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(54) PREDICTING QUALITY OF A 3D OBJECT PART

VORHERSAGE DER QUALITÄT EINES 3D-OBJEKTTEILS

PRÉDICTION DE LA QUALITÉ D’UNE PARTIE D’OBJET TRIDIMENSIONNEL

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Description

BACKGROUND

[0001] In three-dimensional (3D) printing, an additive printing process may be used to make three-dimensional solid parts from a digital model. 3D printing may be used in rapid product prototyping, mold generation, mold master generation, and short run manufacturing. Some 3D printing techniques are considered additive processes because they involve the application of successive layers of material. This is unlike traditional machining processes, which often rely upon the removal of material to create the final part. In 3D printing, the building material may be cured or fused, which for some materials may be performed using heat-assisted extrusion, melting, or sintering, and for other materials, may be performed using digital light projection technology.

[0002] EP2918395A1 discloses a technique that includes forming, on a surface of a first layer of material, a second layer of material using an additive manufacturing process. The technique also may include imaging the second layer using a laser imaging device to generate a second layer image. Further, the technique may include determining, by a computing device, whether a thickness of the second layer, in a direction substantially normal to the surface of the first layer of material, is within a defined range of thickness for the second layer.

[0003] US2015266242A1 discloses a method and system for printing a three-dimensional part, which includes printing a plurality of successive layers of the three-dimensional part with the additive manufacturing system based on bitslices in a bitslice stack, measuring surface heights of the successive layers after each of the successive layers are printed, determining differences between the measured surface heights and predicted stack heights of the bitslices, identifying one or more topographical error regions based on the determined differences, and modifying the bitslice stack to compensate for the one or more topographical error regions.

[0004] DE102015011013A1 discloses a quality assurance system for additive manufacturing. The invention teaches a multi-sensor, a real-time quality system comprising sensors, integrated hardware and data processing algorithms with respect to reference systems of the associated input measurements. The quality system for additive manufacturing is capable of measuring actual process status variables in conjunction with a generative manufacturing process. The process state variables can also be correlated with the substructure or microstructure and thus be helpful in identifying certain areas within the part that are likely to contain defects.

[0005] WO2014118635A2 discloses systems, methods, and program products for managing digital production from one or more production devices with one or more sources providing inputs of production designs and/or production options are disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Features of the present disclosure are illustrated by way of example and not limited in the following figure(s), in which like numerals indicate like elements, in which:

FIG. 1 shows a simplified isometric view of an example three-dimensional (3D) printer for generating, building, or printing three-dimensional parts;

FIGS. 2A and 2B, respectively, show simplified block diagrams of example computing apparatuses; and

FIGS. 3-5, respectively, depict example methods for predicting a quality of a part formed of build materials in a layer of the build materials.

DETAILED DESCRIPTION

[0007] For simplicity and illustrative purposes, the present disclosure is described by referring mainly to an example thereof. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be readily apparent however, that the present disclosure may be practiced without limitation to these specific details. In other instances, some methods and structures have not been described in detail so as not to unnecessarily obscure the present disclosure. As used herein, the terms "a" and "an" are intended to denote at least one of a particular element, the term "includes" means includes but not limited to, the term "including" means including but not limited to, and the term "based on" means based at least in part on.

[0008] The scope of the invention is defined by the appended claims.

[0009] Disclosed herein are a computing apparatus, methods for implementing the computing apparatus, and a machine or computer readable medium on which is stored machine readable instructions for implementing the computing apparatus. The computing apparatus disclosed herein includes a processing device that accesses, from a sensing device, information pertaining to formation of a part of a 3D object in a layer of build materials upon which fusing agent droplets have been or are to be selectively deposited. The processing device predicts, based upon the accessed information, a quality of the part and outputs an indication of the predicted quality of the part. In one regard, a user may be notified of the predicted quality of the part and may decide whether to proceed with printing of the 3D object. For instance, a user may decide to abort printing of the 3D object in response to being notified of the print quality of the part.

[0010] In another example, the processing device may determine whether an issue exists with the part being formed based upon the predicted quality of the part. As discussed in greater detail herein below, the processing device may determine that an issue exists with the part in instances in which the predicted quality of the part fails to meet or falls below a predefined threshold. In addition, the processing device may determine whether a solution to the determined issue is available and may implement the solution. Implementation of the solution may include, for instance, controlling a component of a 3D printer to modify application of a fusing agent, modify application of fusing radiation, modify application of warming heat, or the like.

[0011] Through implementation of the computing apparatus and methods disclosed herein, the quality of a 3D object part being formed in a layer of build materials is predicted based upon conditions detected by a sensing device. In addition, the quality of the part may be improved through modifying an operation performed by the 3D printer. The processing device may modify the operation of the 3D printer automatically, i.e., without user intervention. However, a user may be notified of the predicted quality and may also be alerted to issues having relatively large severities such that the user may intervene in the printing process if necessary or desired.

[0012] With reference first to FIG. 1, there is shown a simplified isometric view of an example three-dimensional (3D) printer 100 for generating, building, or printing three-dimensional parts. It should be understood that the 3D printer 100 depicted in FIG. 1 may include additional components and that some of the components described herein may be removed and/or modified without departing from a scope of the 3D printer 100 disclosed herein.

[0013] The 3D printer 100 is depicted as including a build area platform 102, a build material supply 104 containing build materials 106, and a recoater 108. The build material supply 104 may be a container or surface that is to position build materials 106 between the recoater 108 and the build area platform 102. The build material supply 104 may be a hopper or a surface upon which the build materials 106 may be supplied, for instance, from a build material source (not shown) located above the build material supply 104. Additionally, or alternatively, the build material supply 104 may include a mechanism to provide, e.g., move, the build materials 106 from a storage location to a position to be spread onto the build area platform 102 or a previously formed layer of build materials 106. For instance, the build material supply 104 may include a hopper, an auger conveyer, or the like. Generally speaking, 3D objects or parts are to be generated from the build materials 106 and the build materials 106 may be formed of any suitable material including, but not limited to, polymers, metals, and ceramics. In addition, the build materials 106 may be in the form of a powder.

[0014] The recoater 108 may move in a direction as denoted by the arrow 110, e.g., along the y-axis, over the build material supply 104 and across the build area platform 102 to spread the build materials 106 into a layer 114 over a surface of the build area platform 102. The layer 114 may be formed to a substantially uniform thickness across the build area platform 102. In an example, the thickness of the layer 114 may range from about 90 μm to about 110 μm, although thinner or thicker layers may also be used. For example, the thickness of the layer 114 may range from about 20 μm to about 200 μm, or from about 50 μm to about 200 μm. The recoater 108 may also be returned to a position adjacent the build material supply 104 following the spreading of the build materials 106. In addition, or alternatively, a second build material supply (not shown) may be provided on an opposite side of the build area platform 102 and the recoater 108 may be positioned over the second build material supply after forming the layer of build materials 106. The recoater 108 may be a doctor blade, roller, a counter rotating roller or any other device suitable for spreading the build materials 106 over the build area platform 102.

[0015] The 3D printer 100 is also depicted as including a plurality of warming devices 120 arranged in an array above the build area platform 102. Each of the warming devices 120 may be a lamp or other heat source that is to apply heat onto spread layers of the build materials 106, for instance, to maintain the build materials 106 within a predetermined temperature range. The warming devices 120 may maintain the temperatures of the build materials 106 at a relatively high temperature that facilitates the selective fusing of the build materials 106. That is, the warming devices 120 may maintain the build materials 106 at a sufficiently high temperature that enables the build materials 106 upon which fusing agent droplets are provided to fuse together upon receipt of fusing radiation without causing the build materials 106 to otherwise fuse together. The warming devices 120 may be activated in a non-continuous manner such that the build materials 106 may be kept within a predetermined temperature range as various processes, including application of fusing radiation, are performed on the build materials 106.

[0016] The 3D printer 100 is further depicted as including a first delivery device 122 and a second delivery device 124, which may both be scanned across the layer 114 on the build area platform 102 in both of the directions indicated by the arrow 126, e.g., along the x-axis. For instance, the first delivery device 122 may deposit first liquid droplets as the first delivery device 122 is scanned in a first x direction 126 and the second delivery device 124 may deposit second liquid droplets as the second delivery device 124 is scanned in an opposite x direction 126. The first delivery device 122 and the second delivery device 124 may be thermal inkjet printheads, piezoelectric printheads, or the like, and may extend a width of the build area platform 102. The first delivery device 122 and the second delivery device 124 may each include a printhead or multiple printheads available from the Hewlett Packard Company of Palo Alto, California. Although the first delivery device 122 and the second delivery device 124 have each been depicted in FIG. 1 as being formed of separate devices, it should be understood that each of the first delivery device 122 and the second delivery device 124 may be included on the same printhead. For instance, the first delivery device 122 may include a first set of actuators and nozzles in a printhead and the second delivery device 124 may include a second set of actuators and nozzles in the printhead.

[0017] In other examples in which the first delivery device 122 and the second delivery device 124 do not extend the width of the build area platform 102, the first delivery device 122 and the second delivery device 124 may also be scanned along the y-axis to thus enable the first delivery device 122 and the second delivery device 124 to be positioned over a majority of the area above the build area platform 102. The first delivery device 122 and the second delivery device 124 may thus be attached to a moving XY stage or a translational carriage (neither of which is shown) that is to move the first delivery device 122 and the second delivery device 124 adjacent to the build area platform 102 in order to deposit respective liquids in predetermined areas of the layer 114 of the build materials 106.

[0018] Although not shown, the first delivery device 122 and the second delivery device 124 may each include a plurality of nozzles through which the respective liquid droplets are to be ejected onto the layer 114. The first delivery device 122 may deposit a first liquid and the second delivery device 124 may deposit a second liquid. The first liquid and the second liquid may both be fusing agents, may both be detailing agents, or one may be a fusing agent and the other may be detailing agent. A fusing agent may be a liquid that is to absorb fusing radiation (e.g., in the form of light and/or heat) to cause the build materials 106 upon which the fusing agent has been deposited to fuse together when the fusing radiation is applied. A detailing agent may be a liquid that may absorb significantly less of the fusing radiation as compared with the fusing agent. In one example, the detailing agent may prevent or significantly reduce the fusing together of the build materials 106 upon which the detailing agent has been deposited. In other examples, the detailing agent may be implemented to provide coloring to exterior portions of the build materials 106 that have been fused together.

[0019] The first liquid and the second liquid may also include various additives and/or catalysts that either enhance or reduce radiation absorption. For instance, the first liquid may include a radiation absorbing agent, i.e., an active material, metal nanoparticles, or the like. The first liquid and the second liquid may also include any of a co-solvent, a surfactant, a biocide, an anti-kogation agent, a dispersant, and/or combinations thereof.

[0020] Although not shown, the 3D printer 100 may include additional delivery devices, e.g., printheads, that may deposit multiple liquids having different radiation absorption properties with respect to each other. By way of example, the multiple liquids may have different colors with respect to each other, may have different chemical compositions (e.g., different reactants and/or catalysts) with respect to each other, or the like. In the example in which the 3D printer 100 may deposit multiple liquids, the 3D printer 100 may include multiple printheads, in which each of the multiple printheads may deposit a liquid having a different radiation absorption property with respect to the other liquids.

[0021] Following deposition of the first liquid droplets and/or the second liquid droplets onto selected areas of the layer 114 of the build materials 106, a first radiation generator 130 and/or a second radiation generator 132 may be implemented to apply fusing radiation onto the build materials 106 in the layer 114. Particularly, the radiation generator(s) 130, 132 may be activated and moved across the layer 114, for instance, along the directions indicated by the arrow 126 to apply fusing radiation in the form of light and/or heat onto the build materials 106. Examples of the radiation generators 130, 132 may include UV, IR or near-IR curing lamps, IR or near-IR light emitting diodes (LED), halogen lamps emitting in the visible and near-IR range, or lasers with desirable electromagnetic wavelengths. The types of radiation generators 130, 132 may depend, at least in part, on the type of active material used in the liquid(s). According to an example, the first delivery device 122, the second delivery device 124, the first fusing radiation generator 130, and the second fusing radiation generator 132 may be supported on a carriage (not shown) that may be scanned over the build area platform 102 in the directions denoted by the arrow 126.

[0022] Following application of liquid droplets during the multiple passes and following application of the radiation to fuse selected sections of the build materials 106 together, the build area platform 102 may be lowered as denoted by the arrow 112, e.g., along the z-axis. In addition, the recoater 108 may be moved across the build area platform 102 to form a new layer of build materials 106 on top of the previously formed layer 114. Moreover, the first delivery device 122 may deposit first liquid droplets and the second delivery device 124 may deposit second liquid droplets onto respective selected areas of the new layer of build materials 106 in single and/or multiple passes as discussed above. The above-described process may be repeated until parts of the 3D object have been formed in a predetermined number of layers to fabricate a green body of the 3D object.

[0023] Additionally, following a liquid deposition operation across a build material layer or following multiple liquid deposition operations across multiple build material layers, the first delivery device 122 and the second delivery device 124 may be positioned adjacent to a wiping mechanism 134. The wiping mechanism 134 may wipe the nozzles of the first delivery device 122 and the second delivery device 124, as well as the nozzles of additional delivery devices if included in the 3D printer 100. The wiping mechanism 134 may be moved to a position in which a surface, such as a cleaning web (not shown), of the wiping mechanism 134 is in contact with the exterior surfaces of the nozzles. The wiping mechanism 134 may be moved in the z-direction as noted by the arrow 136 to remove debris such as, build materials 106, liquid, dust, etc., that may be in contact with the exterior surfaces of the first delivery device 122 and the second delivery device 124, to maintain the delivery devices 122, 124 at or above desired performance levels.

[0024] As further shown in FIG. 1, the 3D printer 100 includes a processing device 140 that may control operations of the build area platform 102, the build material supply 104, the recoater 108, the warming devices 120, the first delivery device 122, the second delivery device 124, the radiation generators 130, 132, and the wiping mechanism 134. Particularly, for instance, the processing device 140 controls actuators (not shown) to control various operations of the 3D printer 100 components. The processing device 140 is a computing device, a semiconductor-based microprocessing device, a central processing unit (CPU), an application specific integrated circuit (ASIC), and/or other hardware device. Although not shown, the processing device 140 may be connected to the 3D printer 100 components via communication lines.

[0025] The processing device 140 is also depicted as being in communication with a data store 142. The data store 142 includes data pertaining to a 3D object to be printed by the 3D printer 100. For instance, the data may include the locations in each build material layer that the first delivery device 122 is to deposit a first liquid and that the second delivery device 124 is to deposit a second liquid to form the green body of the 3D object. In one example, the processing device 140 may use the data to control the locations on each of the build material layers that the first delivery device 122 and the second delivery device 124 respectively deposit droplets of the first and second liquids.

[0026] The 3D printer 100 also includes sensing devices 144, 146 that detects and/or measure attributes pertaining to the formation of a part of a 3D object in the layer 114 of build materials 106. The part may be a portion of the 3D object that is formed through selective fusing of a plurality of the build materials 106 in the layer 114. In any regard, the attributes that the sensing devices 144, 146 detect and include, for instance, temperatures across the layer 114, an advancement of the build material platform 102, temperatures of the build materials 106 stored in the build material supply 104, etc. By way of example, a first sensing device 144 may be a thermal sensing device, e.g., an infrared sensing device, that may detect temperatures across the layer 114 at least one of prior to, during, and after selective application of fusing agent droplets onto the build materials 106 forming the layer 114. In addition, the second sensing device 146 may be a positional sensing device, e.g., an encoder, that may detect and track movement of the build area platform 102. The sensing devices 144, 146 communicates the detected conditions to the processing device 140. As discussed in greater detail herein below, the processing device 140 predicts a quality of the part being formed in the layer 114 based upon the detected conditions. The processing device 140 may also determine, from the predicted quality, whether an issue exists with the part based upon the predicted quality and may take corrective measures, if available, and may output an indication of the predicted quality.

[0027] Turning now to FIGS. 2A and 2B, there respectively shown simplified block diagrams of example computing apparatuses 200, 200'. According to an example, either of the computing apparatuses 200, 200' may be implemented as part of the 3D printer 100. For instance, either of the computing apparatuses 200, 200' may be a command module or other control system of the 3D printer 100. In another example, either of the computing apparatuses 200, 200' may be separate from the 3D printer 100 and may be, for instance, a personal computer, a laptop computer, a server computer, or the like. It should be understood that the computing apparatuses 200. 200' depicted in FIGS. 2A and 2B may include additional components and that some of the components described herein may be removed and/or modified without departing from scopes of the computing apparatuses 200, 200' disclosed herein.

[0028] With reference first to FIG. 2A, the computing apparatus 200 is shown as including a processing device 140, which may be the same as the processing device 140 depicted in and described above with respect to FIG. 1. As such, the processing device 140 depicted in FIG. 2A is not described in detail and instead, the description of the processing device 140 provided above with respect to the 3D printer 100 is intended to also describe this component with respect to the computing apparatus 200.

[0029] The computing apparatus 200 includes a machine readable storage medium 210 on which is stored machine readable instructions 212, 216, and 224 that the processing device 140 may execute. More particularly, the processing device 140 fetches, decodes, and executes the instructions 212, 216, and 224 to access information pertaining to a part of a 3D object in a layer 114 of build materials 106 upon which fusing agent droplets have been or are to be selectively deposited 212, to predict a quality of the part 216, and to output the predicted quality 224. As an alternative or in addition to retrieving and executing instructions, the processing device 140 may include one or more electronic circuits that include components for performing the functionalities of the instructions 212, 216, and 224. In any regard, and as discussed above, the processing device 140 may communicate instruction signals to the various components of the 3D printer 100 via communication lines such that the components may operate in the manners described herein.

[0030] With reference now to FIG. 2B, the computing apparatus 200' is shown as including a processing device 140 and a data store 142, which may be the same as the processing device 140 and the data store 142 depicted in and described above with respect to FIG. 1. As such, the processing device 140 and the data store 142 depicted in FIG. 2B are not described in detail and instead, the descriptions of the processing device 140 and the data store 142 provided above with respect to the 3D printer 100 are intended to also describe these components with respect to the computing apparatus 200'.

[0031] The computing apparatus 200' includes a machine readable storage medium 210 on which is stored machine readable instructions 212-224 that the processing device 140 executes. More particularly, the processing device 140 fetches, decodes, and executes the instructions 212-224 to access information pertaining to a part of a 3D object in a layer 114 of build materials 106 upon which fusing agent droplets have been or are to be selectively deposited 212, to compare values in the accessed information with predetermined values 214, to predict a quality of the part 216, to determine whether an issue with the part exists 218, to determine whether a solution to a determined issue is available/implement a solution 220, to determine whether a severity of the determined issue exceeds a predefined severity level 222, and to output the predicted quality and/or a quality alert 224. As an alternative or in addition to retrieving and executing instructions, the processing device 140 may include one or more electronic circuits that include components for performing the functionalities of the instructions 212-228. In any regard, and as discussed above, the processing device 140 communicates instruction signals to the various components of the 3D printer 100 via communication lines such that the components operate in the manners described herein.

[0032] The machine readable storage medium 210 depicted in FIGS. 2A and 2B may be any electronic, magnetic, optical, or other physical storage device that contains or stores executable instructions. Thus, the machine readable storage medium 210 may be, for example, Random Access Memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage device, an optical disc, and the like. The machine readable storage medium 210 may be a non-transitory machine-readable storage medium, where the term "non-transitory" does not encompass transitory propagating signals.

[0033] Various manners in which the computing apparatuses 200, 200' may be implemented are discussed in greater detail with respect to the methods 300, 400, and 500 respectively depicted in FIGS. 3-5. Particularly, FIGS. 3-5, respectively, depict example methods 300, 400, and 500 for predicting a quality of a part formed of build materials 106 in a layer 114 of the build materials 106. It should be apparent to those of ordinary skill in the art that the methods 300, 400, and 500 may represent generalized illustrations and that other operations may be added or existing operations may be removed, modified, or rearranged without departing from the scopes of the methods 300, 400, and 500.

[0034] The descriptions of the methods 300, 400, and 500 are made with reference to the 3D printer 100 illustrated in FIG. 1 and the computing apparatuses 200, 200' illustrated in FIGS. 2A and 2B for purposes of illustration. It should, however, be understood that 3D printers and computing apparatuses having other configurations may be implemented to perform any of the methods 300, 400, and 500 without departing from the scopes of the methods 300, 400, and 500.

[0035] With reference first to FIG. 3, at block 302, information pertaining to formation of a part of a 3D object in a layer 114 of build materials 106 upon which fusing agent droplets have been or are to be selectively deposited are accessed from a sensing device 144, 146. The processing device 140 executes the instructions 212 to access information, such as conditions detected by the sensing devices 144, 146. The processing device 140 accesses this information directly from the sensing devices 144, 146 and/or from a data storage location, such as the data store 142, and in instances in which the sensing devices 144, 146 store detected condition information in the data storage location.

[0036] At block 304, a quality of the part are predicted based upon the accessed information. For instance, the processing device 140 executes the instructions 216 to predict the quality of the part based upon the detected conditions as the part is being formed. For instance, the processing device 140 may predict that the quality of the part is relatively low in response to the temperatures of the build materials 106 forming the part being below a threshold temperature. By way of particular example, the threshold temperature may be a temperature at which the build materials 106 become fused together. In this example, the processing device 140 may predict that the mechanical properties of the part are below a threshold because the build materials 106 may not have sufficiently been fused together.

[0037] The processing device 140 predicts other types of factors in predicting the quality of the part. For instance, the processing device 140 may predict that the part may have a particular roughness, a particular dimensional accuracy, a particular color, or the like, based upon the accessed information. The processing device 140 accesses data pertaining to correlations between different predicted properties of the part and different conditions that may be detected during formation of the part. In an example, the data may be generated through testing various conditions resulting properties.

[0038] At block 306, an indication of the predicted quality of the part is outputted. The processing device 140 executes the instructions 224 to output the predicted quality. For instance, the processing device 140 may output the predicted quality by storing the predicted quality in the data store 142, by communicating the predicted quality to a user's computing device, by displaying the predicted quality on a display monitor, or the like. The processing device 140 may also output detected values of the accessed information used in determining the quality of the part, e.g., the predicted mechanical strength, the predicted color, etc.

[0039] With reference now to FIG. 4, at blocks 402 and 404, information pertaining to formation of a part accessed from a sensing device 144, 146 and based upon the accessed information, a quality of the part may be predicted. Blocks 402 and 404 may be equivalent to blocks 302 and 304 described above with respect to the method 300 in FIG. 3.

[0040] At block 406, a determination may be made that an issue exists with the part based upon the predicted quality of the part. The processing device 140 may execute the instructions 218 to determine whether an issue with the part exists based upon the predicted quality of the part. The processing device 140 may determine that an issue exists with the part if the predicted quality of the part falls below a predetermined quality threshold level. By way of example in which the predicted quality of the part is mechanical strength, the processing device 140 may determine that an issue exists with the part if the mechanical strength of the part is predicted to fall below a predetermined threshold level, e.g., that the part is unable to withstand about 30 megapascals of pressure. In another example in which the predicted quality of the part is color, the processing device 140 may determine that an issue exists with the part if the color of the part is predicted to differ by a predetermined threshold amount from a desired color, in which the predetermined threshold amount may be user defined.

[0041] At block 408, a solution to the issue may be implemented and/or an indication of the predicted quality of the part may be outputted in response to the determination that an issue exists with the part. The processing device 140 may execute the instructions 220 to implement a solution to the determined issue and/or may execute the instructions 224 to output the predicted quality of the part. For instance, the processing device 140 may implement the solution when the solution is available and may output the predicted quality of the part when a solution is not available. In another example, the processing device 140 may both output the predicted quality of the part and may implement the solution. In any regard, the processing device 140 may output the predicted quality of the part in any of the manners discussed above with respect to block 306 in FIG. 3,

[0042] According to an example, the processing device 140 may determine a particular solution to the determined issue based upon the type of issue that has been determined. For instance, in an example in which the color of the part is predicted to fail to meet a desired color, the processing device 140 may determine that the solution is to add additional liquid droplets of the correct color onto the build materials 106 forming the part. In this example, the processing device 140 may implement the solution at block 408 by controlling a delivery device 122 to deposit the additional liquid droplets of the correct color onto the build materials 106. In another example in which the mechanical strength of the part is predicted to fail to meet a predetermined threshold, the processing device 140 may determine that the solution is to apply additional fusing radiation onto the build materials 106 forming the part. In this example, the processing device 140 may implement the solution at block 408 by controlling a fusing radiation generator 130 to apply additional fusing radiation onto the build materials 106 forming the part.

[0043] With reference now to FIG. 5, at block 502, information pertaining to formation of a part of a 3D object to be formed in a layer of build materials may be accessed from a sensing device 144, 146. Block 502 may be equivalent to block 302 described above with respect to the method 300 in FIG. 3.

[0044] At block 504, values in the accessed information may be compared with corresponding predetermined values. The processing device 140 may compare the values in the accessed information with corresponding predetermined values. For instance, the processing device 140 may compare the temperatures detected across the layer 114 with predetermined temperature values. As another example, the processing device 140 may compare the detected movement distance of the build area platform 102 with a predefined movement distance. As a yet further example, the processing device 140 may compare the detected color of the build materials 106 forming the part following application of liquid droplets onto the build materials 106 with a predefined color.

[0045] At block 506, a quality of the part may be predicted based upon a result of the comparison performed at block 504. The processing device 140 may execute the instructions 216 to predict or otherwise determine the quality of the part based upon, for instance, how the values in the accessed information relate with respect to corresponding predetermined values. For instance, the processing device 140 may determine that the part is of relatively high quality in response to the values in the accessed information being within a range of or matching the corresponding predetermined values. In another example, the processing device 140 may determine that the part is of relatively low quality in response to the values in the accessed information either falling below or exceeding a range of the corresponding predetermined values. The processing device 140 may determine, for instance, that certain attributes of the part are predicted to have a relatively high quality while also determining that other attributes of the part are predicted to have a relatively low quality based upon the comparison of the values.

[0046] At block 508, a determination may be made as to whether an issue exists with the part based upon the predicted quality of the part. The processing device 140 may execute the instructions 218 to determine whether the predicted quality of the part indicates that an issue, such as a potential problem, exists with the part. For instance, the processing device 140 may determine that the predicted quality of the part indicates that an issue exists because the predicted quality of the part falls below a predetermined threshold. By way of example, the processing device 140 may determine that an issue exists with the part in any of the manners discussed above with respect to block 406 in FIG. 4.

[0047] In response to a determination that an issue with the part does not exist, an indication of the predicted quality of the part may be outputted as indicated at block 510. For instance, the processing device 140 may execute the instructions 224 to output the predicted quality of the part in any of the manners discussed above with respect to block 306 in FIG. 3. However, in response to a determination that an issue with the part does exist, a determination may be made as to whether a solution to the issue is available, as indicated at block 512. The processing device 140 may execute the instructions 220 to determine whether a solution to the issue is available. For instance, the processing device 140 may determine that a solution to the issue is available if the issue matches or is equivalent to a previously identified issue for which a solution has been identified and has been stored in the data store 142.

[0048] In response to a determination that a solution to the issue is available, the solution may be implemented as indicated at block 514. For instance, the processing device 140 may execute the instructions 220 to control a component of the 3D printer 100 to resolve the issue. By way of example, in which the issue is that the build area platform 102 advanced farther than intended from a prior layer processing operation, the processing device 140 may control the warming devices 120 to increase energy output to compensate for the increased distance between the warming devices 120 and the layer 114. In this example, the processing device 140 may increase the pulse width modulation signals communicated to the warming devices 120 to cause the increase in the energy output from the warming devices 120.

[0049] According to another example, however, the processing device 140 may not always implement a solution when a solution is available. Instead, the processing device 140 may determine whether to implement a solution based upon a selected print mode of the 3D printer 100 in printing the part. The print mode may include, for instance, a draft quality print mode, a custom quality print mode, a high quality print mode, etc., in which the quality of the part (and the 3D object) may correspond to the selected print mode. In this example, the processing device 140 may implement the solution in response to the selected print mode being higher than the draft quality print mode. That is, for instance, a user may select to print the 3D object in a draft quality print mode in cases where the quality of the 3D object may not be of importance and thus, a lower quality part may be suitable.

[0050] With reference back to block 512, in response to a determination that a solution to the issue is not available, a determination may be made as to whether a severity of the issue exceeds a predefined severity level. The processing device 140 may execute the instructions 222 to determine the severity of the issue and may compare the determined severity of the issue to a predefined severity level. According to an example, the predefined severity level may be based upon the selected print mode at which the 3D object is to be printed. Thus, for instance, the predefined severity level may be relatively higher for lower quality print modes than for higher quality print modes. In addition, the predefined severity level may depend upon the type of issue determined and/or may be user-defined.

[0051] In response to a determination that the severity of the issue does not exceed the predefined severity level threshold, an indication of the predicted quality of the part may be outputted at block 510. However, in response to a determination that the severity of the issue does exceed the predefined severity level, a quality alert may be outputted at block 518. For instance, the processing device 140 may execute the instructions 224 to output either or both of the predicted quality and the quality alert. The processing device 140 may output either or both of the predicted quality and quality alert through a display monitor, an audible alarm, etc. A user may continue or may cancel printing of the part in response to being alerted to the predicted quality of the part.

[0052] Some or all of the operations set forth in the methods 300, 400, and 500 may be contained as utilities, programs, or subprograms, in any desired computer accessible medium. In addition, the methods 300, 400, and 500 may be embodied by computer programs, which may exist in a variety of forms both active and inactive. For example, they may exist as machine readable instructions, including source code, object code, executable code or other formats. Any of the above may be embodied on a non-transitory machine (or computer) readable storage medium. Examples of non-transitory machine readable storage media include computer system RAM, ROM, EPROM, EEPROM, and magnetic or optical disks or tapes. It is therefore to be understood that any electronic device capable of executing the above-described functions may perform those functions enumerated above.

[0053] Although described specifically throughout the entirety of the instant disclosure, representative examples of the present disclosure have utility over a wide range of applications, and the above discussion is not intended and should not be construed to be limiting, but is offered as an illustrative discussion of aspects of the disclosure. What has been described and illustrated herein is an example of the disclosure along with some of its variations. The terms, descriptions and figures used herein are set forth by way of illustration only and are not meant as limitations.

Claims

1. A computing apparatus (200) comprising:

a processing device (140);
a machine readable storage medium (210) on which is stored instructions that when executed by the processing device, cause the processing device to:

access (212), from a sensing device, information pertaining to a formation of a part of a 3D object in a layer of build materials upon which fusing agent droplets have been or are to be selectively deposited;
access data pertaining to correlations between different predicted properties of the part and different conditions detected during the formation of the part; predict (216) a quality of the part based upon the accessed information and based upon the accessed data pertaining to correlations; and output (224) an indication of the predicted quality of the part.

2. The computing apparatus according to claim 1, wherein the accessed information comprises temperatures detected by the sensing device of the layer of build materials and wherein to predict the quality of the part, the instructions are further to cause the processing device to:

compare (214) the detected temperatures with a predetermined range of temperatures; and
predict (216) the quality of the part based upon a result of the comparison.

3. The computing apparatus according to claim 2, wherein the instructions are further to cause the processing device to:

determine (218) whether an issue exists with respect to the part based upon the predicted quality; and
in response to a determination that an issue exists, determine (220) whether a solution to the determined issue is available, wherein the solution to the determined issue is dependent upon whether the detected temperatures exceed or fall below the predetermined threshold range and includes varying an operation of a warming device.

4. The computing apparatus according to claim 1, wherein the instructions are further to cause the processing device to:

determine (218) whether an issue exists with respect to the part based upon the predicted quality;
in response to a determination that an issue exists, determine (220) whether a solution to the issue is available; and
in response to a determination that a solution to the issue is available, implement the solution.

5. The computing apparatus according to claim 1, wherein the instructions are further to cause the processing device to:

determine whether an issue exists with respect to the part based upon the predicted quality;
determine (222) whether a severity of the issue exceeds a predefined severity level; and
in response to a determination that the severity of the issue exceeds the predefined severity level, output (224) a quality alert.

6. The computing apparatus according to claim 5, wherein the predefined severity level corresponds to a selected print mode for formation of the part.

7. The computing apparatus according to claim 1, wherein the instructions are further to cause the processing device to:

identify a print mode to be followed in the formation of the part;
determine (218), based upon the predicted quality, whether an issue exists with respect to the part;
in response to a determination that an issue exists, determine (220) whether a solution to the issue is available;
determine (222) whether the identified print mode exceeds a predefined quality level; and
implement the solution in response to the identified print mode exceeding the predefined quality level.

8. The computing apparatus according to claim 1, wherein the accessed information comprises a detected advance of a build area platform upon which the layer of build materials is supported and wherein to predict the quality of the part, the instructions are further to cause the processing device to:

compare a detected advancement of the build area platform with a predetermined advancement distance; and
predict the quality of the part based upon a result of the comparison.

9. The computing apparatus according to claim 1, wherein the predicted quality of the part includes at least one of mechanical properties, roughness, dimensional accuracy, and color of the part.

10. A method (400) comprising:

accessing (402), by a processing device and from a sensing device, information pertaining to formation of a part of a 3D object in a layer of build materials upon which fusing agent droplets have been or are to be selectively deposited;
accessing data pertaining to correlations be-

tween different predicted properties of the part and different conditions detected during the formation of the part;
predicting (404), by the processing device, a quality of the part based upon the accessed information and based upon the accessed data pertaining to correlations;
determining (406), by the processing device, that an issue exists with the part based upon the predicted quality; and
at least one of implementing (408), by the processing device, a solution to the issue and outputting, by the processing device, an indication of the predicted quality of the part in response to the determination.

11. The method according to claim 10, wherein accessing information further comprises accessing at least one of detected temperatures of the layer of build materials and a detected advancement of a build area platform upon which the layer of build materials is supported.

12. The method according to claim 10, further comprising:

identifying a print mode to be followed in the formation of the part; and
determining whether the identified print mode exceeds a predefined quality level, and wherein implementing the solution further comprises implementing the solution in response to the identified print mode exceeding the predefined quality level.

13. The method according to claim 10, further comprising:

determining a severity of the determined issue;
determining (516) whether the severity of the determined issue exceeds a predefined severity level; and
in response to a determination that the severity of the determined issue exceeds the predefined severity level, outputting (518) a quality alert.

14. The method according to claim 10, further comprising:
implementing the solution by varying application of warming energy onto the layer of build materials from a predefined application of the warming energy.

15. A non-transitory computer readable medium on which is stored machine readable instructions that when executed by a processing device, cause the processing device to:

access, from a sensing device, information pertaining to formation of a part of a 3D object in a layer of build materials upon which fusing agent droplets have been or are to be selectively deposited;
access data pertaining to correlations between different predicted properties of the part and different conditions detected during the formation of the part; predict a quality of the part based upon the accessed information and based upon the accessed data pertaining to correlations;
determine that a potential problem exists with the part based upon the predicted quality; and
at least one of implement a solution to the determined potential problem and output an indication of the predicted quality of the part.

Patentansprüche

1. Rechenvorrichtung (200), die Folgendes umfasst:

eine Verarbeitungsvorrichtung (140);
ein maschinenlesbares Speichermedium (210), auf dem Anweisungen gespeichert sind, die, wenn sie durch die Verarbeitungsvorrichtung ausgeführt werden, die Verarbeitungsvorrichtung zu Folgendem veranlassen:

Abrufen (212), von einer Erfassungsvorrichtung, von Informationen, die eine Ausbildung eines Teils eines 3D-Objekts in einer Schicht von Baumaterialien betreffen, auf die Schmelzmitteltröpfchen selektiv abgeschieden wurden oder werden sollen;
Abrufen von Daten, die Korrelationen zwischen verschiedenen vorhergesagten Eigenschaften des Teils und verschiedenen Bedingungen betreffen, die während der Ausbildung des Teils erkannt werden; Vorhersagen (216) einer Qualität des Teils auf der Basis der abgerufenen Informationen und auf der Basis der abgerufenen Informationen, die Korrelationen betreffen; und
Ausgeben (224) einer Angabe der vorhergesagten Qualität des Teils.

2. Rechenvorrichtung nach Anspruch 1, wobei die abgerufenen Informationen durch die Erfassungsvorrichtung der Schicht von Baumaterialien erkannte Temperaturen umfassen und wobei, um die Qualität des Teils vorherzusagen, die Anweisungen ferner dazu dienen, die Verarbeitungsvorrichtung zu Folgendem zu veranlassen:

Vergleichen (214) der erkannten Temperaturen mit einem zuvor bestimmten Temperaturbereich; und
Vorhersagen (216) der Qualität des Teils auf der

Basis eines Ergebnisses des Vergleichs.

3. Rechenvorrichtung nach Anspruch 2, wobei die Anweisungen ferner dazu dienen, die Verarbeitungsvorrichtung zu Folgendem zu veranlassen:

Bestimmen (218), ob ein Problem in Bezug auf das Teil besteht, auf der Basis der vorhergesagten Qualität; und
als Reaktion auf eine Bestimmung, dass ein Problem besteht, Bestimmen (220), ob eine Lösung für das bestimmte Problem verfügbar ist, wobei die Lösung für das bestimmte Problem davon abhängt, ob die erkannten Temperaturen den zuvor bestimmten Schwellenwertbereich über- oder unterschreiten, und ein Variieren eines Betriebs einer Erwärmungsvorrichtung beinhaltet.

4. Rechenvorrichtung nach Anspruch 1, wobei die Anweisungen ferner dazu dienen, die Verarbeitungsvorrichtung zu Folgendem zu veranlassen:

Bestimmen (218), ob ein Problem in Bezug auf das Teil besteht, auf der Basis der vorhergesagten Qualität;
als Reaktion auf eine Bestimmung, dass ein Problem besteht, Bestimmen (220), ob eine Lösung für das Problem verfügbar ist; und
als Reaktion auf eine Bestimmung, dass eine Lösung für das Problem verfügbar ist, Implementieren der Lösung.

5. Rechenvorrichtung nach Anspruch 1, wobei die Anweisungen ferner dazu dienen, die Verarbeitungsvorrichtung zu Folgendem zu veranlassen:

Bestimmen, ob ein Problem in Bezug auf das Teil besteht, auf der Basis der vorhergesagten Qualität;
Bestimmen (222), ob ein Schwierigkeitsgrad des Problems eine vordefinierte Schwierigkeitsstufe überschreitet; und
als Reaktion auf eine Bestimmung, dass der Schwierigkeitsgrad des Problems die vordefinierte Schwierigkeitsstufe überschreitet, Ausgeben (224) einer Qualitätswarnung.

6. Rechenvorrichtung nach Anspruch 5, wobei die vordefinierte Schwierigkeitsstufe einem ausgewählten Druckmodus für die Ausbildung des Teils entspricht.

7. Rechenvorrichtung nach Anspruch 1, wobei die Anweisungen ferner dazu dienen, die Verarbeitungsvorrichtung zu Folgendem zu veranlassen:

Identifizieren eines Druckmodus, der bei der Ausbildung des Teils befolgt werden soll;
Bestimmen (218), auf der Basis der vorhergesagten Qualität, ob ein Problem in Bezug auf das Teil besteht;
als Reaktion auf eine Bestimmung, dass ein Problem besteht, Bestimmen (220), ob eine Lösung für das Problem verfügbar ist;
Bestimmen (222), ob der identifizierte Druckmodus eine vordefinierte Qualitätsstufe überschreitet; und
Implementieren der Lösung als Reaktion auf den identifizierten Druckmodus, der die vordefinierte Qualitätsstufe überschreitet.

8. Rechenvorrichtung nach Anspruch 1, wobei die abgerufenen Informationen ein erkanntes Vorschieben einer Baubereichsplattform umfassen, auf der die Schicht von Baumaterialien getragen wird, und wobei, um die Qualität des Teils vorherzusagen, die Anweisungen ferner dazu dienen, die Verarbeitungsvorrichtung zu Folgendem zu veranlassen:

Vergleichen eines erkannten Vorschubs der Baubereichsplattform mit einem zuvor bestimmten Vorschubabstand; und
Vorhersagen der Qualität des Teils auf der Basis eines Ergebnisses des Vergleichs.

9. Rechenvorrichtung nach Anspruch 1, wobei die vorhergesagte Qualität des Teils mechanische Eigenschaften, Rauheit, Maßhaltigkeit und/oder Farbe des Teils beinhaltet.

10. Verfahren (400), das Folgendes umfasst:

Abrufen (402) durch eine Verarbeitungsvorrichtung und von einer Erfassungsvorrichtung, von Informationen, die die Ausbildung eines Teils eines 3D-Objekts in einer Schicht von Baumaterialien betreffen, auf die Schmelzmitteltröpfchen selektiv abgeschieden wurden oder werden sollen;
Abrufen von Daten, die Korrelationen zwischen verschiedenen vorhergesagten Eigenschaften des Teils und verschiedenen Bedingungen betreffen, die während der Ausbildung des Teils erkannt werden;
Vorhersagen (404), durch die Verarbeitungsvorrichtung, einer Qualität des Teils auf der Basis der abgerufenen Informationen und auf der Basis der abgerufenen Daten, die Korrelationen betreffen;
Bestimmen (406), durch die Verarbeitungsvorrichtung, dass ein Problem mit dem Teil besteht, auf der Basis der vorhergesagten Qualität; und
Implementieren (408), durch die Verarbeitungsvorrichtung, einer Lösung des Problems und/oder Ausgeben, durch die Verarbeitungsvorrichtung, einer Angabe der vorhergesagten Qualität des Teils als Reaktion auf die Bestim-

mung.

11. Verfahren nach Anspruch 10, wobei das Abrufen von Informationen ferner das Abrufen von erkannten Temperaturen der Schicht von Baumaterialien und/oder einen erkannten Vorschub einer Baubereichsplattform umfasst, auf der die Schicht von Baumaterialien getragen wird.

12. Verfahren nach Anspruch 10, das ferner Folgendes umfasst:

Identifizieren eines Druckmodus, der bei der Ausbildung des Teils zu befolgen ist; und
Bestimmen, ob der identifizierte Druckmodus eine vordefinierte Qualitätsstufe überschreitet, und wobei das Implementieren der Lösung ferner das Implementieren der Lösung als Reaktion auf den identifizierten Druckmodus, der die vordefinierte Qualitätsstufe überschreitet, umfasst.

13. Verfahren nach Anspruch 10, das ferner Folgendes umfasst:

Bestimmen eines Schwierigkeitsgrads des bestimmten Problems;
Bestimmen (516), ob der Schwierigkeitsgrad des bestimmten Problems eine vordefinierte Schwierigkeitsstufe überschreitet; und
als Reaktion auf eine Bestimmung, dass der Schwierigkeitsgrad des bestimmten Problems die vordefinierte Schwierigkeitsstufe überschreitet, Ausgeben (518) einer Qualitätswarnung.

14. Verfahren nach Anspruch 10, das ferner Folgendes umfasst:
Implementieren der Lösung durch Variieren einer Anwendung von Erwärmungsenergie auf die Schicht von Baumaterialien von einer vordefinierten Anwendung der Erwärmungsenergie.

15. Nichtflüchtiges, computerlesbares Medium, auf dem maschinenlesbare Anweisungen gespeichert sind, die, wenn sie durch eine Verarbeitungsvorrichtung ausgeführt werden, die Verarbeitungsvorrichtung zu Folgendem veranlassen:

Abrufen, von einer Erfassungsvorrichtung, von Informationen, die die Ausbildung eines Teils eines 3D-Objekts in einer Schicht von Baumaterialien betreffen, auf die Schmelzmitteltröpfchen selektiv abgeschieden wurden oder werden sollen;
Abrufen von Daten, die Korrelationen zwischen verschiedenen vorhergesagten Eigenschaften des Teils und verschiedenen Bedingungen betreffen, die während der Ausbildung des Teils erkannt werden; Vorhersagen einer Qualität des Teils auf der Basis der abgerufenen Informationen und auf der Basis der abgerufenen Daten, die Korrelationen betreffen;
Bestimmen, dass ein potenzielles Problem mit dem Teil besteht, auf der Basis der vorhergesagten Qualität; und
Implementieren einer Lösung des bestimmten potenziellen Problems und/oder Ausgeben einer Angabe der vorhergesagten Qualität des Teils.

Revendications

1. Appareil informatique (200) comprenant :

un dispositif de traitement (140) ;
un support de stockage lisible par machine (210) sur lequel sont stockées des instructions qui, lorsqu'elles sont exécutées par le dispositif de traitement, amènent le dispositif de traitement à :

consulter (212), depuis un dispositif de détection, des informations concernant une formation d'une pièce d'un objet 3D dans une couche de matériaux de construction sur laquelle des gouttelettes d'agent de fusion ont été ou doivent être déposées sélectivement ;
consulter des données concernant des corrélations entre différentes propriétés prédites de la pièce et différentes conditions détectées lors de la formation de la pièce ; prédire (216) une qualité de la pièce sur la base des informations consultées et sur la base des données consultées concernant des corrélations ; et
fournir (224) une indication de la qualité prédite de la pièce.

2. Appareil informatique selon la revendication 1, dans lequel les informations consultées comprennent des températures détectées par le dispositif de détection de la couche de matériaux de construction et dans lequel, pour prédire la qualité de la pièce, les instructions doivent en outre amener le dispositif de traitement à :

comparer (214) les températures détectées à une plage de températures prédéterminée ; et
prédire (216) la qualité de la pièce sur la base d'un résultat de la comparaison.

3. Appareil informatique selon la revendication 2, dans lequel les instructions doivent en outre amener le dispositif de traitement à :

déterminer (218) si un problème existe par rapport à la pièce sur la base de la qualité prédite ; et en réponse à la détermination selon laquelle un problème existe, déterminer (220) si une solution au problème déterminé est disponible, la solution au problème déterminé dépendant du fait de savoir si les températures détectées dépassent ou tombent en dessous de la plage seuil prédéterminée et comportant la variation d'un fonctionnement d'un dispositif de chauffage.

4. Appareil informatique selon la revendication 1, dans lequel les instructions doivent en outre amener le dispositif de traitement à :

déterminer (218) si un problème existe par rapport à la pièce sur la base de la qualité prédite ;
en réponse à une détermination selon laquelle un problème existe, déterminer (220) si une solution au problème est disponible ; et
en réponse à une détermination selon laquelle une solution au problème est disponible, mettre en oeuvre la solution.

5. Appareil informatique selon la revendication 1, dans lequel les instructions doivent en outre amener le dispositif de traitement à :

déterminer si un problème existe par rapport à la pièce sur la base de la qualité prédite ;
déterminer (222) si une gravité du problème dépasse un niveau de gravité prédéfini ; et
en réponse à une détermination selon laquelle la gravité du problème dépasse le niveau de gravité prédéfini, fournir (224) une alerte de qualité.

6. Appareil informatique selon la revendication 5, dans lequel le niveau de gravité prédéfini correspond à un mode d'impression sélectionné pour la formation de la pièce.

7. Appareil informatique selon la revendication 1, dans lequel les instructions doivent en outre amener le dispositif de traitement à :

identifier un mode d'impression à suivre dans la formation de la pièce ;
déterminer (218), sur la base de la qualité prédite, si un problème existe par rapport à la pièce ;
en réponse à une détermination selon laquelle un problème existe, déterminer (220) si une solution au problème est disponible ;
déterminer (222) si le mode d'impression identifié dépasse un niveau de qualité prédéfini ; et
mettre en oeuvre la solution en réponse au dépassement du niveau de qualité prédéfini par le mode d'impression identifié.

8. Appareil informatique selon la revendication 1, dans lequel les informations consultées comprennent une avancée détectée d'une plate-forme de zone de construction sur laquelle la couche de matériaux de construction est soutenue et dans lequel, pour prédire la qualité de la pièce, les instructions doivent en outre amener le dispositif de traitement à :

comparer un avancement détecté de la plate-forme de zone de construction avec une distance d'avancement prédéterminée ; et
prédire la qualité de la pièce sur la base d'un résultat de la comparaison.

9. Appareil informatique selon la revendication 1, dans lequel la qualité prédite de la pièce comporte les propriétés mécaniques, et/ou la rugosité, et/ou la précision dimensionnelle, et/ou la couleur de la pièce.

10. Procédé (400) comprenant :

le fait de consulter (402), par un dispositif de traitement et depuis un dispositif de détection, des informations concernant la formation d'une pièce d'un objet 3D dans une couche de matériaux de construction sur laquelle des gouttelettes d'agent de fusion ont été ou doivent être déposées sélectivement ;
le fait de consulter des données concernant des corrélations entre différentes propriétés prédites de la pièce et différentes conditions détectées lors de la formation de la pièce ;
la prédiction (404), par le dispositif de traitement, d'une qualité de la pièce sur la base des informations consultées et sur la base des données consultées concernant des corrélations ;
la détermination (406), par le dispositif de traitement, selon laquelle un problème existe avec la pièce sur la base de la qualité prédite ; et
la mise en œuvre (408), par le dispositif de traitement, d'une solution au problème et/ou la fourniture, par le dispositif de traitement, d'une indication de la qualité prédite de la pièce en réponse à la détermination.

11. Procédé selon la revendication 10, dans lequel le fait de consulter des informations comprend en outre le fait de consulter des températures détectées de la couche de matériaux de construction et/ou un avancement détecté d'une plate-forme de zone de construction sur laquelle la couche de matériaux de construction est soutenue.

12. Procédé selon la revendication 10, comprenant en outre :

l'identification d'un mode d'impression à suivre dans la formation de la pièce ; et
la détermination du fait de savoir si le mode d'impression identifié dépasse un niveau de qualité prédéfini, et la mise en œuvre de la solution comprenant en outre la mise en œuvre de la solution en réponse au mode d'impression identifié dépassant le niveau de qualité prédéfini.

13. Procédé selon la revendication 10, comprenant en outre :

la détermination d'une gravité du problème déterminé ;
la détermination (516) du fait de savoir si la gravité du problème déterminé dépasse un niveau de gravité prédéfini ; et
en réponse à une détermination selon laquelle la gravité du problème déterminé dépasse le niveau de gravité prédéfini, la fourniture (518) d'une alerte de qualité.

14. Procédé selon la revendication 10, comprenant en outre :
la mise en œuvre de la solution en faisant varier l'application d'énergie de chauffage sur la couche de matériaux de construction à partir d'une application prédéfinie de l'énergie de chauffage.

15. Support non transitoire lisible par ordinateur sur lequel sont stockées des instructions lisibles par machine qui, lorsqu'elles sont exécutées par un dispositif de traitement, amènent le dispositif de traitement à :

consulter, depuis un dispositif de détection, des informations concernant la formation d'une pièce d'un objet 3D dans une couche de matériaux de construction sur laquelle des gouttelettes d'agent de fusion ont été ou doivent être déposées sélectivement ;
consulter des données concernant des corrélations entre différentes propriétés prédites de la pièce et différentes conditions détectées lors de la formation de la pièce ; prédire une qualité de la pièce sur la base des informations consultées et sur la base des données consultées concernant des corrélations ;
déterminer qu'un problème potentiel existe avec la pièce sur la base de la qualité prédite ; et
mettre en œuvre une solution au problème potentiel déterminé et/ou fournir une indication de la qualité prédite de la pièce.

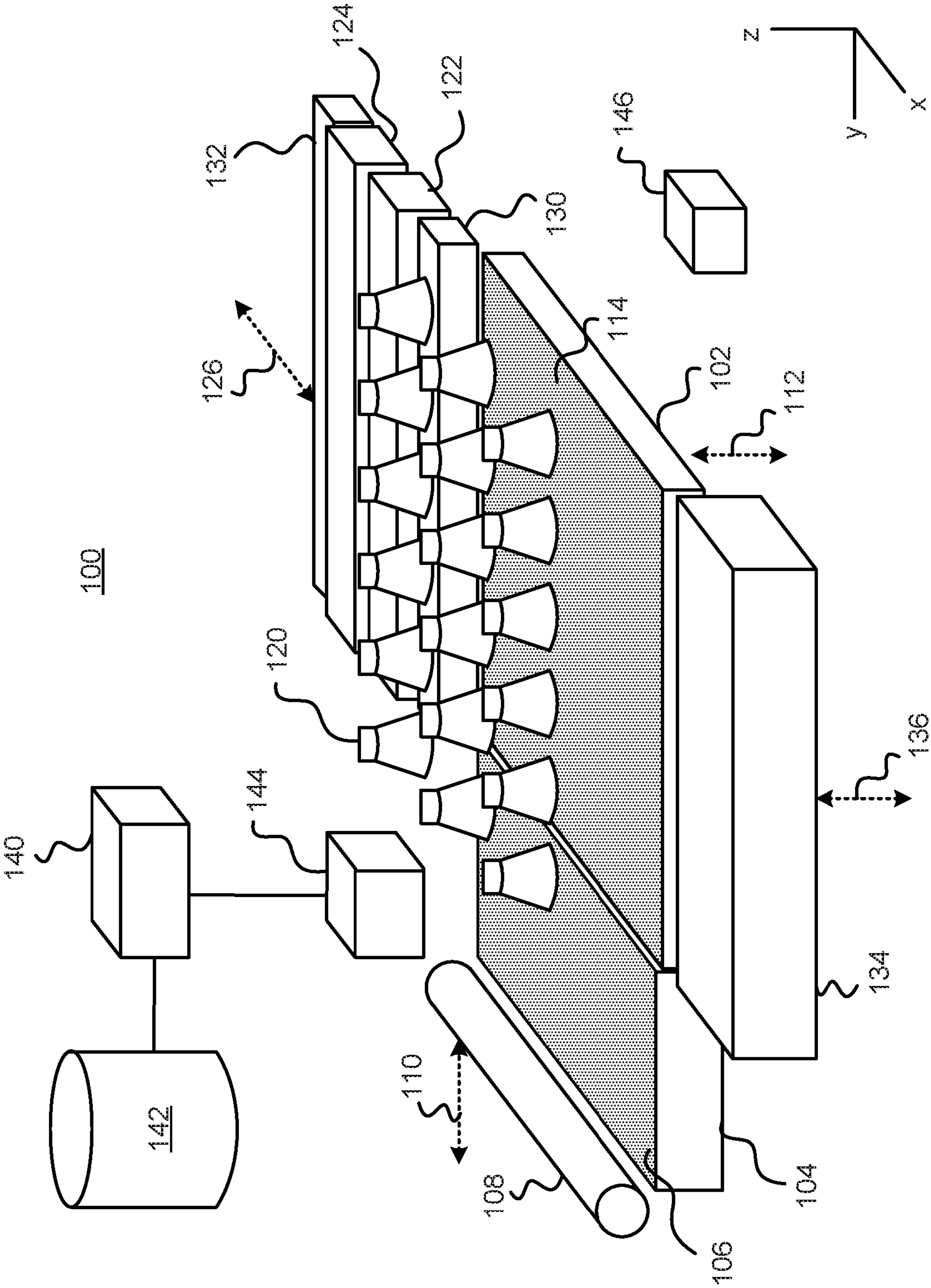
100
102
104
106
108
110
112
114
120
122
124
126
130
132
134
136
140
142
144
146
z
y
x

FIG. 1

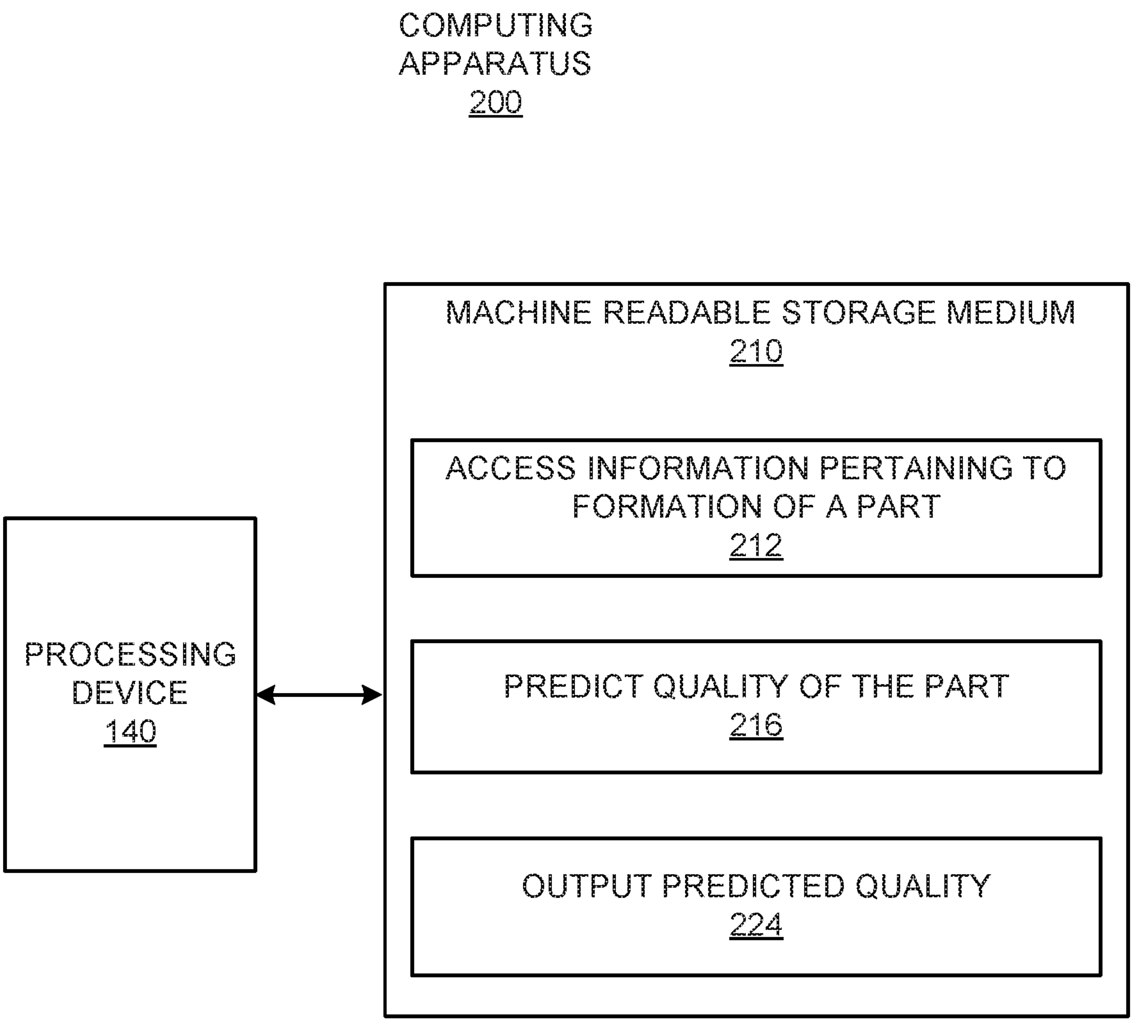
COMPUTING
APPARATUS
200
MACHINE READABLE STORAGE MEDIUM
210
ACCESS INFORMATION PERTAINING TO
FORMATION OF A PART
212
PROCESSING
DEVICE
140
PREDICT QUALITY OF THE PART
216
OUTPUT PREDICTED QUALITY
224

FIG. 2A

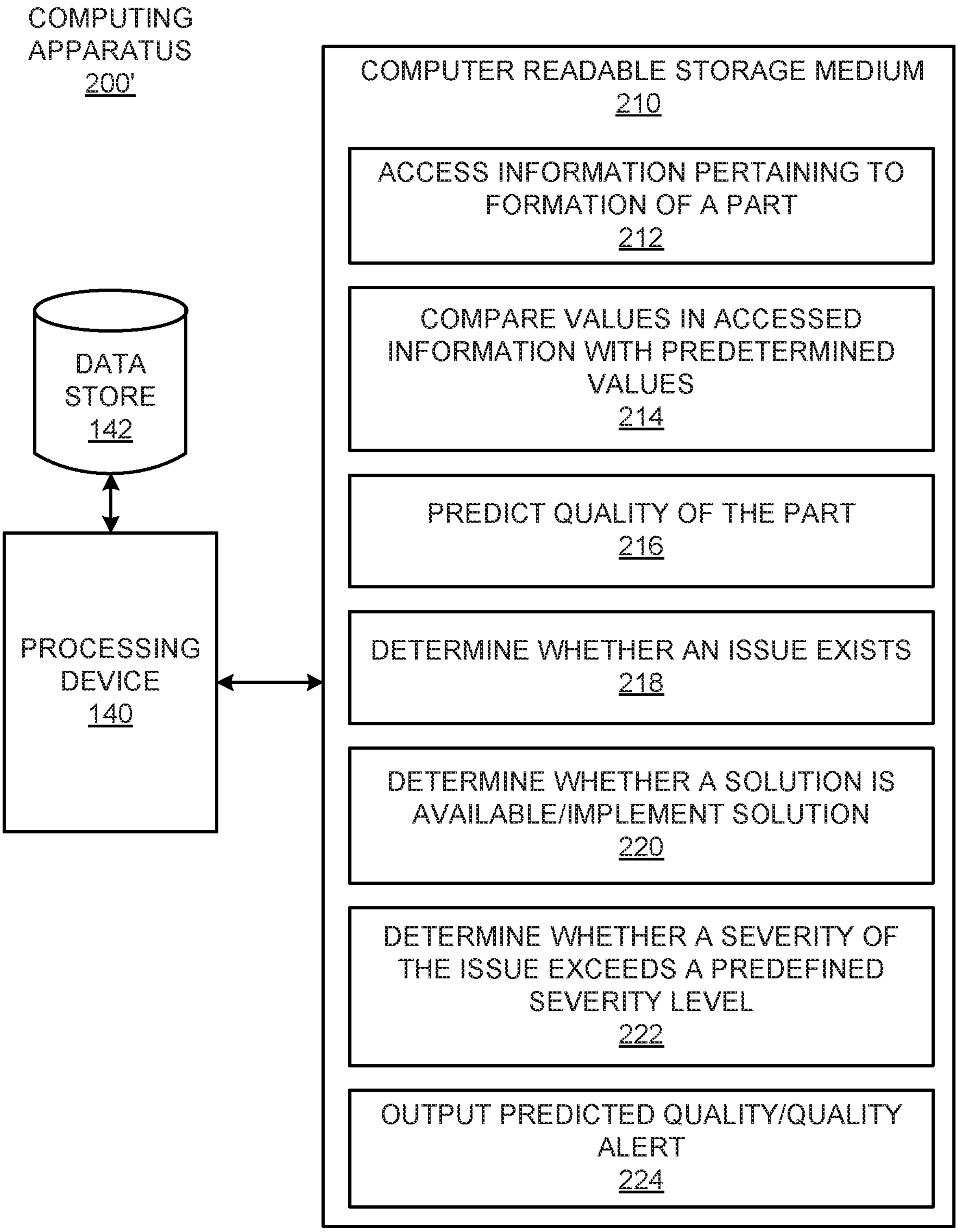
COMPUTING APPARATUS 200'
COMPUTER READABLE STORAGE MEDIUM 210
ACCESS INFORMATION PERTAINING TO FORMATION OF A PART 212
COMPARE VALUES IN ACCESSED INFORMATION WITH PREDETERMINED VALUES 214
DATA STORE 142
PREDICT QUALITY OF THE PART 216
PROCESSING DEVICE 140
DETERMINE WHETHER AN ISSUE EXISTS 218
DETERMINE WHETHER A SOLUTION IS AVAILABLE/IMPLEMENT SOLUTION 220
DETERMINE WHETHER A SEVERITY OF THE ISSUE EXCEEDS A PREDEFINED SEVERITY LEVEL 222
OUTPUT PREDICTED QUALITY/QUALITY ALERT 224

FIG. 2B

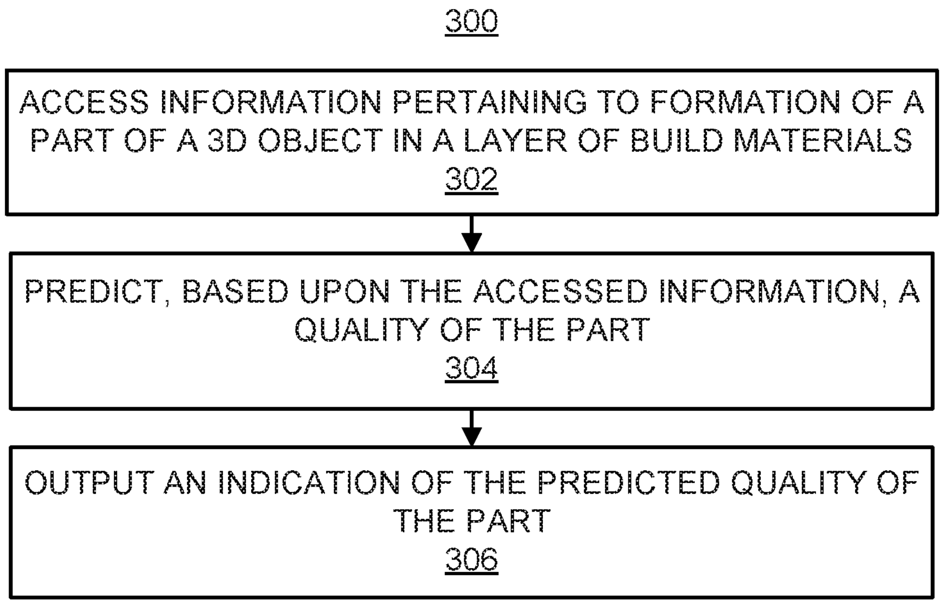
300
ACCESS INFORMATION PERTAINING TO FORMATION OF A PART OF A 3D OBJECT IN A LAYER OF BUILD MATERIALS
302
PREDICT, BASED UPON THE ACCESSED INFORMATION, A QUALITY OF THE PART
304
OUTPUT AN INDICATION OF THE PREDICTED QUALITY OF THE PART
306

FIG. 3

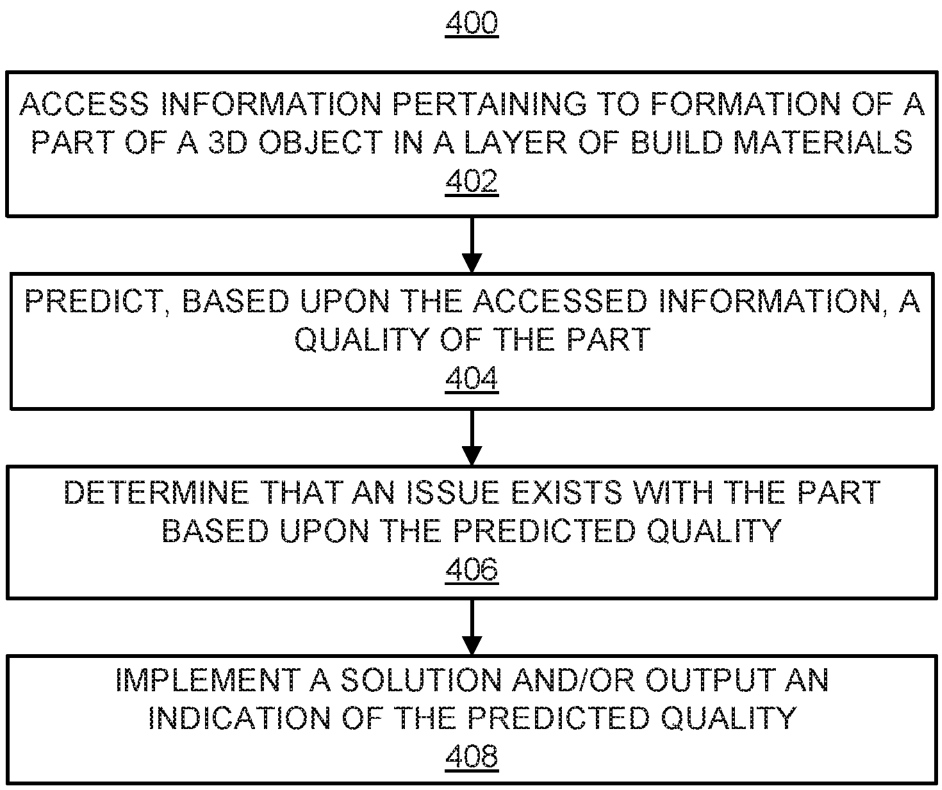
400
ACCESS INFORMATION PERTAINING TO FORMATION OF A PART OF A 3D OBJECT IN A LAYER OF BUILD MATERIALS
402
PREDICT, BASED UPON THE ACCESSED INFORMATION, A QUALITY OF THE PART
404
DETERMINE THAT AN ISSUE EXISTS WITH THE PART BASED UPON THE PREDICTED QUALITY
406
IMPLEMENT A SOLUTION AND/OR OUTPUT AN INDICATION OF THE PREDICTED QUALITY
408

FIG. 4

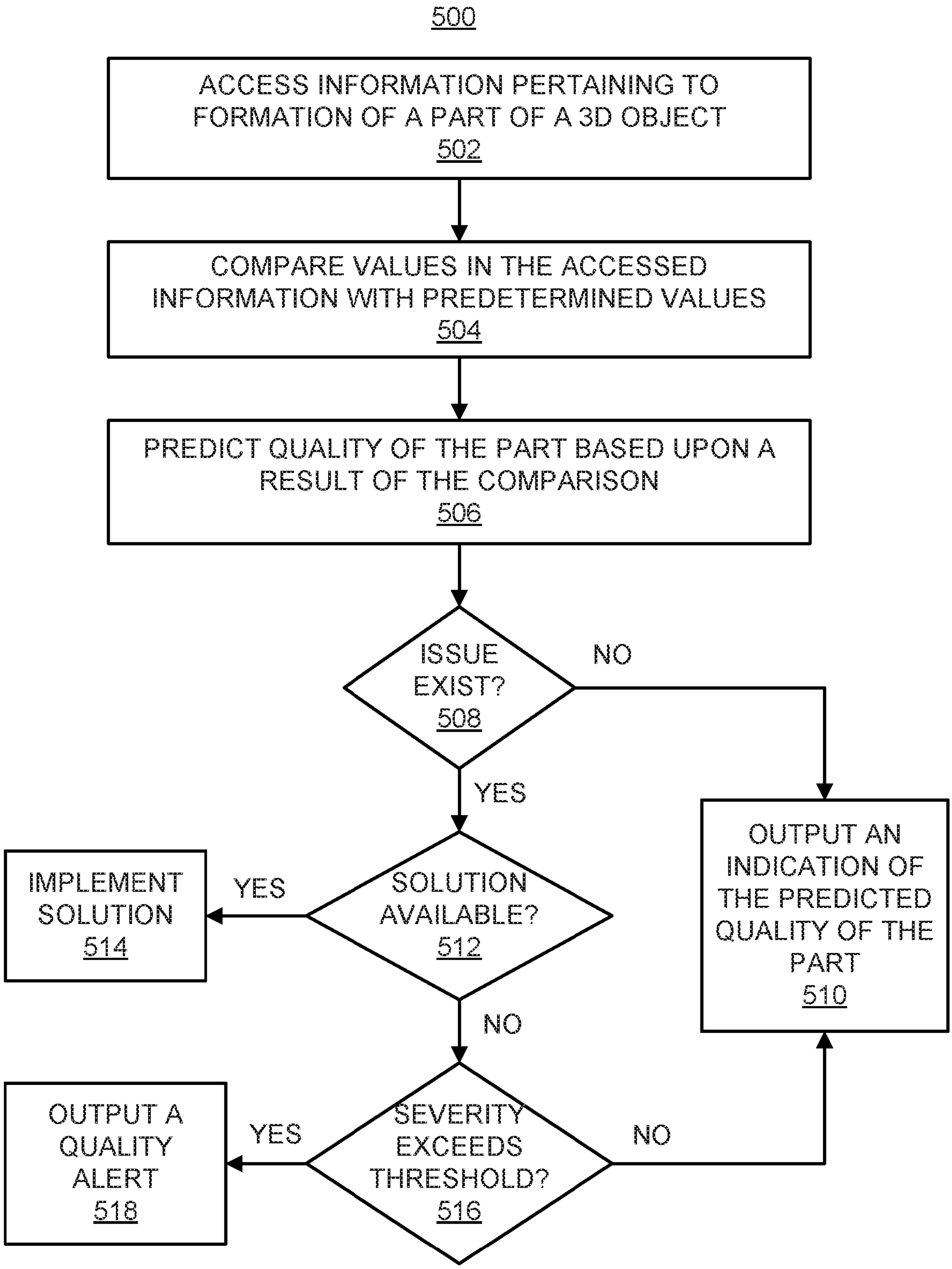
500
ACCESS INFORMATION PERTAINING TO FORMATION OF A PART OF A 3D OBJECT 502
COMPARE VALUES IN THE ACCESSED INFORMATION WITH PREDETERMINED VALUES 504
PREDICT QUALITY OF THE PART BASED UPON A RESULT OF THE COMPARISON 506
ISSUE EXIST? 508
NO
YES
OUTPUT AN INDICATION OF THE PREDICTED QUALITY OF THE PART 510
IMPLEMENT SOLUTION 514
YES
SOLUTION AVAILABLE? 512
NO
OUTPUT A QUALITY ALERT 518
YES
SEVERITY EXCEEDS THRESHOLD? 516
NO

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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- US 2015266242 A1 **[0003]**
- DE 102015011013 A1 **[0004]**
- WO 2014118635 A2 **[0005]**