[0009] In accordance with another exemplary embodiment of the present technique, a computer program to enable a controller operating an adaptive machining system for machining a component having a native component portion is disclosed. The computer program includes programming instructions stored in a tangible medium that enable the controller to receive actual measurements of a component having an undesirable portion. The undesirable portion includes a deformation, a damaged portion, an undesirable shape, or a combination thereof. The computer program also includes programming instructions stored in a tangible medium that enable the controller to transforming a computer model of the component based on the actual measurements and an original design intent, a new optimized design, or a combination thereof.

[0010] In accordance with an aspect of the present invention, there is provided a method of repair, comprising: removing a deformed portion of a component to define a native component portion; measuring actual points on the native component portion in a first measuring step; adding a replacement portion to the native component portion; measuring actual points on the native component portion in a second measuring step and subsequent to inclusion of the replacement portion to determine deviations in measurement of points obtained in the first measuring step; identifying a rigid patch and a warp patch on the native component portion based on deviations between actual measurements on the native component portion and a computer model; adding points in the warp patch to obtain smooth transitions; registering the computer model of the component to a fraction of the actual points on the native component portion; altering the computer model based on the actual points and the original design intent to generate a transformation model; modifying a nominal tool path according to the transformation model to generate a deformed tool path; and adaptively machining the replacement portion utilizing the deformed tool path and according to original design parameters of the component.

DRAWINGS

[0011~~0010~~] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0012~~0011~~] FIG. 1 is a diagrammatical representation of a system for machining a component, for example an airfoil in accordance with an exemplary embodiment of the present technique;

[0013~~0012~~] FIG. 2 is a diagrammatical representation of a component surface having a warp patch and rigid patch in accordance with an exemplary embodiment of the present technique;

[0014~~0013~~] FIG. 3 is a diagrammatical representation of nominal cutter contact points and morphed cutter contact points generated by an adaptive machining system in accordance with an exemplary embodiment of the present technique;

[0015~~0014~~] FIG. 4 is a diagrammatical representation of a flow chart illustrating exemplary steps involved in adaptive machining in accordance with an exemplary embodiment of the present technique; and

[0016~~0015~~] FIG. 5 is a diagrammatical representation of a flow chart illustrating exemplary steps involved in adaptive machining used for machining an airfoil in accordance with an exemplary embodiment of the present technique.~~; and~~

~~[0016]~~

DETAILED DESCRIPTION

[0017] As discussed in detail below, embodiments of the present technique provide a method for repairing a component, for example, an airfoil. The method includes removing a deformed portion of a component to define a native component portion. A replacement portion is added to the native component portion. The replacement portion is adaptively machined based on one or more parameters of the native component portion and also one or more original design parameters of the component. Other embodiments include a computer-implemented method, a tangible medium including computer-readable or machine-readable code, and a method of operating an adaptive machining system configured to repair a component based on at least in part on an original design intent, an optimum design, or a combination thereof, as well as present measurements (e.g., dimensions) of the component undergoing repair. In one embodiment, the exemplary technique is applicable to a manufactured component having an undesirable shape, e.g. an airfoil with a blunted leading edge.

[0018] The exemplary embodiments provide a technique for defining and machining the final shape of a repaired part. The exemplary technique employs a geometric model of the component. This model may be a CAD model or geometry constructed from a library of measurement data. In one embodiment, the model may be a mesh model. The exemplary technique extrapolates information from measured points on the component and computer model to obtain a smooth "as-is" shape of the component. An initial position for the computer model is determined using a rigid

CLAIMS:

1. A method of repair, comprising:

removing a deformed portion of a component (12) to define a native component portion (44);

adding a replacement portion (46) to the native component portion (44); and

adaptively machining the replacement portion (46) based on one or more parameters of the native component portion (44) and based on one or more original design parameters of the component (12).

2. The method of claim 1, wherein adaptively machining comprises machining the deformed portion on an airfoil (12) at least generally consistent with an original airfoil design despite warping and/or damage to the airfoil (12) as evident by measurements taken on the native component portion (44) of the airfoil (12).

3. The method of claims 1 or 2, comprising adjusting an original design, including geometry and/or dimensions, based on actual measurements of the native component portion.

4. A computer-implemented method, comprising:

receiving actual measurements of a component (12) having an undesirable portion, wherein the undesirable portion comprises a deformation, a damaged portion, an undesirable shape, or a combination thereof; and

transforming a computer model (18) of the component (12) based on the actual measurements and an original design intent, a new optimized design, or a combination thereof.

5. The computer-implemented method of claim 4, comprising identifying deviation between the actual measurements and points in the computer model (18).

6. The computer-implemented method of claim 4, comprising identifying a rigid patch (48) and a warp patch (50) on the component (12) based on deviation between actual measurements and the computer model (18).

7. A method of operating an adaptive machining system (10) for machining a component (12) having a native component portion (44), comprising:

measuring a first set of points (16) on the native component portion (44);

determining an initial position of a computer model (18) of the component (12) by rigid body transformation using the first set of points (16) measured on the native component portion (44) to form a transformed computer model;

creating a second set of points on the transformed computer model; wherein the second set of points on the transformed computer model corresponds with the first set of points (16) on the native component portion (44); and

morphing the transformed computer model by matching the first set of points (16) with the second set of points.

8. A method of operating an adaptive machining system (10) for machining a component (12) having a native component portion (44), comprising:

creating a set of points in a built-up region (46) of a transformed computer model representative of the native component portion (44); and

applying a rigid body transformation and morphing to a plurality nominal cutter contact points (56) of a nominal tool path (36) so as to match the nominal cutter contact points (56) with the set of points to form a plurality of deformed cutter contact points (58); wherein the plurality of deformed cutter contact points (58) form a deformed tool path (38).

9. The method of claim 8, wherein morphing the plurality of nominal cutter contact points (56) of the nominal tool path (36) comprises overlapping the nominal cutter contact points (56) with the set of points to form the plurality of deformed cutter contact points (58) of the deformed tool path (38).

10. The method of claims 8 or 9, wherein morphing the plurality of nominal cutter contact points (56) of the nominal tool path (36) comprises offsetting the nominal cutter contact points (56) from the set of points to form the plurality of deformed cutter contact points (58) of the deformed tool path (38).

CLAIMS:

1. A method of repair, comprising:

removing a deformed portion of a component to define a native component portion;

measuring actual points on the native component portion in a first measuring step;

adding a replacement portion to the native component portion;

measuring actual points on the native component portion in a second measuring step and subsequent to inclusion of the replacement portion to determine deviations in measurement of points obtained in the first measuring step;

identifying a rigid patch and a warp patch on the native component portion based on deviations between actual measurements on the native component portion and a computer model;

adding points in the warp patch to obtain smooth transitions;

registering the computer model of the component to a fraction of the actual points on the native component portion;

altering the computer model based on the actual points and the original design intent to generate a transformation model;

modifying a nominal tool path according to the transformation model to generate a deformed tool path; and

adaptively machining the replacement portion utilizing the deformed tool path and according to original design parameters of the component.

2. The method of claim 1, wherein adaptively machining comprises machining the deformed portion on an airfoil at least generally consistent with an original airfoil design despite warping and/or damage to the airfoil as evident by measurements taken on the native component portion of the airfoil.

3. The method of claim 1, comprising adjusting an original design, including geometry and/or dimensions, based on actual measurements of the native component portion while maintaining design intent.

4. The method of claim 1, wherein the one or more original design parameters comprise a geometric model of the component.

5. The method of claim 1, comprising performing a single pass machining or a multi-pass machining of the replacement portion.