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(54) **OBJECT RECOGNITION FOR 3D PRINTING**

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(57) **ABSTRACT**

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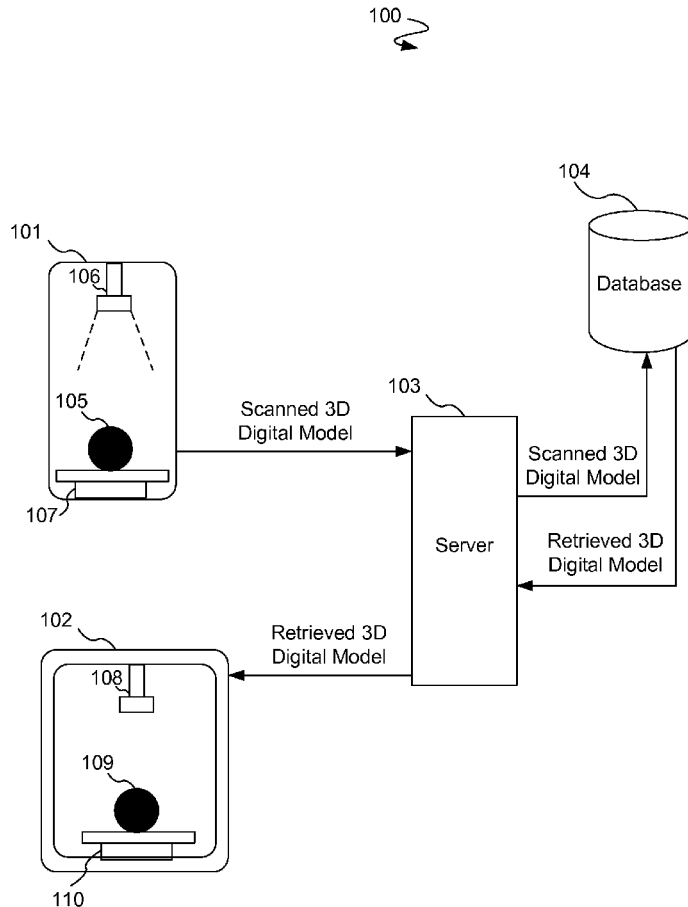
A process and system scan an object to generate a first 3D digital model of the object. Further, the process and system send data corresponding to the first 3D digital model to a server that is in communication with a database of high quality 3D digital models of a plurality of objects. In addition, the process and system receive a second 3D digital model of the object from the server based upon a matching of the first 3D digital model and the second 3D digital model, the second 3D digital model having a higher resolution of the object than the first 3D digital model. The process and system also print a 3D replica of the object based upon the second 3D digital model.

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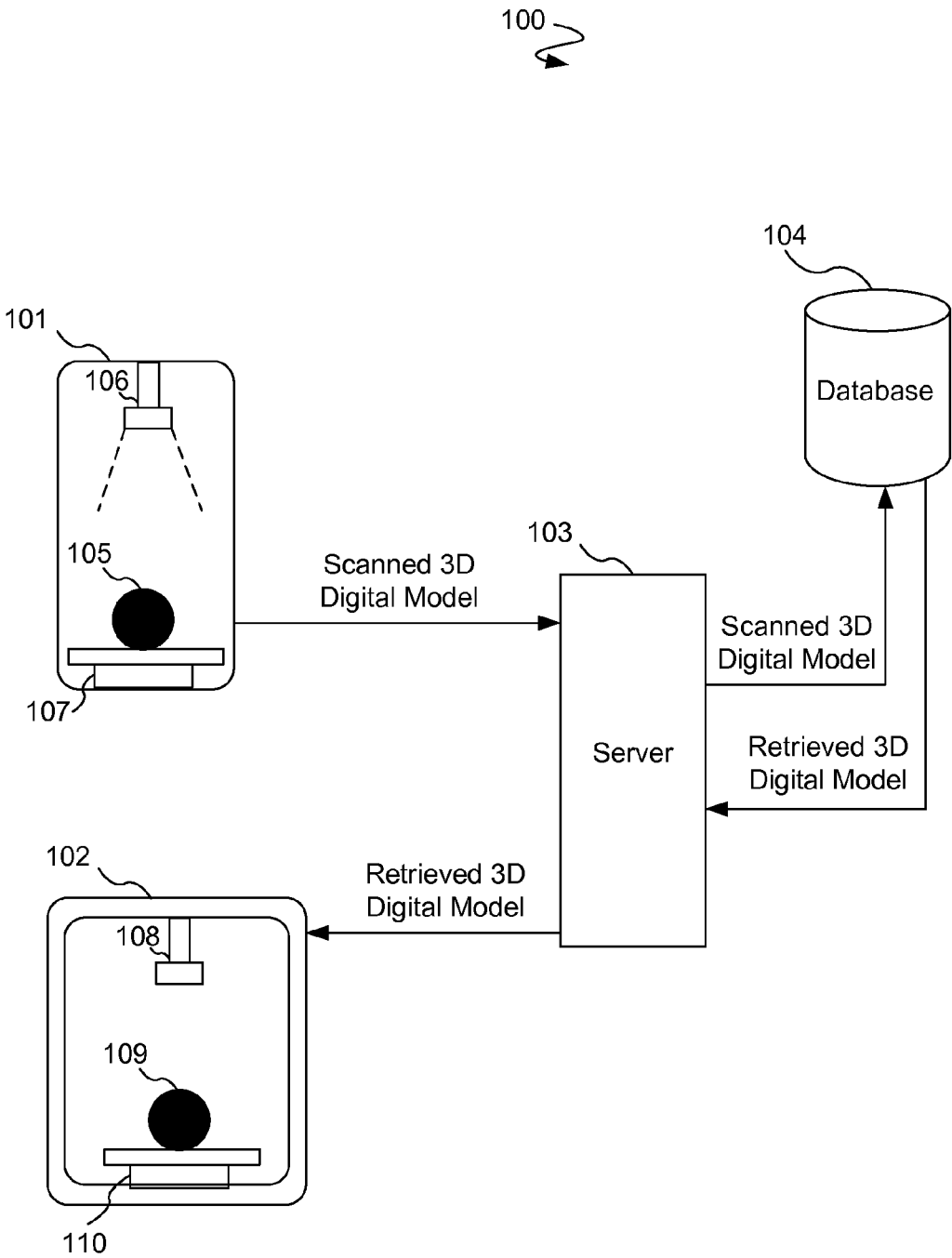


Figure 1

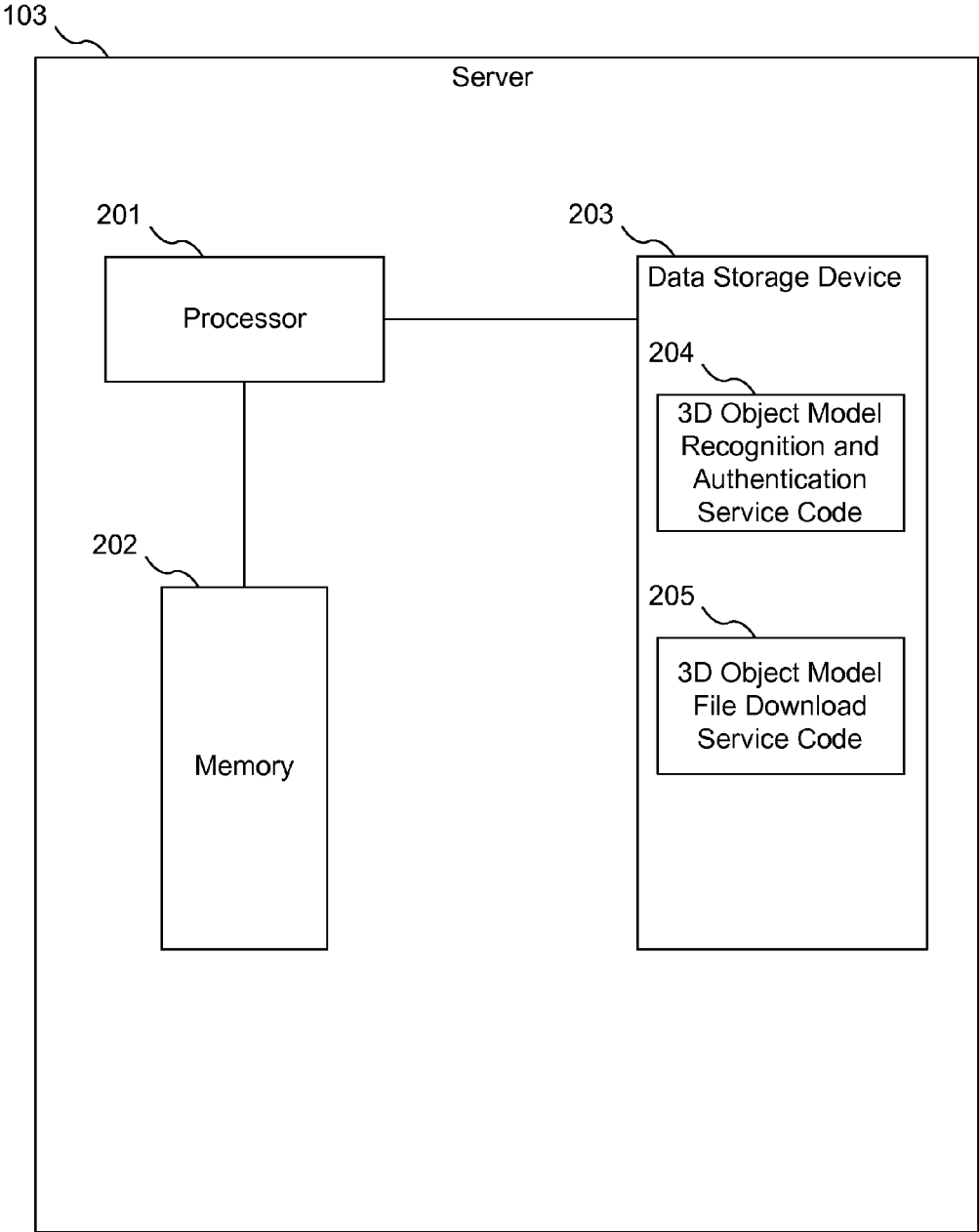


Figure 2

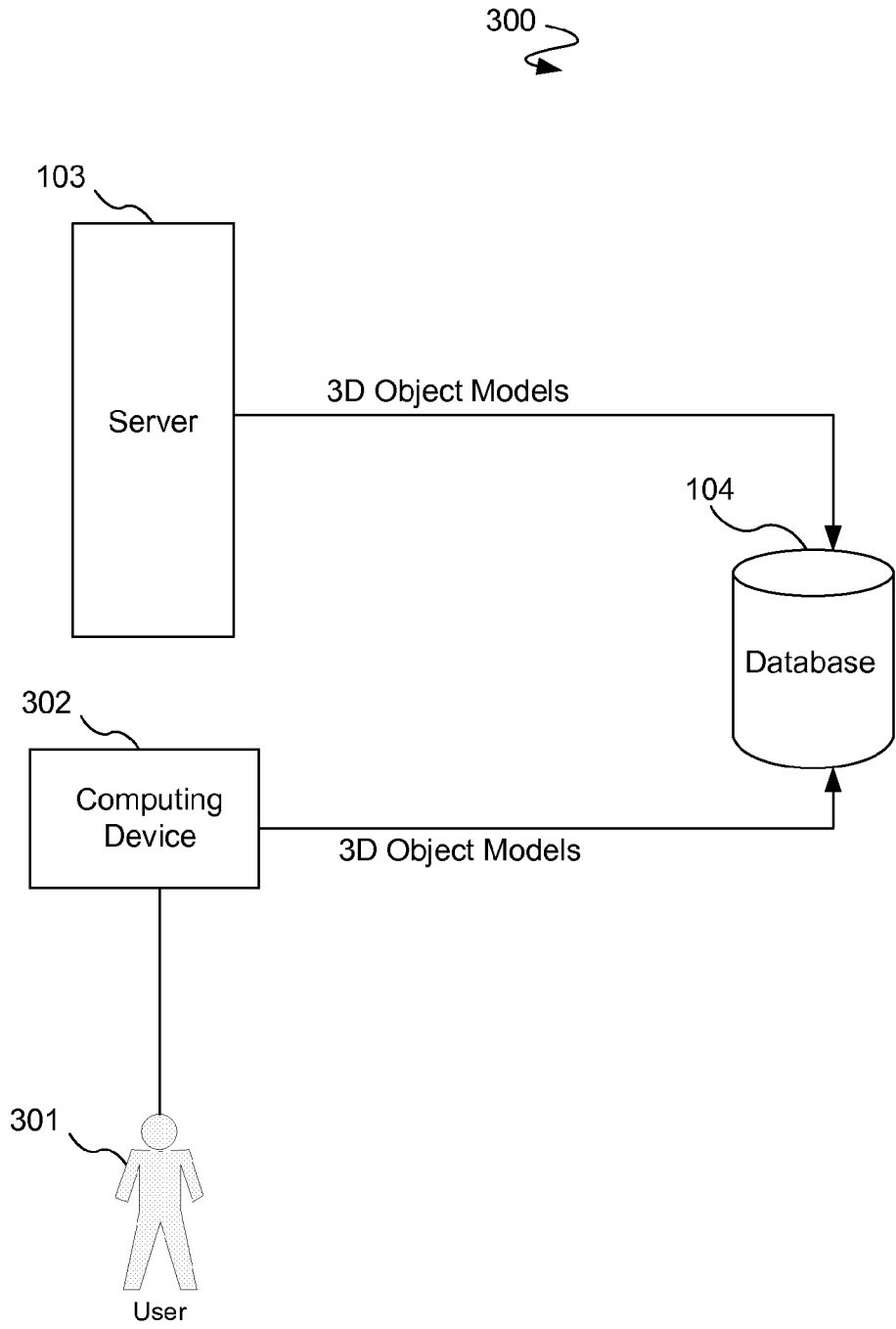


Figure 3

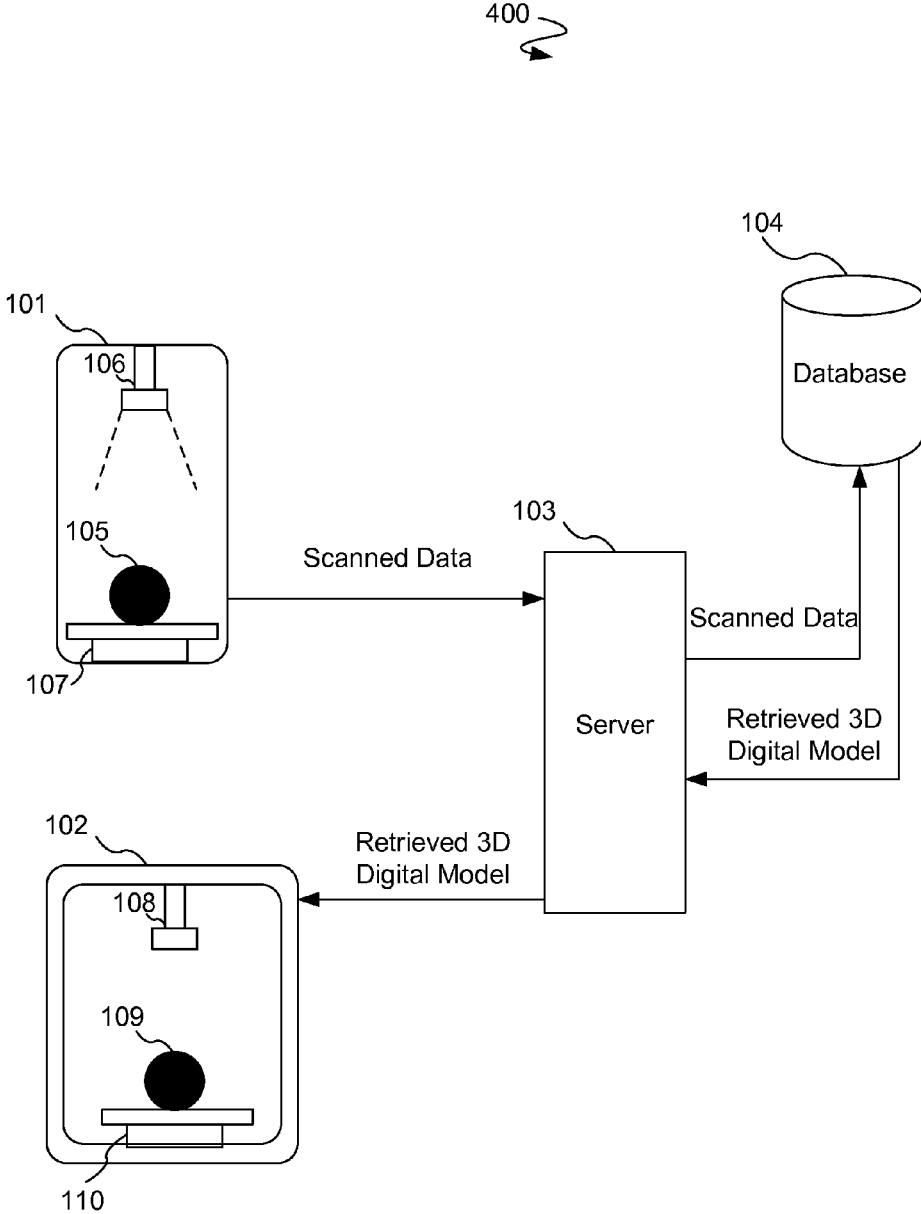


Figure 4A

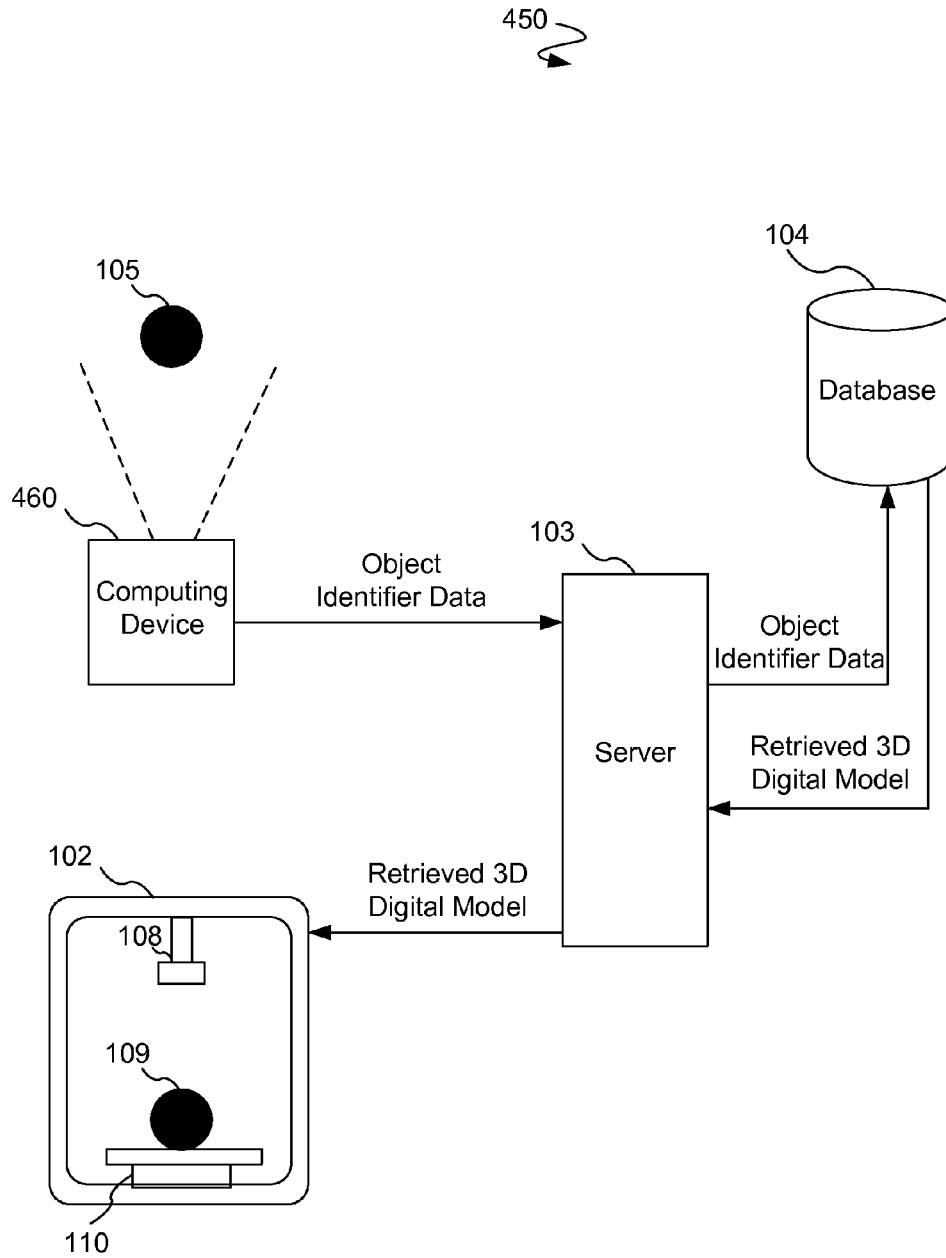


Figure 4B

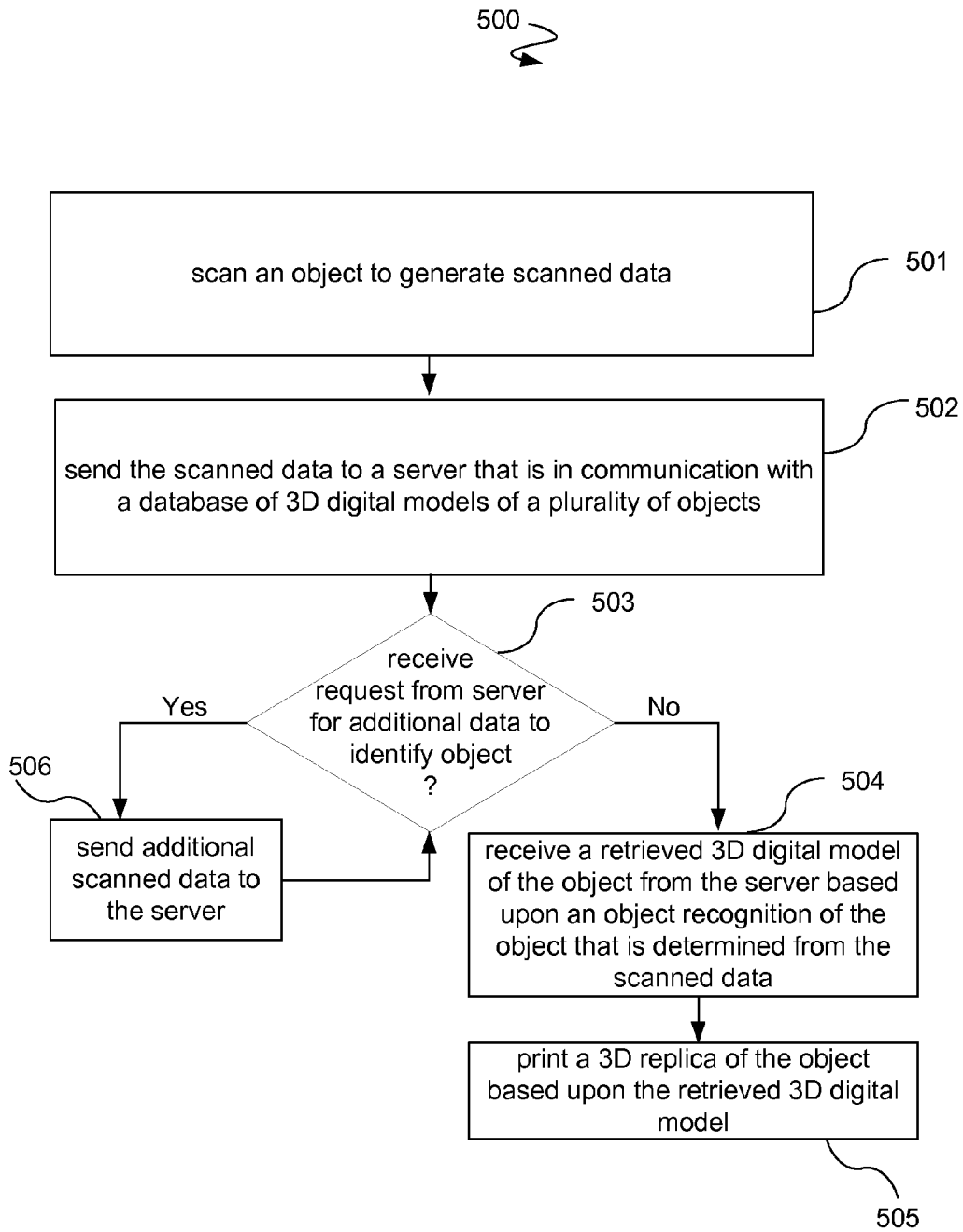


Figure 5

OBJECT RECOGNITION FOR 3D PRINTING

BACKGROUND

[0001] 1. Field

[0002] This disclosure generally relates to the field of printer configurations. More particularly, the disclosure relates to 3D printer configurations.

[0003] 2. General Background

[0004] Several current 3D printer configurations allow for a 3D printer to be operably connected to an accessory scanner that may be used by a user to scan an object for 3D printing. As an example, an accessory scanner has a turntable on which the object to be scanned is positioned, an image capture device such as a camera, and a plurality of light emitting devices. As the turntable is rotated by the scanner, the image capture device captures images of the object as light from the emitters is reflected from the object and to the camera.

[0005] The user scans the object with the scanner, e.g., the user places the object inside of the scanner. The scanner itself or a computing device operably connected to the scanner then generates a 3D digital model of the scanned object. The 3D printer then prints the object based on the 3D digital model.

[0006] The 3D digital models generated by the current scanner accessories for 3D printer configurations are typically generated at a low resolution. The typical components of an accessory scanner for a 3D printer, e.g., a turntable, an image capture device, and a plurality of light emitting devices, are generally only capable of generating a low resolution 3D digital model. By utilizing a low resolution 3D digital model, the 3D printer often prints a low quality 3D copy of the object with substantial errors.

[0007] Therefore, it is very difficult and expensive to get a high quality, 3D printed copy of a scanned object. An object recognition system that performs object recognition directly or uses the 3D digital model generated by the 3D printer scanner accessory is needed to recognize the object that is being 3D printed, retrieve a high resolution 3D digital model based upon the recognized object, and perform 3D printing based upon the retrieved high resolution 3D digital model.

SUMMARY

[0008] A process and system scan an object to generate a first 3D digital model of the object. Further, the process and system send data corresponding to the first 3D digital model to a server that is in communication with a database of 3D digital models of a plurality of objects. In addition, the process and system receive a second 3D digital model of the object from the server based upon a matching of the first 3D digital model and the second 3D digital model, the second 3D digital model having a higher resolution of the object than the first 3D digital model. The process and system also print a 3D replica of the object based upon the second 3D digital model.

[0009] A process and system also scan an object to generate scanned data. Further, the process and system send the scanned data to a server that is in communication with a database of 3D digital models of a plurality of objects. In addition, the process and system receive a 3D digital model of the object from the server based upon an object recognition of the object that is determined from the scanned data. The process and system print a 3D replica of the object based upon the 3D digital model.

[0010] A process and system also receive object identifier data for an object from a computing device that performs

object recognition of the object. The process and system retrieve a 3D digital model of the object from a database of a plurality of 3D digital models of objects based upon the object identifier data. Further, the process and system send the 3D digital model of the object to a 3D printer that prints a 3D replica of the object based upon the 3D digital model.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above-mentioned features of the present disclosure will become more apparent with reference to the following description taken in conjunction with the accompanying drawings wherein like reference numerals denote like elements and in which:

[0012] FIG. 1 illustrates an object recognition system.

[0013] FIG. 2 illustrates the internal components of the server.

[0014] FIG. 3 illustrates a 3D model storage configuration.

[0015] FIG. 4A illustrates an alternative implementation that uses scanned data rather than scanned 3D digital models.

[0016] FIG. 4B illustrates yet another alternative implementation that performs direct object recognition of the object.

[0017] FIG. 5 illustrates a process that is used by the alternative implementation to iteratively obtain scanned data to find a high resolution 3D digital model.

DETAILED DESCRIPTION

[0018] An object recognition system is provided to recognize an object for 3D printing purposes. By identifying the object to be 3D printed, the object recognition system is able to retrieve a high quality 3D digital model of the object that has been previously stored in a database of high quality 3D digital models. As a result, a user does not have to attempt to scan an object and then obtain a 3D replica based upon a low quality scan of the object. The user scans enough information about the object so that the object can be identified by the object recognition system. After identifying the object, the object recognition system obtains a high quality 3D digital model of the object and sends that high quality 3D digital model to a 3D printer for printing.

[0019] The object recognition system allows a user to obtain a more high quality 3D printed replica than those provided by previous configurations that rely on a scanner that is typically only able to generate low resolution 3D digital models. Further, the object recognition system provides a less time consuming process for scanning and 3D printing since the object recognition system relies on obtaining only enough information from the scanner as needed for object recognition purposes rather than previous configurations that relied on obtaining as much information as possible about the object that is being 3D printed from the scanner in an attempt to perform 3D printing based on that information.

[0020] FIG. 1 illustrates an object recognition system 100. The object recognition system 100 includes a scanner 101, a 3D printer 102, a server 103, and a database 104.

[0021] In one implementation, a user places an object 105 that the user wants to replicate in 3D inside of the scanner 101. The scanner 101 may have a turntable 107 or other mechanism for rotating the object 105 to different orientations. During the rotation of the object 105, an image capture device 106, e.g., camera, records images of various features of the object 105. The scanner 101 and/or a computing device in operable communication with the scanner 101 then generates

a 3D digital model of the object **105**. The scanned 3D digital model includes only enough information as needed to identify distinguishing features of the object **105**. In other words, the scanned 3D digital model is not a high resolution scanned model.

[0022] In another implementation, a user uses a wand scanner to scan the object **105**. Various types of scanner configurations may be used as the scanner **101**.

[0023] The scanner **101** and/or a computing device in operable communication with the scanner **101** then sends the scanned 3D digital model to a server **103**. The server **103** searches a database **104** for a high resolution 3D digital model that was previously stored and that has corresponding identifying features to that of the scanned 3D digital model. After obtaining the retrieved high resolution 3D digital model, the server **103** sends the retrieved high resolution 3D digital model to a 3D printer **102** and/or a computing device in operable communication with the 3D printer **102**.

[0024] The 3D printer **102** has a fixed build plate **110** on which a material **109** is placed. The 3D printer **102** uses a printer head **108** that is able to send one or more lasers toward the material **109** to print a 3D replica of the object **105**. The 3D printer **102** uses the retrieved high resolution 3D digital model as the basis for the replication. The 3D printer **102** can be any 3D printer that is capable of printing high resolution objects from a 3D model.

[0025] FIG. 2 illustrates the internal components of the server **103**. The server **103** includes a processor **201**, a memory **202**, and a data storage device **203**. The data storage device **203** includes 3D object recognition and authentication service code **204** in addition to 3D object model file download service code **205**.

[0026] The server **103** uses the processor **201** to retrieve the 3D object recognition and authentication service code **204** to recognize identifying features of the scanned 3D digital model. For example, the scanned object **105** may have corners in particular locations. The 3D object recognition and authentication service code **204** is used by the processor **201** to retrieve high resolution 3D models from the database **104** based on those identifying features. In one implementation, the 3D object recognition and authentication service code **204** is used by the processor **201** to authenticate which of the retrieved high resolution 3D models most closely resembles the scanned object **105**. For instance, the retrieved high resolution 3D models may have some features in common with the scanned object **105**. The processor **201** uses the 3D object recognition and authentication service code **204** to determine which of the retrieved high resolution 3D models shares the most common distinguishing features with that of the scanned object **105**.

[0027] In another implementation, the 3D object recognition and authentication service code **204** uses a criterion that each distinguishing feature determined from the scanned 3D digital model has to be present in the retrieved high resolution 3D digital model. The 3D object recognition and authentication service code **204** attempts to narrow the possible 3D digital models to a single digital model based upon such criterion. If multiple high resolution models are retrieved based upon such criterion, the server **103** requests additional distinguishing features from the scanner **101** and/or a computing device in operable communication with the scanner **101**. The scanner **101** may automatically provide such additional data or inform the user that further scanning is necessary to obtain such additional data so that the scanner **101** may

send the additional data to the server **103**. The 3D object recognition and authentication service code **204** is then used by the processor **201** to further narrow the search results from the database **104**. The processor **201** iteratively searches and requests further data as necessary until a single high resolution 3D digital model is obtained.

[0028] After determining the high resolution 3D digital model, the processor **201** uses 3D object model file download service code **205** to send the high resolution retrieved 3D digital model to the 3D printer so that the 3D printer **102** replicates the object **105** with the material **109** based upon the high resolution retrieved 3D digital model.

[0029] FIG. 3 illustrates a 3D model storage configuration **300**. The 3D model storage configuration **300** allows a user **301** to use a computing device **302** to store high resolution 3D object models in the database **104** for subsequent retrieval by the server **103** based upon receiving a scanned 3D model. Further, the 3D model storage configuration **300** allows the server **103** to also store high resolution 3D object models in the database **104** for subsequent retrieval by the server **103** based upon receiving a scanned 3D model. Accordingly, a variety of devices may be used to store 3D models prior to retrieval based upon scanning of objects **105** for replication.

[0030] FIG. 4A illustrates an alternative implementation **400** that uses scanned data rather than scanned 3D digital models. The scanner **101** scans data, e.g., distinguishing features of the object **105**, rather than a 3D digital model. The scanner **101** then sends the scanned data to the server **103** so that the server **103** searches the database **104** based upon the scanned data. The server **103** then obtains a retrieved 3D digital model based upon the scanned data. Further, the server **103** sends the retrieved 3D digital model to the 3D printer **102** so that the 3D printer replicates the object **105** with the material **109**.

[0031] FIG. 4B illustrates yet another alternative implementation **450** that performs direct object recognition of the object **105**. A computing device **460**, e.g., smartphone, tablet device, personal computer ("PC"), laptop computer, etc. performs an image capture of the object **105** and then uses object recognition code to identify the object **105**. In one implementation, the computing device **450** stores the object recognition code and an object database. The computing device **460** can use a built in or image capture device, e.g., camera, or an image capture device that is in operable communication with the computing device **460**. The computing device **460** then performs object recognition according to an object recognition algorithm that matches various features of the object captured in an image with features stored in the object database to find a matching object. In another implementation, the computing device **450** sends the image to an object recognition server that performs the object recognition, retrieves the object identifier from an object database, and sends the object identifier to the computing device **450**.

[0032] After performing object recognition or requesting an object recognition server to perform the object recognition, the computing device **450** obtains object identifier data for the object. The computing device **450** sends the object identifier data to the server **103**. The server sends the object identifier data to the database **104** to retrieve a high quality 3D digital model. The server **103** then sends the retrieved 3D digital model to the 3D printer **102** so that a replica is 3D printed.

[0033] FIG. 5 illustrates a process **500** that is used by the alternative implementation **400** to iteratively obtain scanned

data to find a high resolution 3D digital model. At **501**, the process **500** scans an object **105** to generate scanned data. Further, at **502**, the process **500** sends the scanned data to the server **103** to the database **104**. At **503**, the process **500** determines whether or not a request has been received from the server **103** for additional data to identify the object **105**. In one implementation, a time threshold is used to determine whether or not a request has or has not been received within a particular time period. If a request has not been received from the server **103**, the process **500** proceeds to **504**. At **504**, a 3D digital model of the object is received from the server **103** based upon an object recognition of the object that is determined from the scanned data. The process **500** then proceeds to **505**. At **505**, the process **500** prints a 3D replica of the object **105** based upon the retrieved high quality, 3D digital model.

[0034] If a request has been received from the server **103** at **503**, the server **103** sends additional scanned data to the server **103** at **506**. The process **500** then proceeds again to **503** to determine if a further request has been received from the server **103** for additional data to identify the object. Accordingly, the process **500** iteratively sends data and additional data to the server **103** until the server **103** has enough data with distinguishing features to narrow the searched 3D digital models from the database **104** to a single 3D digital model.

[0035] Prior to 3D printing the high resolution replica of an object, various processing can be performed. As an example, scaling can be performed to scale the replica of the object to different dimensions than that of the original object that is being replicated. Further, the processing can also include the addition or deletion of certain features such as colors, shapes, etc.

[0036] The processes described herein may be implemented in a general, multi-purpose or special purpose processor. Such a processor will execute instructions, either at the assembly, compiled or machine-level, to perform the processes. Those instructions can be written by one of ordinary skill in the art following the description herein and stored or transmitted on a computer readable medium. The instructions may also be created using source code or a computer-aided design tool. A computer readable medium may be any medium capable of carrying those instructions and include a CD-ROM, DVD, magnetic or other optical disc, tape, silicon memory (e.g., removable, non-removable, volatile or non-volatile), packetized or non-packetized data through wireline or wireless transmissions locally or remotely through a network. A computer is herein intended to include any device that has a general, multi-purpose or single purpose processor as described above. For example, a computer may be a personal computer ("PC"), laptop, smartphone, tablet device, set top box, or the like.

[0037] It is understood that the apparatuses, systems, computer program products, and processes described herein may also be applied in other types of apparatuses, systems, computer program products, and processes. Those skilled in the art will appreciate that the various adaptations and modifications of the aspects of the apparatuses, systems, computer program products, and processes described herein may be configured without departing from the scope and spirit of the present apparatuses, systems, computer program products, and processes. Therefore, it is to be understood that, within the scope of the appended claims, the present apparatuses, systems, computer program products, and processes may be practiced other than as specifically described herein.

We claim:

1. A method comprising:
 - scanning an object to generate a first 3D digital model of the object;
 - sending data corresponding to the first 3D digital model to a server that is in communication with a database of 3D digital models of a plurality of objects;
 - receiving a second 3D digital model of the object from the server based upon a matching of the first 3D digital model and the second 3D digital model, the second 3D digital model having a higher resolution of the object than the first 3D digital model; and
 - printing a 3D replica of the object based upon the second 3D digital model.
2. The method of claim 1, wherein the first 3D digital model and the second 3D digital model are of a different scale.
3. The method of claim 1, wherein the 3D replica is printed without the first 3D digital model.
4. The method of claim 1, further comprising selecting the data corresponding to the first 3D digital model such that the data is only enough information to match the second 3D digital model with the first 3D digital model.
5. The method of claim 4, wherein the data is less than an entirety of the first 3D digital model.
6. A method comprising:
 - scanning an object to generate scanned data;
 - sending the scanned data to a server that is in communication with a database of 3D digital models of a plurality of objects;
 - receiving a 3D digital model of the object from the server based upon an object recognition of the object that is determined from the scanned data; and
 - printing a 3D replica of the object based upon the 3D digital model.
7. The method of claim 6, wherein the scanned data comprises a portion of a set of distinguishing features.
8. The method of claim 7, further comprising receiving a request from the server for additional data to identify the object, scanning the object to generate additional scanned data, and sending the additional scanned data to the server, the additional scanned data comprising an additional portion of a set of distinguishing features.
9. The method of claim 8, wherein the object recognition of the object is also determined from the additional scanned data.
10. A method comprising:
 - receiving data corresponding to a first 3D digital model of an object from a scanner that scanned the object;
 - identifying a second 3D digital model of the object by matching a distinguishing feature of the data with a distinguishing feature of the second 3D digital model from a database of a plurality of 3D digital models of objects, the second 3D digital model having a higher resolution of the object than the first 3D digital model;
 - sending the second 3D digital model of the object to a 3D printer that prints a 3D replica of the object based upon the second 3D digital model.
11. The method of claim 10, wherein the first 3D digital model and the second 3D digital model are of a different scale.
12. The method of claim 10, wherein the 3D replica is printed without the first 3D digital model.

13. The method of claim **10**, wherein the data corresponding to the first 3D digital model is selected such that the data is only enough information to match the second 3D digital model with the first 3D digital model.

14. The method of claim **13**, wherein the data is less than an entirety of the first 3D digital model.

15. A method comprising:

receiving scanned data of an object from a scanner that scans the object;

identifying a 3D digital model of the object by matching a distinguishing feature of the scanned data with a distinguishing feature of the 3D digital model from a database of a plurality of 3D digital models of objects;

sending the 3D digital model of the object to a 3D printer that prints a 3D replica of the object based upon the 3D digital model.

16. The method of claim **15**, wherein the scanned data comprises a portion of a set of distinguishing features.

17. The method of claim **16**, further comprising sending a request to the scanner for additional data to identify the object, the additional scanned data comprising an additional portion of a the set of distinguishing features.

18. The method of claim **17**, wherein the identification of the 3D model of the object is also determined from the additional scanned data.

19. A system comprising:

a scanner that scans an object to generate a first 3D digital model of the object, sends data corresponding to the first 3D digital model to a server that is in communication with a database of 3D digital models of a plurality of objects, and receives a second 3D digital model of the object from the server based upon a matching of the first 3D digital model and the second 3D digital model, the second 3D digital model having a higher resolution of the object than the first 3D digital model; and

a 3D printer that prints a 3D replica of the object based upon the second 3D digital model.

20. A system comprising:

a processor that receives data corresponding to a first 3D digital model of an object from a scanner that scanned the object, identifies a second 3D digital model of the object by matching a distinguishing feature of the data with a distinguishing feature of the second 3D digital model from a database of a plurality of 3D digital models of objects, and sends the second 3D digital model of the object to a 3D printer that prints a 3D replica of the object based upon the second 3D digital model, the second 3D digital model having a higher resolution of the object than the first 3D digital model.

21. A method comprising:

receiving object identifier data for an object from a computing device that performs object recognition of the object;

retrieving a 3D digital model of the object from a database of a plurality of 3D digital models of objects based upon the object identifier data; and

sending the 3D digital model of the object to a 3D printer that prints a 3D replica of the object based upon the 3D digital model.

22. The method of claim **21**, wherein the computing device captures an image of the object and performs the object recognition of the object based upon the image.

23. The method of claim **21**, wherein the 3D replica is printed without the image.

24. The method of claim **21**, wherein the object recognition is based upon identification of a set of distinguishing features from the image that match features of the object.

25. The method of claim **21**, wherein the computing device performs the object recognition through by communicating with a server that accesses an object database.

* * * * *