CON-CURRENT CONTROL ROBOTIC SYSTEM

Field of the Invention

This invention relates to a robotic system which consists of 2 sets of gantry and 1 slider to perform multiple simultaneous and independent operations with greater flexibility, shorter cycle time and larger gantry working area.

Background of the Invention

In the manufacturing environment, profit is measured in terms of the outputs versus the capital investment. As such, the ideal scenario is to minimize the machine cost and size while maximizing its output. This invention requires the same floor area as a traditional system while having twice the capacity. Standard components are used to keep the machine cost low. It is ideal for application requiring high accuracy and throughput with flexible hardware configuration.

Conventional gantry systems include a set of XYZ axes configuration. To achieve high throughput, additional robotic development have been made to further increase the gantry speed. However, simply increasing the acceleration, deceleration and velocity of gantry generates further problem that must be overcome. For example, a typical pick and place unit with a mass of 0.01 kg, coupled with the 10 kg mass of the supporting driver which generates the motion of the transfer unit has a total mass of about 10 kg. When travelling at a speed of a speed of 1 m/s, the initial force (momentum) of the moving axes is approximately 50 N. On acceleration and deceleration, the energy generated must be dissipated by the driver acting on the robot frame. If insufficient dissipation occurs within the robot frame, the whole system will vibrate as the transfer part is accelerated to and decelerated from high velocity, and may even move across the position.

Therefore, simply increasing the gantry speed will soon become impractical due to the costly efforts to dissipate the energy. For example, a high-precision robot designed to reach velocities of over 4 m/s require a stationary mass of about 3500 kg to 5000 kg marble table in order to minimize positional instability due to inefficient momentum and energy dissipation.

Increasing the number of machines will increase the output, but the production area might have concern in accommodating the increase in number of machines and total cost of machines will be much higher. Simply by placing 2 gantry systems in a machine will significantly increase the size of the machine as each system require its own working area, which usually takes up a significant portion of the machine overall size. The focus of the invention is thus to accommodate the 2 gantry systems without affecting the overall machine size. In a traditional system, the working area of the gantry is determined by the size of the gantry. For this invention, the actual working area of the gantry will be enlarged by the slider, which does so by controlling the position of the jig. As such, the size of the 2 gantry systems can be reduced and placed beside each other with the slider controlling the portion of the jig to be accessed by each gantry system. This also implies that both gantry systems will be able to work on the same jig concurrently.

This invention requires a motion control module that is able to control multiple axes to move independently or concurrently. The motion control module includes a power supply,

programmable machine with control software and motion controller. The programmable machine with HMI acts as a main processing unit for data transfer, calculation as well as control for the motion system.

It would be desirable to keep the overall design of the gantry system as simple as possible by assembling the 2 gantries with 1 slider, and yet be able multi function and achieve high throughput system with this invention.

Summary of the Invention

The invention provides 2 sets of gantry module, with 1 slider, in concurrent motion on same or different sequence to reduce the cycle time. The gantries will be mounted in the left and right orientation, which enables the gantries to perform concurrent operation on the same product. The gantries will also be able to access the same position on the product through either gantry or slider motion. Due to the proximity of the 2 gantries, the time between the completions of first process to the start of the second process is significantly reduced as compare to conventional method. Furthermore, the product is held firmly in place by the jig throughout the process, which means that positioning accuracy is ensured. Total processing time will be half of conventional gantry method which performed both tasks on single gantry.

It would be convenience hereinafter to describe the invention in greater detail by reference to the accompanying drawing which illustrates preferred embodiments of the invention.

Brief Description of the Drawing

An example of a preferred embodiment of a Con-Current Control Robotic System in accordance with the invention will now be described with reference to the accompanying drawing. In which:

FIG. 1 is an isometric view of a Con-Current Control Robotic System according to the preferred embodiment of the invention. The gantry system (10) generally comprises 2 base supports (14, 14ô).

There are 2 sets of XY sliding mechanism (11, 12) and (11ô, 12ô), which is mounted together with bracket (15) and (15ô) respectively.

The end effectors unit (13, 13ô) is mounted on the gantries (11, 11ô) and (12, 12ô), which results in a 3-Dimensional work space for the device attached to the end effectors unit. The end effectors (13, 13ô) will be driven by another movable mechanism, such as actuator, linear motor or cylinder. Bracket (16, 16ô) is to secure (13, 13ô) onto (11, 11ô).

Slider (17) is located below of the gantry system. It is mounted parallel to the gantry beam (11). Work piece (19) will be mounted on top of slider (17) through a bracket (18).

FIG. 2 is a plan view of the gantry system (10). The gantry has access over a work surface (20), which comprises of 2 gantries (11, 12, 13), slider (17) and work piece (19).

FIG. 3 illustrates a front elevation of the embodiment show in FIG. 1

FIG. 4 illustrates a side elevation of the embodiment show in FIG. 1

FIG. 5 illustrates the motion control block diagram of the Con-Current Control Robotic System according to the preferred embodiment of the invention.

Power supply (21) ensures sufficient power and current to all the components. Programmable machine (22) acts as a processing unit for data transfer and data calculation for control software and interface with motion controller. Motion controller (23) is to generate set points and close a position and/or velocity feedback loop. Control functions include Velocity control, Position (point-to-point) control and torque control.

Detailed Description of the Preferred Embodiment of the Invention

In one embodiment, the present invention provides a multi-functionality and flexible system. It includes 2 gantries (14, 14ô) comprising at least 2 end effectors, a slider (17) to shift the portion of the jig (19) into the gantry working area, control means for controlling movement of the gantries; and means adapted to substantially level and/or cancel out inertial forces generated during acceleration and/or deceleration.

In certain embodiment of the above system, the control means is adapted to effect substantially simultaneous and oppositely directed movement of the end effectors and/or the 2 gantries (14, 14ô) so that the overall motion profiles thereof substantially match with one another.

In certain embodiment of the above system, the end effectors unit (13, 13ô) and/or the 2 gantries (14, 14ô) are controlled to travel substantially the same distance for a given sequence.

In certain embodiment of the above system, the control means is adapted to effect independent movement of the 2 gantries (14, 14ô) with respect to all axes.

In certain embodiment of the above system, the invention provides a computer software product directly loadable to the internal memory of a digital computer, comprising software code portions for performing the steps of a method set forth above when the product is run from a computer (22).

In one embodiment of the above system, the slider (17) will shift the portion of the jig (19) into the gantry working area for the gantries (14, 14ô) to execute the desired routine. Slider (17) will then move the next portion of the jig (19) into the gantries (14, 14ô) working area.

In one embodiment of the above system, the 2 gantries (14, 14ô) and 1 slider (17) can be mounted to any platform. Individual gantry (14, 14ô) can be configured to any application by varying the gantry length and end effectors (13, 13ô).

In one embodiment of the above system, the slider (17) can be configured to hold various products in linear or rotary form.

In one embodiment of the above system, the end effectors (13, 13ô) on the 2 gantries (14, 14ô) can access the same position on the slider (17).

Claims

1. A Con-Current Robotic System, comprising:
    a) 2 Gantries, each comprises at least one end effectors.
    b) Control means for controlling movement of the 2 Gantries; wherein the control means control the movement of the Gantry such that the forces generated during acceleration and/or deceleration is substantially eliminated.
    c) Slider to ensure the desired portion of the jig is within the gantry working area.
2. A system as claimed in claim 1, wherein Y axis is mounted to the base structure.
3. A system as claimed in claim 2, wherein X axis is mounted perpendicularly to the Y axis to form X-Y configuration.
4. A system as claimed in claim 1c), wherein the Slider mounted on the base structure is to move the jig along the working envelope.
5. A system as claimed in claim 3, wherein End Effectors mounted on the X axis can be move through cylinder or motors.
6. A system as claimed in claim 2, 3 and/or 4, wherein ball screw is used to achieve the positioning accuracy.
7. A system as claimed in claim 2, 3 and/or 4, wherein lead screw is used to achieve the positioning accuracy.
8. A system as claimed in claim 2, 3 and/or 4, wherein linear guide is used to achieve the positioning accuracy.
9. A system as claimed in claim 2, 3 and/or 4, wherein actuators is used to achieve the positioning accuracy.
10. A system as claimed in claim 4, wherein conveyor is fixed on top of the slider to shift the jig to the desired position on the slider.
11. A system as claimed in claim 4, wherein rotary table is fixed on top of the slider to shift the jig to the desired position on the slider.
12. A system as claimed in claim 10 and 11, wherein the product is kept in place by Vacuum and/or Clamp
13. A system as claimed in claim 6, 7, 8 or 9, wherein the motors comprise linear motors.
14. A system as claimed in claim 6, 7, 8 or 9, wherein the motors comprise stepper motors.
15. A system as claimed in claim 6, 7, 8 or 9, wherein the motors comprise rotary servo motors.
16. A system as claimed in claim 5, wherein the contact measurement device is a linear variable differential transducer
17. A system as claimed in claim 5, wherein the non-contact measurement device is a vision camera and/or laser sensor.

18. A system as claimed in claim 5, wherein dispensing application is performed through a dispensing micro-valve or valve.

19. A system as claimed in claim 5, wherein pick and place is performed by a device with grip and/or suction capability.

20. A system as claimed in claim 5, wherein de-panelling is performed with a tooling apparatus and a cutting apparatus.

21. The system of claim 1, wherein the control means effects substantially and oppositely directed movements on the end effectors and/or the 2 Gantries so that the overall motion profiles thereof substantially match with one another together with slider movement.

22. The system of claim 21, wherein the end effectors and/or the 2 Gantries are controlled to travel substantially the same distance for a given step together with slider movement.

23. The system of claim 21, wherein the control means effects independent movement of the 2 Gantries and slider with respect to all axes.

24. A multi axes electrical hardware design circuitry and computer software product directly loadable to the internal memory of a digital computer, comprising software code portion for performing the steps of a method according to claim 22 or 23, when the product is run on a computer.

25. A computer software product stored on a computer, comprising computer readable program for causing a computer to control movement for the Con-Current Robotic System.