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HEIGHT DETECTION ROUTINE BETWEEN TWO AXES TO AVOID COMPONENTS DAMAGE

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Height Detection Routine between two axes to avoid components damage

Abstract

On a mechanical device comprising at least two moving axes, one may clash against the other if axes are not well synchronized or in case one of the axes is not properly assembled.

A sensor is typically used to prevent such clash; but this requires extra hardware. Alternatively, an obstacle detection functionality on the controlling servo could be used, but it may damage the components if bumping force is too high.

In this article, a sequence is described to detect relative position between both axes that uses robust features on the axes to estimate the position of other fragile components to avoid the last from being damaged.

Description

On a mechanical device comprising at least two moving axes, one may clash against the other if axes are not well synchronized or in case one of the axes is not properly assembled. This is more prone to occur in case axes are not mechanically linked but controlled by independent servo controllers, as the controlling program may command incompatible movements. Also, when some parts of the axes must be manipulated by human intervention the chance of not being in the correct position is high. Moreover, if one of the axes contains a fragile component exposed the problem becomes more critical.

For instance, as illustrated in Fig.1, the axis1 is moving right to left and carries the component1 which is fragile and needs to be exposed without any possibility of a protection. At the same time, the device includes the axis2 which moves up and down and carries the component2 attached on it. Both axes can enter on the common space but controlling program should prevent from so by synchronizing both movements.

In the event component2 is not properly installed and protruding more than expected, fragile component1 on axis1 will clash against component2 when entering the common space as shown on Fig.2.

To avoid such clash situation, that may damage the fragile component1 in the example, a sensor will be typically used. It could be, for instance, a proximity sensor mounted on axis1 (e.g., sensor1 on Fig.1). Such sensor will detect component2 on axis2 in advance and will trigger axis1 to stop before critical clash occurs.

Above solution, however, requires the implementation of extra hardware that will increase the cost and complexity of the device.

Another solution could be using obstacle detection by the servo controller. This consists of monitoring the current or voltage being applied to the actuator, for instance an electrical motor. In case such output reaches a given threshold, the controller will assume an obstacle is increasing the required torque to be applied to move the axis and will stop the movement.

However, applying this method on the normal movement at nominal speeds, the fragile components maybe already damaged by the impact and the time required to stop the axes.

A solution to above problems consists of using the obstacle detection functionality on the servo against a non-fragile component and then estimate the relative position of the fragile one. This is done during an initialization phase, before starting the functional movements. To be able to do so, it is required to have a controlled dimension linking the bumping feature with respect the fragile component as shown on Fig.3a.

The sequence of movement starts placing axis1 next to axis2 as shown on Fig.3a. Then, axis2 moves up to a position that it will interfere with bumping feature on axis1 as seen on Fig.3b. At this moment, axis1 moves forward with a controlled low force till its bumping feature hits the axis2 and obstacle detection functionality stops the movement as per Fig.3c. Then, axis1 is moved backwards, axis2 is lowered, and bumping process is repeated. Sequence keeps repeating till axis1 does not detect any object on its movement as shown on Fig.3d. Note that axis1 is always moved to a position away from fragile component.

By the moment no obstacle is detected by axis1, the position of the highest surface of axis1 with respect bumping element is known. Now, if axis1 is lowered at least the known controlled dimension, it can be ensured that no clash will occur between axes.

The search of the highest position of axis2 not interfering with bumping feature on axis1 can be done by incremental steps, lowering axis2 as described above; or it can be done by performing a dichotomic search between an upper known position it will interfere for shoer and a lower one known not to interfere. This way, edge detection search time is optimized.

Once the sequence has been run on one side of the axis2, process can be repeated on the other side to make sure no clashing will occur in either of the sides.

This method does not only avoid the usage of extra sensors, but it may also help to have a better positioning of fragile component on axis1 with respect component2 on axis2 regardless the manufacturing tolerances or actual installation position.

Figures

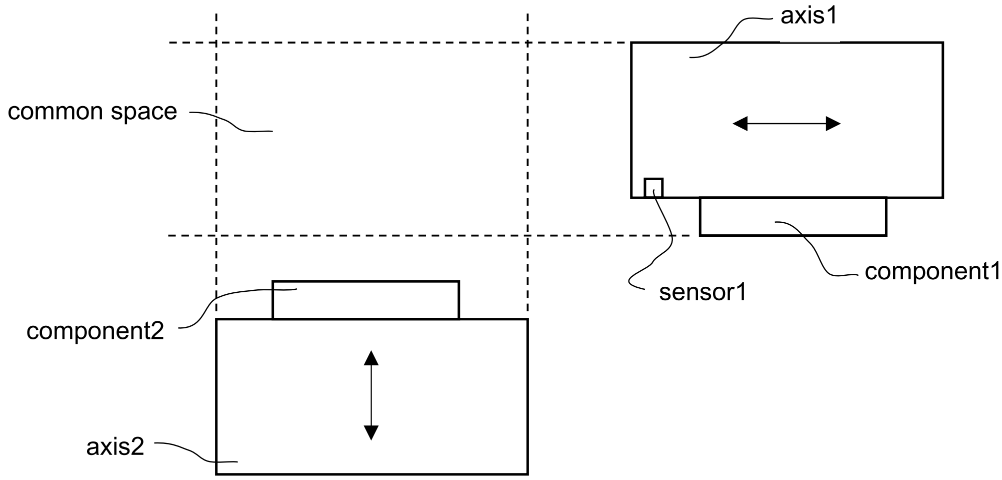

Figure 1

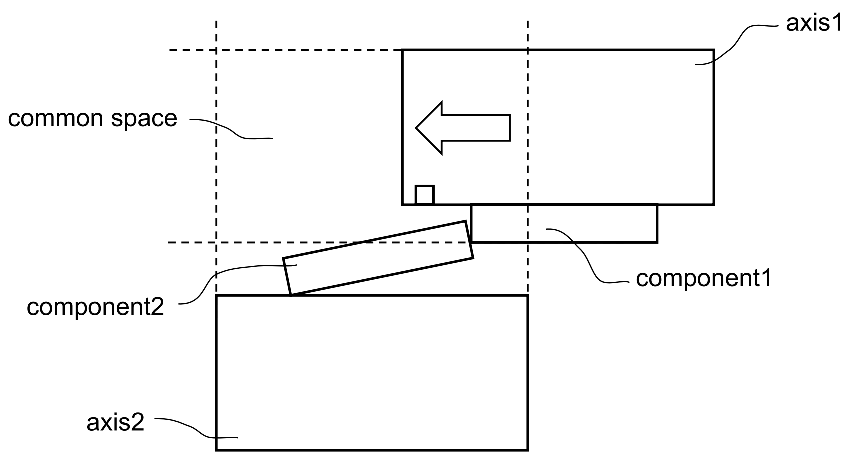

Figure 2

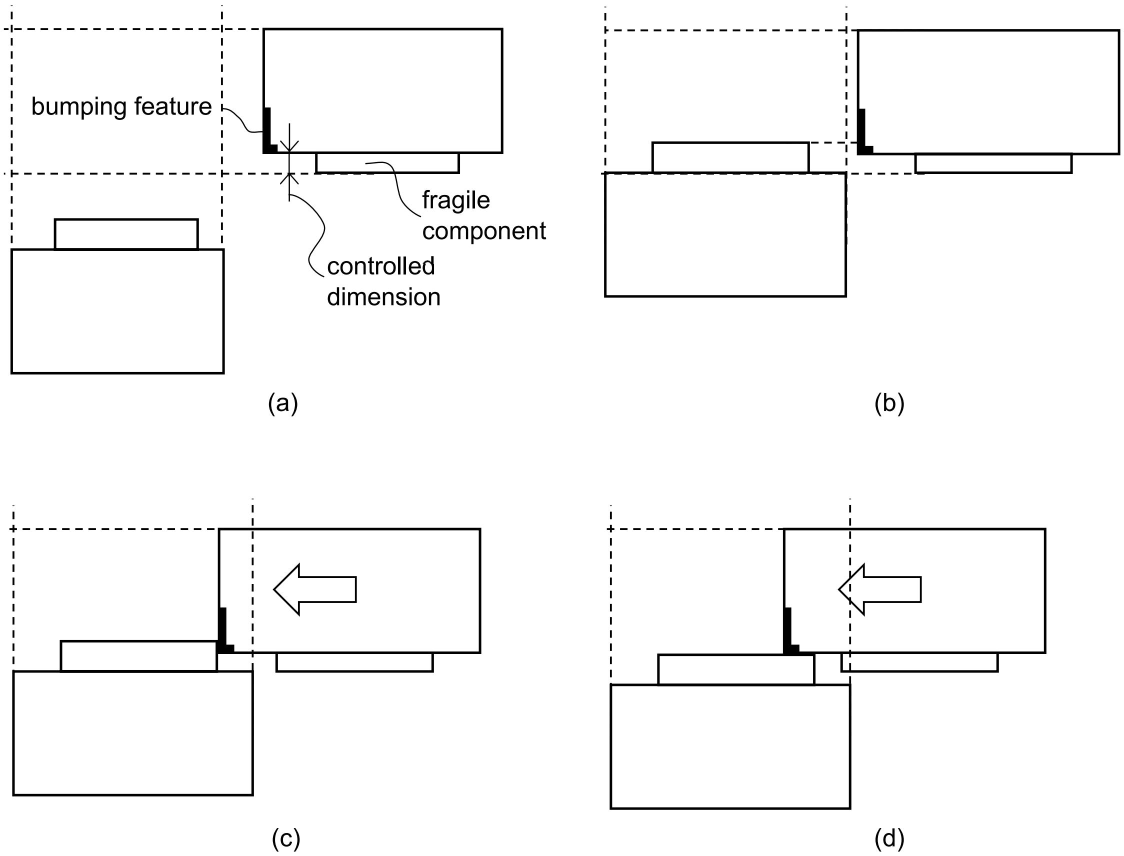

Figure 3

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