual postprocessing in response to determining that an item in the kitted items is not positioned correctly.

20. A computer readable medium comprising instructions for automatic kitting of items in a robotic system, the instructions causing a controller in the robotic system to:

image kitted items to generate first image data;

determine whether each item desired to be in the kitted items is present or absent in the kitted items in response to the first image data;

generate data based on whether an item desired to be in the kitted items is absent from the kitted items;

generate robotic control instructions in response to the item desired to be in the kitted items being absent from the kitted items; and

provide the robotic control instructions to a robotic device to control movement of an arm and a robotic gripper of the robotic device, wherein the robotic control instructions comprise one or more instructions to pick an item corresponding to the item desired to be in the kitted items which is absent from the kitted items and place the picked item into the kitted items.