CLAIMS

What is claimed is:

1. A system for pick-and-place calibration of a machine assembly comprising multiple modules of pick-and-place machines, the system comprising:

a universal teach apparatus for teaching pick-and-place positions and coupleable to a pick head of each of the multiple modules of pick-and-place machines, the universal teach apparatus comprising imaging means for capturing images, the captured images comprising defined markings on one or more products to be picked by each pick-and-place machine and/or trays for holding the products to be picked, wherein the defined markings comprise fiducial markings;

a computing means coupled to the universal teach apparatus for receiving the captured images and configured to generate, for each of the multiple modules of pick-and-place machines,

one or more virtual parameters from the captured images, the one or more virtual parameters corresponding at least to a center of the one or more products and/or trays and a size and/or shape of the one or more products and/or trays, and

a virtual product outline based on the one or more virtual parameters;

wherein the computing means is further configured to link the multiple modules together to calibrate the pick-and-place machines of the multiple modules of pick-and-place machines to resolve stack up tolerances in the multiple modules of pick-and-place machines by overlapping the virtual product outlines generated for each of the multiple modules of pick-and-place machines.

2. The system of claim 1, further comprising:

motor control means coupled to the computing means, the pick head of each of the multiple modules of pick-and-place machines, and the universal teach apparatus and configured to move the pick head under control of the computing means and/or the universal teach apparatus,

wherein during a process of teaching pick-and-place positions, the computing means is

configured to adjust a pick head position of the pick head of each of the multiple modules of pick-and-place machines via the motor control means based on alignment of a center of the pick head with at least one virtual image corresponding to one or more parameters of the captured images, generated by the computer means, and

is further configured to record a plurality of coordinate parameters corresponding to position data of the motor control means when the center of the pick head fully and accurately aligns with the at least one virtual image.

3. The system in accordance with Claim 2, wherein the at least one virtual image corresponding to the one or more parameters of the captured images that the computing means generates are selected from a group of virtual images comprising a virtual product outline of one or more products to be picked, a virtual center of the one or more products, a virtual center point of one or more trays configured to hold the one or more products to be picked, a virtual line, a virtual midpoint, and a virtual boundary.

4. The system in accordance with Claim 2 or Claim 3, wherein the one or more parameters of the captured images are selected from a group of parameters comprising

a fiducial mark on the one or more trays, a fiducial mark on a device on the one or more trays, and an outline of the device on the one or more trays.

5. The system in accordance with Claim 4, wherein the fiducial mark on the one or more trays and/or the fiducial mark on the device on the one or more trays comprises a five-point fiducial mark square-shaped design comprising one mark at a center point of the five-point fiducial mark square-shaped design and four points at each corner of the five-point fiducial mark square-shaped design.

6. The system in accordance with any of Claims 2 to 5, wherein each of the plurality of coordinates which the computing means is configured to record are selected from a group of coordinates comprising an x-axis coordinate, a y-axis coordinate, a z-axis coordinate and a rotation coordinate.

7. A method to resolve stack up tolerances in a machine assembly comprising a pick-and-place machine and using a universal teach apparatus including an image capturing device, the method comprising:

mounting the universal teach apparatus to a pick head of the pick-and-place machine;

using the image capturing device of the universal teach apparatus to capture images of defined markings on one or more products to be picked by the pick-and-place machine and/or trays for holding the products to be picked, wherein the defined markings comprise fiducial markings;

generating one or more virtual parameters from the captured images, the one or more virtual parameters corresponding at least to a center of the one or more

products and/or trays and a size and/or shape of the one or more products and/or trays;

generating a virtual product outline based on the one or more virtual parameters; and

calibrating the pick-and-place machine in response to the virtual product outline to resolve stack up tolerances of a pick-and-place operation of the pick-and-place machine;

wherein the machine assembly comprises multiple modules of pick-and-place machines, and wherein the steps of mounting the universal teach apparatus, using the image capturing device of the universal teach apparatus to capture the images of the defined markings, generating the one or more virtual parameters from the captured images, and generating the virtual product outline are performed for each of the multiple modules of pick-and-place machines, and wherein the step of calibrating the pick-and-place machine in response to the virtual product outline to resolve stack up tolerances comprises linking the multiple modules together to calibrate the pick-and-place machines of the multiple modules of pick-and-place machines to resolve stack up tolerances in the multiple modules of pick-and-place machines by overlapping the virtual product outlines generated for each of the multiple modules of pick-and-place machines.

8. The method in accordance with Claim 7, wherein the step of mounting the universal teach apparatus to the pick head of the pick-and-place machine comprises calibrating the universal teach apparatus to have a vision center of the universal teach apparatus aligned with a center of the pick head of the pick-and-place machine.