Claims

1. A computer-implemented method comprising:

~~Identifying~~identifying, within an environment, a robotic device and a calibration fixture in a vicinity of the robotic device;

~~Referencing~~ referencing the calibration fixture to a predetermined portion of the robotic device to determine a first pose of the robotic device relative to the calibration fixture;

~~Receiving~~receiving, from a sensor, a 3D image of the environment wherein the 3D image includes the calibration fixture;

~~Determining~~determining, based on the 3D image, a second pose of the calibration fixture relative to the sensor;

~~Determining~~ determining a third pose of the robotic device relative to the sensor based on the first pose and the second pose;

~~Receiving~~ receiving a plurality of trajectory points from a display interface or a device interface;

~~Determining~~ determining a plurality of virtual trajectory points corresponding to the plurality of trajectory points based on the 3D image and the third pose, wherein the method further comprises:

receiving a 2D image of the environment;

providing for display of the 2D image of the environment overlaid with the virtual trajectory points;

providing for display of the 2D image of the environment superimposed with the 3D image received from the sensor, wherein the 3D image being superimposed on the 2D image of the environment can appear visible or invisible on the display interface;

in response to changes in orientation of the display device, updating the display to show at least a portion of the 2D image superimposed with 3D image from a corresponding point of view.

2. The method according to claim 1, wherein the determining of a second pose of calibration fixture relative to the sensor is based on recognizing 3-dimensional feature of the calibration fixture in the 3D image.

3. The method according to one of claims 1 or 2, further comprising:

~~Providing~~ providing for display of an overlaid virtual representation of a trajectory for the robotic device, wherein the trajectory comprises a sequence of at least some of the plurality of trajectory points.

4. The method according to ~~one of claims 1 to 3~~claim 3, further comprising:

~~Generating~~ generating and displaying a graphical representation of a trajectory orientation in one or a plurality of the virtual trajectory points;

~~Generating~~ generating and displaying a graphical representation of a tool performing a process along the trajectory.

5. The method according to one of claims 1 to 4, further comprising:

~~Receiving~~receiving, from the display interface, input data indicating one or more adjustments to one or more properties of one or more of the plurality of ~~the~~ virtual trajectory points, the properties being one or more selected from the group consisting of a trajectory position, a trajectory orientation, an end-effector state, a trajectory speed, an electronic signal input and an electronic signal output;

~~Receiving~~receiving, from the display interface, input data to create, duplicate or delete one or more of the virtual trajectory points;

~~Determining~~determining, based on the received input data on the display interface, one or more adjusted properties of one or more of the trajectory points that correspond to the one or more of the plurality of virtual trajectory points.

6. The method according to one of claims 1 to 5, further comprising:

~~Receiving~~receiving, from the display interface or the device interface, input data that provides instructions for the robotic device to move in accordance to one or more of the trajectory points or virtual trajectory points and their respective properties;

~~Transmitting~~ transmitting the aforementioned instructions to the robotic device.

7. The method according to claim 6, wherein transmitting the aforementioned instructions to the robotic device includes:

~~Translating~~ translating the virtual trajectory points to physical trajectory points and sending the physical trajectory points to the robotic device.

8. The method according to one of claims 1 to 7, further comprising:

~~Providing~~ providing the display interface for manipulating the virtual trajectory points;

~~Receiving~~receiving, from the display interface, input data indicating creation of and/or adjustment to a two-dimensional trajectory pattern that comprises the plurality of virtual trajectory points arranged in a specified pattern;

~~Based~~ based on the trajectory pattern created or adjusted, converting the two-dimensional trajectory pattern into a three-dimensional trajectory pattern on the display interface; Receiving, from the display interface, input data to translate and/or rotate the three-dimensional trajectory pattern on the display interface;

~~Receiving~~receiving, from the display interface, input data to project the three-dimensional trajectory pattern onto a portion of the 3D image shown on the display interface.

9. The method according to one of claims 1 to 8, wherein the trajectory points are in the form of user entry via the display interface or in the form of robotic scripts via the device interface.

10. The method according to one of claims 1 to 9, further comprising:

~~Interpolating~~ interpolating or extrapolating, based on the 3D image, one or a plurality of trajectory points along a surface of an object and an environment.

11. The method according to one of claims 1 to10, further comprising:

~~Transmitting~~ transmitting robot information such as robot joint angles, robot status and an end-effector state from the robotic device to a mobile device, a laptop or desktop computer;

~~Generating~~ generating and displaying the received robot information on a virtual robot that is overlaid onto a representation of the real robotic device on the display interface.

~~12. The method according to one of claims 1 to 11, further comprising:~~

~~Receiving a 2D image of the environment;~~

~~Providing for display of the 2D image of the environment overlaid with the virtual trajectory points.~~

~~13. The method according to claim 12, further comprising:~~

~~Providing for display of the 2D image of the environment superimposed with the 3D image received from the sensor, wherein the 3D image being superimposed on the 2D image of the environment can appear visible or invisible on the display interface;~~

~~In response to changes in orientation of the display device, updating the display to show at least a portion of the 2D image superimposed with 3D image from a corresponding point of view.~~

~~14~~12. A system for programming a robotic device, the system comprising:

~~A~~ a sensor; and

~~A~~ a computing system communicably coupled to the sensor and configured to:

~~Identify~~identify, within an environment, a robotic device and a calibration fixture in a vicinity of the robotic device;

~~Reference~~ reference the calibration fixture to a predetermined portion of the robotic device to determine a first pose of the robotic device relative to the calibration fixture;

~~Receive~~receive, from the sensor, a 3D image of the environment wherein the 3D image includes the calibration fixture; Determine, based on the 3D image, a second pose of the calibration fixture relative to the sensor;

~~Determine~~ determine a third pose of the robotic device relative to the sensor based on the first pose and the second pose;

~~Receive~~ receive a plurality of trajectory points from a display interface or a device interface;

~~Determine~~ determine a plurality of virtual trajectory points corresponding to the plurality of trajectory points based on the 3D image and the third pose, wherein the computing system is further configured to:

receive a 2D image of the environment;

provide for display of the 2D image of the environment overlaid with the virtual trajectory points;

provide for display of the 2D image of the environment superimposed with the 3D image received from the sensor, wherein the 3D image being superimposed on the 2D image of the environment can appear visible or invisible on the display interface;

in response to changes in orientation of the display device, update the display to show at least a portion of the 2D image superimposed with 3D image from a corresponding point of view.

~~15~~13. The system according to claim ~~14~~12, wherein the computing system is further configured to:

~~Determine~~determine, based on recognition of 3D features of the calibration fixture in the 3D image, the second pose of the calibration fixture relative to the sensor.

~~16~~14. The system according to one of claims ~~14~~ 12 to ~~15~~13, wherein the computing system is further configured to:

~~Provide~~ provide the display interface to adjust one or more properties of one or more of the plurality of virtual trajectory points, the properties being one or more selected from the group consisting of a trajectory position, a trajectory orientation, an end-effector state, a trajectory speed, an electronic signal input and an electronic signal output;

~~Provide~~ provide the said display interface to create, duplicate or delete the virtual trajectory points;

~~Determine~~ determine one or more adjusted properties of one or more of the trajectory points that correspond to the one or more of the plurality of virtual trajectory points.

~~17~~15. The system according to one of claims ~~14~~12 to ~~16~~14, wherein the computing system is further configured to:

~~Generate~~ generate and display a graphical representation of a trajectory orientation in one or a plurality of the virtual trajectory points; and

~~Generate~~ generate and display a graphical representation of a tool performing a process along ~~the~~ a trajectory comprising a sequence of at least some of the plurality of trajectory points.

~~18~~16. The system according to one of claims ~~14~~12 to ~~17~~15, wherein the computing system is further configured to:

~~Providing~~ provide the display interface for manipulating the virtual trajectory points;

~~Receiving~~receive, from the display interface, input data indicating creation of and/or adjustment to a two-dimensional trajectory pattern that comprises the plurality of virtual trajectory points arranged in a specified pattern;

~~Based~~ based on the trajectory pattern created or adjusted, ~~converting~~ convert the two-dimensional trajectory pattern into a three-dimensional trajectory pattern on the display interface;

~~Receiving~~receive, from the display interface, input data to translate and/or rotate the three-dimensional trajectory pattern on the display interface;

~~Receiving~~receive, from the display interface, input data to project the three-dimensional trajectory pattern onto a portion of the 3D image shown on the display interface.

~~19~~17. The system according to one of claims ~~14~~12 to ~~18~~16, ~~further comprising:~~wherein the computing system is further configured to:

~~Receiving~~receive, from the display interface or the device interface, input data that provides instructions for the robotic device to move in accordance to one

or more of the trajectory points or virtual trajectory points and their respective properties;

~~Transmitting~~ transmit the aforementioned instructions to the robotic device, including translating the virtual trajectory points to physical trajectory points and sending the physical trajectory points to the robotic device.

~~20~~18. A non-transitory computer-readable medium having stored therein instructions that, when executed by a computing system, cause the computing system to perform the method of any one of claims 1 to ~~13~~11.

~~21. A method comprising:~~

~~Identifying, within an environment, a robotic device and a~~

~~calibration fixture in a vicinity of the robotic device;~~

~~Referencing the calibration fixture to a predetermined portion of the robotic device to determine a first pose of the robotic device relative to the calibration fixture;~~

~~Receiving, from a sensor, a 3D image of the environment wherein the 3D image includes the calibration fixture;~~

~~Determining, based on the 3D image, a second pose of the calibration fixture relative to the sensor;~~

~~Determining a third pose of the robotic device relative to the sensor based on the first pose and the second pose;~~

~~Providing a display interface for creating a virtual trajectory point; and~~

~~Determining a trajectory point corresponding to the virtual trajectory point based on the 3D image and the third pose.~~