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(54) Title: 3D PRINTER ARCHITECTURE

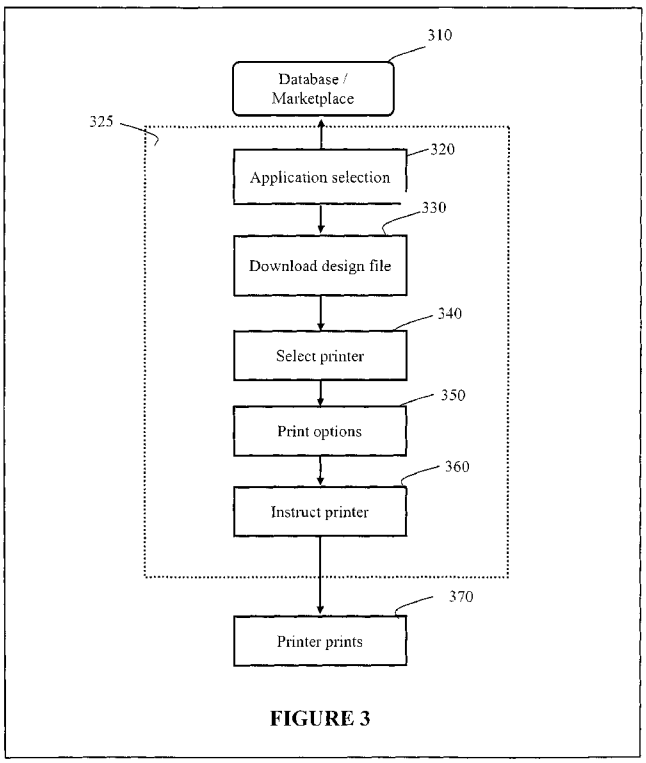

FIGURE 3

(57) Abstract: There is a system suitable for three dimensional printing comprising a server, an application residing on a device and a 3D printer. The application and the 3D printer are able to connect to the server and a design is printed when the application choses the design and the 3D printer retrieves the design from the server.

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3D PRINTER ARCHITECTURE

FIELD OF THE INVENTION

The present invention relates to a system for printing three dimensional (hereinafter referred to as 3D) objects. More particularly, the system for printing 3D objects uses a remote architecture for the printer to access the designs for further printing or fabrication.

BACKGROUND ART

Three-dimensional printing is known in the art. For example, in three-dimensional printing, an image of a three-dimensional structure, for example, on a computer screen, can be printed in three-dimensions using a specially engineered composite material that starts out as a powder. A binding material can be added to the powder to solidify the powder particles together for creating the three-dimensional structure.

These structures typically require a computer generated image of the three-dimensional structure. However, the typical method of three-dimensional printing a structure can run into problems when there is a mismatch between the geometry that is used by the printer and the computer generated image. Calibration of a printer to a particular computer generated image requires a lot of time and is largely a trial and error process that is a lot more tedious than calibrating a conventional paper printer due to the extra dimension.

The present invention seeks to provide a system that alleviates the above mentioned drawbacks at least in part.

SUMMARY OF THE INVENTION

Throughout this document, unless otherwise indicated to the contrary, the terms "comprising", "consisting of", and the like, are to be construed as non-exhaustive, or in other words, as meaning "including, but not limited to".

The above and other problems are alleviated and an improvement in the art is made by a system and method in accordance with this invention. A first

advantage of the system and method in accordance with this invention is that users are able to instruct a 3D printer to print a three dimensional design remotely. This ensures that designs selected are printed accurately without the need for further calibration. A second advantage of the system and method in accordance with this invention is that the instructions are encrypted, encoded and/or authenticated for security and easy identification. This allows a high level of security and peace of mind. A third advantage of the system and method in accordance with this invention is that the library of objects is easily available for selection and printing. This allows for a user to have easy access to complex designs and even upload designs for other people to use. A fourth advantage of the system and method is the ease of use, as a user that is registered is able to select, purchase and issue print commands for a three dimensional design through a single action, like a mouse click.

In accordance with an aspect of the invention there is a system suitable for fabricating three dimensional objects which comprises a computing device configured to access an online database of three dimensional objects and allows the selection of a three dimensional object to be fabricated, a server arranged to receive the information based on the selected three dimensional object, and arranged to use the information to retrieve additional information for preparing a print job, a three dimensional fabricator arranged to receive the print job from said server, whereby the three dimensional fabricator would carry out fabrication of the three dimensional object based on the print job received.

In further embodiments of the invention, the conversion to machine readable code done is by the three dimensional fabricator. Alternatively, the print job includes code that is machine readable. In yet further embodiments of the invention, the conversion to machine readable code is done by the server. An alternate embodiment of the invention is that the print job is converted to machine readable code by the computing device.

In another embodiment of the invention, the server is a virtualized server cloud. Also, the database can be based on the server. In yet another embodiment of the invention, the instruction to prepare the print job is issued by the server to the three dimensional fabricator. Also, the instruction to prepare the print job can be accompanied by the additional information.

In further embodiments of the invention, the instruction to prepare the print job is issued by the application to the three dimensional fabricator. Also, upon receiving the print job, the three dimensional fabricator retrieves additional information from the server.

In another embodiment of the invention, the additional information includes data files relating to the selected three dimensional object to be fabricated. Also, the data files can be in STL format.

In yet another embodiment of the invention, the additional information includes user account information based on the registration and log in of a user. Further, the system can allow for multiple three dimensional objects to be selected at the same time for fabrication. Also, the server would manage multiple print jobs and prioritise them accordingly. Alternatively, the server would manage the multiple print jobs and fabricate the objects concurrently.

In an embodiment of the invention, the computing device can be one of a personal computer, a mobile computing device with an application or a mobile phone with an application. In particular, the computing device may be any device capable of accessing the printer and/or server for selection of a 3D object for printing.

In accordance with another aspect of the invention there is a computer implemented method for fabricating three dimensional objects which comprises allowing a user to access a database of objects, selecting an item to be fabricated from the database, and in response to a single action being

performed, sending a request to fabricate the item with information relating to the user to a server, the server upon receiving the request, carries out the steps of retrieving additional information, generating an order for the item, and sending fabrication instructions a three dimensional fabricator, whereby the item is ordered and fabricated without using a shopping cart ordering model.

In an embodiment of the invention, the fabrication instructions includes machine readable code that the three dimensional fabricator uses to fabricate the item. Also, the three dimensional fabricator converts the fabrication instructions to machine readable code and fabricates the item according to the machine readable code.

In yet another embodiment of the invention, the single action is the clicking a button. In a further embodiment, the additional information includes account information relating to the user. Also, the account information includes payment details that allows the user to purchase items from the database.

In a further embodiment of the invention, the database is hosted on the server. Also, the user can access the database through a website. In yet a further embodiment, the user can access the database through an application on a computing device and instruct the three dimensional fabricator accordingly.

In accordance with an aspect of the invention, there is an apparatus for fabricating three dimensional objects comprising a processor arranged to receive instructions to fabricate at least one three dimensional object, an electronic storage to store the instructions and a three dimensional fabricator, whereby the processor is arranged to process the instructions and instruct the three dimensional fabricator to carry out the fabrication. In a further embodiment of the invention, the processor is arranged to covert the instructions to machine readable code for the three dimensional fabricator.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a view of an embodiment of the invention showing the system and its components.

Fig. 2 is a view of an embodiment of the invention showing the system flowchart.

Fig. 3 is a view of an embodiment of the invention showing the application flowchart.

Fig 4 is of an embodiment of the invention showing the system flow in the view of a user downloading and printing an object.

Fig 5 is of an embodiment of the invention showing the system flow in the view of a user creating an object.

Other arrangements of the invention are possible and, consequently, the accompanying drawings are not to be understood as superseding the generality of the preceding description of the invention.

PREFERRED EMBODIMENTS OF THE INVENTION

Particular embodiments of the present invention will now be described with reference to the accompany drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one or ordinary skill in the art to which this invention belongs.

In accordance with an embodiment of the present invention there is a system comprising a server 110.preferably (but not limited to) a cloud (i.e. a cloud server), an application residing on a device 120, and a 3D printer 130 (as shown in Figure 1). The system is particularly suited, but not limited to 3D printers coupled with cloud architectures for 3D printing or rapid prototyping and will be described in this context. The server comprises a relay server to relay communications via the Internet remotely and library server for the management of the library object database.

The device 120 can be any electronic device that can connect wirelessly to a wireless fidelity (Wi-Fi) networks or conventional phone networks, such as mobile devices like smartphones, personal digital assistant (PDA) phones and tablets, including mobile devices such as the iPhone or the iPad or any other iOS devices, as well as Android-based devices. The 3D printer is a 3D printer 130 that connects to the cloud server 110 either wirelessly or through a wired (e.g. cable) connection 150.

At the initial set up phase, the user downloads a dedicated software application for the 3D printer (hereinafter interchangeably used with the term 'PirateCove'). The dedicated software application comprises user interface and necessary executable software instructions installed on the user device 120 for achieving the following:-

i. allow a user to access the server 110 (which may involve creation of an account); and/or

ii. issuance of instructions to the 3D printer 130 (remotely 140 or otherwise) from the user device 120;

Once the account is created, each user is associated with an account in the server and then each account is paired 140 with the identification number of at least one 3D printer 130. It is to be appreciated that each account may be paired 140 with more than one 3D printers 130. The pairing and account data are recorded by the cloud server 110 and is later used to mediate the interaction between the user and the paired 3D printer 130.

This pairing between the 3D printer 130 and a user's account is achieved through a communication protocol setup between the application running on the device 120 and the 3D printer 130, and has 2 purposes: to associate the 3D printer 130 with the user's account; to transfer network connection data to the firmware on the 3D printer 130. Additional information on the user settings such as specify the 3D printer 130 to connect wirelessly via Wi-Fi to the nearest available hotspot, instead of using the Ethernet cable connection can be communicated and stored. The communication protocol may be audio or comprises any other forms of communication setup, whether wired or wireless, such as Wi-Fi, LAN, etc. The communication connections 140, 150, 160 can be Transmission Control Protcol (TCP) connections that is end-to-end authenticated, encrypted and/or encoded.

Once a user's account has been associated with at least one 3D printer 130, the user may then begin issuing instructions to the 3D printer 130 from his mobile device 120, remotely 140. The mode of communication between the 3D printer and the server or mobile device can either be on demand or polling. The user may associate more than one 3D printer 130 with his account, and the PirateCove app will allow him to choose which 3D printer 130 to print from if there is more than one 3D printer 130 associated. The system can function either via a polling based type communication such as "Restful API" or using open communication channel including other forms of TCP/IP, which can mean that no direct connections are established between the mobile device 120 and 3D printer 130. The 3D printer 130 periodically or at a specified user defined time "checks-in" with the cloud server 110 to see if any instructions were left there by the user's mobile device 120. The time interval for performance of such "checks-in" may be every 30 to 60 seconds or at any

other time interval as predefined. If no instructions are detected, the 3D printer 130 remains idle, and only a status update is delivered. Check-in may also occur even when using an open communication channel, especially when the printer requests for it (predefined) in order for a more responsive system.

The application is also able to check if a 3D printer 130 is locally accessible within the same network, either through a cable connection or wirelessly. The user is then able to easily select a three dimensional object via the application, adjust the printing options such as scale, quality, adhesion, enable support etc, and start the print job. The application would then issue the print instruction with a file format, such as an STL file which is a file format native to the stereolithography CAD or AutoCAD software for use in generation of a 3D object. If the printer 130 is accessible locally, the printer would receive the instructions and fabricate the three dimensional object accordingly. If a printer is not accessible with an ongoing print instruction issued, the STL file and printing request is sent to the cloud server 110 where is it stored temporarily while waiting for a printer 130 to be available. The 3D printers 130 would poll the cloud server 110 and start a new task upon detecting that there is an outstanding print instruction from an associated user in the queue. Alternatively, the cloud server 110 may be configured or arranged to push print instructions to the printer 130.

The 3D printer 130 would queue the requests that can be sent from various sources and prints files based on priority. This can be a first-come-first serve priority or any other priority system. The 3D printer 130 would have a processor that allows the 3D printer 130 to communicate with the cloud server 110 and the mobile device 120 via the application. Upon receiving a print instruction, the processor would save the instructions locally and convert the STL file to machine instructions for the fabrication of the three dimensional object.

Within the cloud server 110, each user's account has a print-queue, which is a list of 3D objects that a user wants the 3D printer 130 to create. Depending on the communication channel, the 3D printer 130 may check-in with the cloud server 110 to discover if any objects are present in the queue. If an object is

present, the 3D printer 130 will first check to see if sufficient raw material is available, and then if the previous object has been cleared from the build platform. If both prior conditions are met, the printer will initialise itself and begin printing the object in the print queue. During printing, the 3D printer 130 continues to deliver a status update about its progress to the cloud server 110 at regular intervals (for example 60 seconds) via connection 150. The user can set up the 3D printer such that if multiple print jobs are received, the 3D printer 130 would evaluate whether it is possible to print multiple print jobs in a single run, so as to minimise time require to fabricate.

As mobile devices also have the requirement on preserving battery life. Thus they can also employ a Restful API, where the Application only checks and receives a 3D printer status update when it is executed. In other cases, a status update may be pushed 160 from the cloud server 110 to the mobile device 120 in the event that an important message sent by the 3D printer 130 needs to be reviewed by the user in a time sensitive manner, for example: insufficient material present, mechanical jamming or network connection failure. This communication stream can be either via TCP or web socket, depending on the application platform being used. A network connection failure can occur if a 3D printer 130 fails to check into the cloud server 110 at the next stipulated time, hence the issuance of a network error message. Other status updates can contain information such as the remaining print-time, remaining material, and other feedback information about the printer's mechanical state such as extrusion temperature, power consumption and settings.

The Restful API functions in an activity-based manner, thus if there was command or communication received from a mobile-device 120 within the last 60 seconds, the printer will check in on a frequency of every 1 second. If no further activity is detected within the next 120 seconds, the printer will revert to checking in every 60 seconds. Thus if a user is actively managing his 3D printer 130, for example, cancelling a print, and then starting a new one right-away, the 3D printer 130 will remain responsive. In addition, for slow connections, a user can force the Application to communicate with the 3D

printer 130 directly over a local-area-network (LAN), assuming that both the mobile device 120 and 3D printer 130 are on the same network.

Status updates are the slowest form of system communication, employed when the 3D printer 130 checks-in with the cloud server 110 either during idle-time or printing-time. Each update is a compressed message containing the printer's mechanical status, platform-state, up-time, connection-ping, and other error messages pertaining to its operation.

When user activity is detected, and the printer is checking-in at a frequency of 1-second, a real-time messaging protocol is used instead of a default compressed status-update. The real-time messaging protocol functions in a synchronize-acknowledge-synchronize manner. To elaborate, if a user is changing the material cartridge, the 3D printer 130 will send a very quick acknowledgement 150 to the cloud server 110 that the filament has been ejected from the feeding assembly. In another scenario, the user may be utilising the Application to manually evaluate the 3D printer's status, in the real-time monitoring mode, messages such as temperature and mechanical position will be sent to the mobile device via the messaging protocol. Messages such as cancel print or reset will also be sent via the messaging protocol.

To receive object-data or information required by the 3D printer 130 to print, the 3D printer 130 will expect a data-transmission (data packet) in the form of a object file format, for example a STL file format or G-code which is specific to the 3D printer 130 for controlling the 3D printer 130. The G-code comprises data on how to move the nozzle (coordinate control) and control the extrusion rate (filament flow control). G-code data is transmitted in between messages sent by the messaging protocol. This G-code is then stored in the printer's memory. Only one object is stored at any one time. If a print is cancelled, the object is erased, and the printer reverts to idle-mode after 60 seconds. G-code may be cached for a user to re-print a 3D object he has recently printed. In such cases, the re-printing process may be considerably sped up as there is no further need to download the data packet again. As G-codes are specific to the make and model of the 3D printer, it can be more efficient to convert the

G-code at the 3D printer end rather than at the server in a process also known as 'slicing'.

Protecting the device relationship between the user's account and 3D printer 130 is very important to ensure that the cloud-architecture does not become confused when the messaging system grows in volume. In addition, the setup procedure relies on a communication protocol, which could produce confusion if the message-bursts are not signed with each 3D printer's signature (for example two 3D printers could hear the same message and act on it, when only one 3D printer is supposed to hear the message) In addition, encryption is necessary to guard against man-in-the-middle attacks and other forms of user-account and 3D printer hijacking or subversion attempts. This can be avoided by having a set up phase.

During set up phase, if the 3D printer is setup in a shared space with other 3D printers, the QR-Code can be used to quickly set up the 3D printer to be used. Before communication starts, the user utilises his smart-phone to scan the QR-code of the 3D printer, this code is actually the public key, and is used to sign all audible messages sent back and forth. This prevents a second 3D printer from becoming confused by messages intended for the first 3D printer. The QR code typically contains information such as the printer name, Wi-Fi information (like the SSID), and the serial number of the printer.

In addition, the user may choose to set a password on the 3D printer as he or she may do this in a shared space to prevent other users from taking ownership of the 3D printer (resetting the 3D printer as their own device). In the event that the user-password is lost, they may reset the printer or call tech-support for assistance.

G-codes or 3D-object-data that are sent from server to printer are encrypted using the printer's identification number. Basically the printer and only the printer can decrypt the data. That way nobody can intercept/interfere the object on the network to save the G-code and put it on a file sharing web resource for example, and nobody can publish on a blog all the objects that a user is 3D-printing with the 3D printer. In addition, encryption of the communication protocol prevents hackers from hijacking the 3D printer's

network connection, and ensures the integrity of all communication between the user's account and 3D printer. This is done by using the following encryption process.

Preferably, the printer 130 is pre-programmed at manufacturing time with a public-private encryption key pair, along with 4 random passwords. The public and private keys and the 4 passwords are stored on both the printer and a central storage facility. The public key is known to the online or cloud servers while the public key is used as the printer identification number, and as the printer's default password. It is printed as both text and a QRCode on a sticker on the printer. The 4 passwords are used as backup passwords –explained as follows.

Direct communication between user and printer is made via audible sound or cable connection and is secured by the password. Messages from the user's phone or computer to the printer are sent unencrypted with a signature. The signature is a hash of the concatenation of the message, the printer identification number and the printer password. Upon receiving a message, the printer recomputes the signature and compares it with the provided signature. If the signature doesn't match, the message is ignored. This happening most often when the message contains errors during transmission, when the password is wrong, or when the printer intercepts a message sent via sound to another printer nearby. The printer password can be changed by sending the appropriate message. Messages from the printer to the user work the same way, signed with the same identification number and password. If the password is lost, the user can contact Tech support to request one of the 4 backup passwords. A message signed with one of those passwords is also considered valid by the printer. Alternatively, a reset button located inside the printer can be pressed to reset the password to the original password.

Communication between the printer and the server is either done via Restful API calls by the printer to the server or via open communication channels setup like TCP/IP between the printer and server. Each call contains the printer's identification number and the server uses it to retrieve data related to the printer, and to encrypt that data. When data is sent from the server to the

printer, it is encrypted using the public key. Only the printer can decrypt the data –using the private key.

The mediating device between the mobile device and the 3D printer is the server 110, which can be a virtual server based on the internet, or a cloud server. It also remembers which 3D printers belong to which user's accounts, and monitors the state of all the 3D printers connected to the network. In most situations, the cloud server's main role is to relay messages between mobile devices and 3D printers. The server system itself is based on a scaleable grid cluster, in which load is balanced between multiple server clusters.

The cloud server 110 stores additional information such as user's account, user's data, 3D printer identification numbers, associations between user's account and 3D printers, printer queue, status of each network 3D printer, library of smart objects and static objects, associations between user's account and the libraries, associations of smart objects, user's account and object-data. In the context of the embodiment, smart objects are defined as dynamic objects editable by a user for the creation of a customized 3D object according to the user preference. Such smart objects comprise minimal object data for a user's modification so as to create a desired 3D object design. The smart object may be java-script based or based on other script-based (including graphical-based) programming languages and the library database of smart objects can be created (hereinafter interchangeably used with the term 'Treasure Island')

The cloud server 110 also mediates real time messages between the mobile device and the 3D printer, as well as manages and advises on the network ping, which may cause the Application to revert to using LAN if possible. The cloud server 110 enforces digital rights management on all objects in the library and also controls access to the object library based on each user's account.

The cloud server 110 also manages new user entries into the smart object library database, which contains uploads of new objects created. The cloud server 110 can also manage the slicing of object data into G-code, and can be

done in a "hurry up and get idle way". Alternatively, this is done at the printer end after the instruction to print is received.

From an application point of view, the cloud server 110 would allow access to the database to view and even edit the designs. The database or marketplace can also be viewed through a website. The server would allow a user (once registered) to select and purchase designs to be printed from the database. The payment details and options can be stored on the secure server to allow users to purchase and print designs quickly without any further inputs. Once the design settings are optimised, the instruction to print is issued from the application and the system takes over, resulting in the fabrication of the chosen three dimensional object at the designated printer. The server is set up to allow registered users to select and print a design using a single action, as the optimisation and instructions to print are handled by the application, the server and or the printer. The system flow is described in detail later in Figure 2.

The Application is responsible for the initial setup of each user during the set up phase, pairing of each 3D printer to a user-account, and relaying all of this information to the cloud server 110. It also allows the user to manage the printer queue on the cloud server 110 or on the 3D printer 130 (local network where user interacts directly with the 3D printer 130), as well as controls and updates all the user-data. The Application also provides access to the library database of smart objects and static objects, and also provides a decoder for running smart Objects. Storage on the Application may be dedicated for user's account login information, account preferences and the serial numbers of 3D printers associated to the user's account.

The Application manages the receipt of content from the object library database and provides an interface to control the 3D printer. It also provides an interface to retrieve and interpret status messages from the cloud server 110. The app has a network connection to the 3D printer either via Wi-Fi or mobile telephone network and manages the initial set up phase as well as any subsequent modifications, additions or deletions of the 3D printer(s). Further, an online version is available, possibly on a dedicated website, where similar

functionality to the Application is provided. More features such as an interactive API for designing new smart or static objects can be incorporated and these can then be uploaded to the library database.

The 3D printer architecture is unique in that it can connect to an IP network in order to receive data from the cloud server 110. The control system of the 3D printer autonomously monitors the device state to manage faults as well as carry out print instructions sent from the cloud server 110. The 3D printer 130 stores information like the G-code file for any object data to be printed, the network access information (SSID and password, DHCP protocol), network identification serial number as well as auto-calibration data for the print-platform.

The 3D printer 130 manages the state of the print platform and negotiates with the cloud server 110 regarding this state. The amount of print material in the cartridge is also monitored and this information can be included in the status updates to the cloud server 110. Real time messages are received from the cloud server 110 or the mobile device and the state of its hardware and communications are also monitored and managed.

The 3D printer 130 is able to communicate via various methods, including direct or adhoc Wi-Fi broadcast, which is mainly used for the initial setting up of the 3D printer 130; local network either wirelessly or through a network cable, whereby other network users can detect the 3D printer and communicate with it; and via the internet, where the 3D printer 130 can be accessed over a relay network of users or printers via relay servers, such that users are able to access the prints they give and get live status of prints from the internet.

An exemplary embodiment of the system is shown in Figure 2. The application 210 resides on a computing device and once the user has selected a design to be 3D fabricated and the server has packaged the print job to be fabricated, the application would check whether there is any printer set up with the account 220 and would direct the user to a set-up process 230 that occurs with the initial use of a three dimensional fabricator. Multiple designs can also be selected at the same time for fabrication. This set-up process 230 was

previously described. If there is already a printer set up with the account 220, the printer would receive the print instructions either from the application or the server 240, and the print instructions would join the print queue 250. The print queue 250 can reside either on the printer itself or on the server, if required, for example when the printer is not currently connected to any network or internet. The clearing of the queue typically follows a first-in-first-out priority, although other priority schemes can also be used. When the print job is to be processed from the queue, the printer would download the files needed to carry out the print job 260, an example of the file data transmission format would be STL, which is a standard format for rapid prototyping systems. The printer would then slice the files 270, which converts the downloaded files into machine code for the printer to carry out the fabrication. The next step of preparing the printer to print 280 may occur concurrently with any of the previous steps 260, 270 and consists of warming up the printer parts, ensuring calibration, heating up the nozzle or platform etc. Once the printer has completed the print job 290, its status 295 is updated and sent to the application accordingly. The status 295 can also be used by the printer to indicate various parameters, for example, the amount of print material remaining, number of jobs on queue, etc. If there are multiple print jobs in queue, the printer would queue them accordingly, or if required, be set up to process whether possible to fabricate multiple print jobs at the same and execute accordingly.

The system flow from the application point of view will be described using Figure 3. The library database or marketplace is presented to the user either via a website or via the application 310, and a design is selected 320 and the application would carry out the following steps 325. The website may also call up the application (via a web browser, for example, Google Chrome™) if required, thus reducing the number of programing steps and translations. Based on the selected design 320, the application would download the design file from the library database 330, which is typically in STL format. The user would be able to preview the STL object in three dimensions, manipulating the object or the viewpoint in order to inspect the selected design in three

dimensions, with functions such as zoom and select. Editing options are also possible, although this may be restricted based on the user account as an incentive to subscribe. If a printer has not been associated with the user account, the printer would have to be selected 340 from the list of available options, either through a locally available printer connected to the same network as the user or via the server, which would be able to show the nearest available printer (based on individual printer availability settings) that is able to carry out the job. Based on the selected printer, the user would be able to adjust the options for printing, including the scale of the design, quality, adhesion, etc, although a default user preferred setting can also be present for quicker printing, allowing for single action print from the time of selection to collection of fabricated design. These instructions are the passed on to the printer 360, which carries on the print instructions and fabricates the design 370. The slicing of the instruction code into machine readable code can occur either at the application level 360, or at the printer itself 370.

In another embodiment, wherein like numerals reference like parts, the user who is more creative may wish to modify the existing 3D design objects by utilizing the smart object functions. In such a case it may be necessary for the user to modify his/her account settings so as to gain access to the 'smart objects' function.

The system flow that provides access to the library of smart objects (or Treasure Island) can be seen in Figure 4. A user is able to access the library of smart objects or marketplace 410 via an application or a website 415. Alternatively, to reduce the number of programming steps and translations, the website may call up the application via a web browser (for example Google Chrome™), vice versa, the application may redirect the user to the website. The smart object to be printer is then selected 420 and the user is directed to customize the object 430 in terms of scale, quality, and other definable parameters. The user is then directed to a print option screen 440, which would enable the printer to be selected as well as other options such as print quality, timing delays, etc. The job is then transferred to the printer for printing 450. The conversion of the selected object to an STL file can occur

either after the object is customised 430 or after the print options are set 440. Alternatively, a pointer command can be passed to the printer to retrieve the STL file from the server directly.

In terms of creating the smart objects, Figure 5 shows the system flow in the creating and adding of smart objects to the library. The user in this case can be a specially defined set of users, known as creators, who are given access to upload smart objects to the server. These rights are define by the administrator and can be allocated exclusively or concurrently with user rights. A user can be automatically made a creator upon their first upload of a smart object or design. These creators access the smart object editor screen 510 either via an application or a website 515. Alternatively, to reduce the number of programming steps and translations, the website may call up the application via a web browser (for example Google Chrome™), vice versa, the application may redirect the user to the website. The smart object may be java-script based or based on other script-based (including graphical-based) programming languages. The creator can also define the parameters of the smart object which can be customized by a user before printing. Once the smart object is previewed and confirmed to be acceptable 520, the creator is able to upload to the library or Treasure Island server 530, and the smart object is available for other users to select and print accordingly.

The above is a description of various embodiments of a 3D printer architecture in accordance with this invention. It is envisioned that those skilled in the art may design alternative embodiment(s) without departing from the scope of the invention as set forth in the followings claims. It should be further appreciated by the person skilled in the art that features and modifications as discussed in the embodiments above, not being alternatives or substitutes unless expressly stated, may be combined to form yet other embodiments that fall within the scope of the invention.

CLAIMS

1. A system for fabricating three dimensional objects comprising:

a computing device configured to access an online database of three dimensional objects and allows the selection of a three dimensional object to be fabricated,

a server arranged to receive the information based on the selected three dimensional object;

said server arranged to use the information to retrieve additional information for preparing a print job;

a three dimensional fabricator arranged to receive the print job from said server;

wherein said three dimensional fabricator would carry out fabrication of the three dimensional object based on the print job received.

2. A system according to claim 1, wherein the print job is converted to machine readable code by the three dimensional fabricator.

3. A system according to claim 1, wherein the print job includes code that is machine readable.

4. A system according to claim 3, wherein the conversion to machine readable code is done by the server.

5. A system according to claim 3, wherein the print job is converted to machine readable code by the computing device.

6. A system according to any one of claim 1-5, wherein the server is a virtualized server cloud.

7. A system according to any one of claims 1-6, wherein said database is based on said server.

8. A system according to claim 1, wherein the instruction to prepare the print job is issued by the server to the three dimensional fabricator.

9. A system according to claim 8, wherein said instruction to prepare the print job is accompanied by the additional information.

10. A system according to claim 1, wherein the instruction to prepare the print job is issued by the application to the three dimensional fabricator.

11. A system according to claim 10, wherein upon receiving the print job, the three dimensional fabricator retrieves additional information from the server.

12. A system according to claim 1 wherein the additional information includes data files relating to the selected three dimensional object to be fabricated.

13. A system according to claim 12, wherein the data files are in STL format.

14. A system according to claim 1, wherein the additional information includes user account information based on the registration and log in of a user.

15. A system according to claim 1, wherein the system allows for multiple three dimensional objects to be selected at the same time for fabrication.

16. A system according to claim 14, wherein the server would manage multiple print jobs and prioritise them accordingly.

17. A system according to claim 14, wherein the three dimensional fabricator would manage multiple print jobs and fabricate the objects concurrently.

18. A system according to claim 1, wherein said computing device can be one of a personal computer, a mobile computing device with an application or a mobile phone with an application.

19. A computer implemented method for fabricating three dimensional objects comprising:

allowing a user to access a database of objects;

selecting an item to be fabricated from the database; and

in response to a single action being performed, sending a request to fabricate the item with information relating to the user to a server;

said server upon receiving the request, carries out the steps of

retrieving additional information;

generating an order for the item; and

sending fabrication instructions a three dimensional fabricator,

wherein said item is ordered and fabricated without using a shopping cart ordering model.

20. The method according to claim 19, wherein said fabrication instructions includes machine readable code that the three dimensional fabricator uses to fabricate the item.

21. The method according to claim 19, wherein the three dimensional fabricator converts said fabrication instructions to machine readable code and fabricates the item according to the machine readable code.

22. The method according to claim 19, wherein said single action is clicking of a button.

23. The method according to claim 19, wherein the additional information includes account information relating to the user.

24. The method according to claim 23, wherein said account information includes payment details that allows the user to purchase items from the database.

25. The method according to claim 19, wherein said database is hosted on the server.

26. The method according to claim 19, wherein the user can access the database through a website.

27. The method according to claim 19, wherein the user can access the database through an application on a computing device and instruct the three dimensional fabricator to fabricate an item.

28. An apparatus for fabricating three dimensional objects comprising:

a processor arranged to receive instructions to fabricate at least one three dimensional object;

an electronic storage to store the instructions;

a three dimensional fabricator

wherein said processor is arranged to process the instructions and instruct said three dimensional fabricator to carry out the fabrication.

29. An apparatus according to claim 28, wherein said processor is arranged to covert said instructions to machine readable code for the three dimensional fabricator.

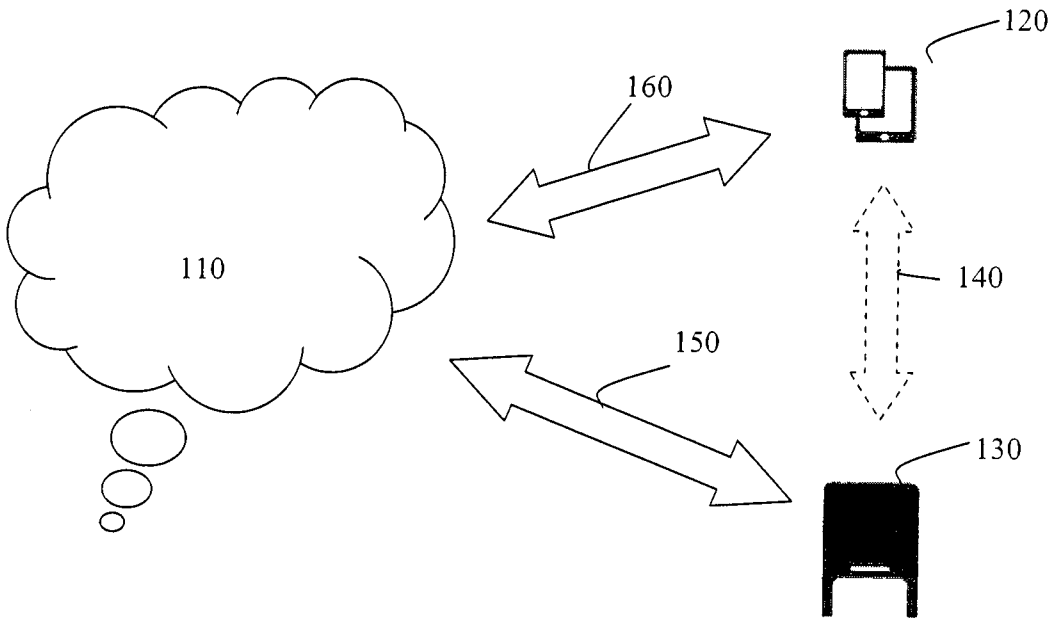

FIGURE 1

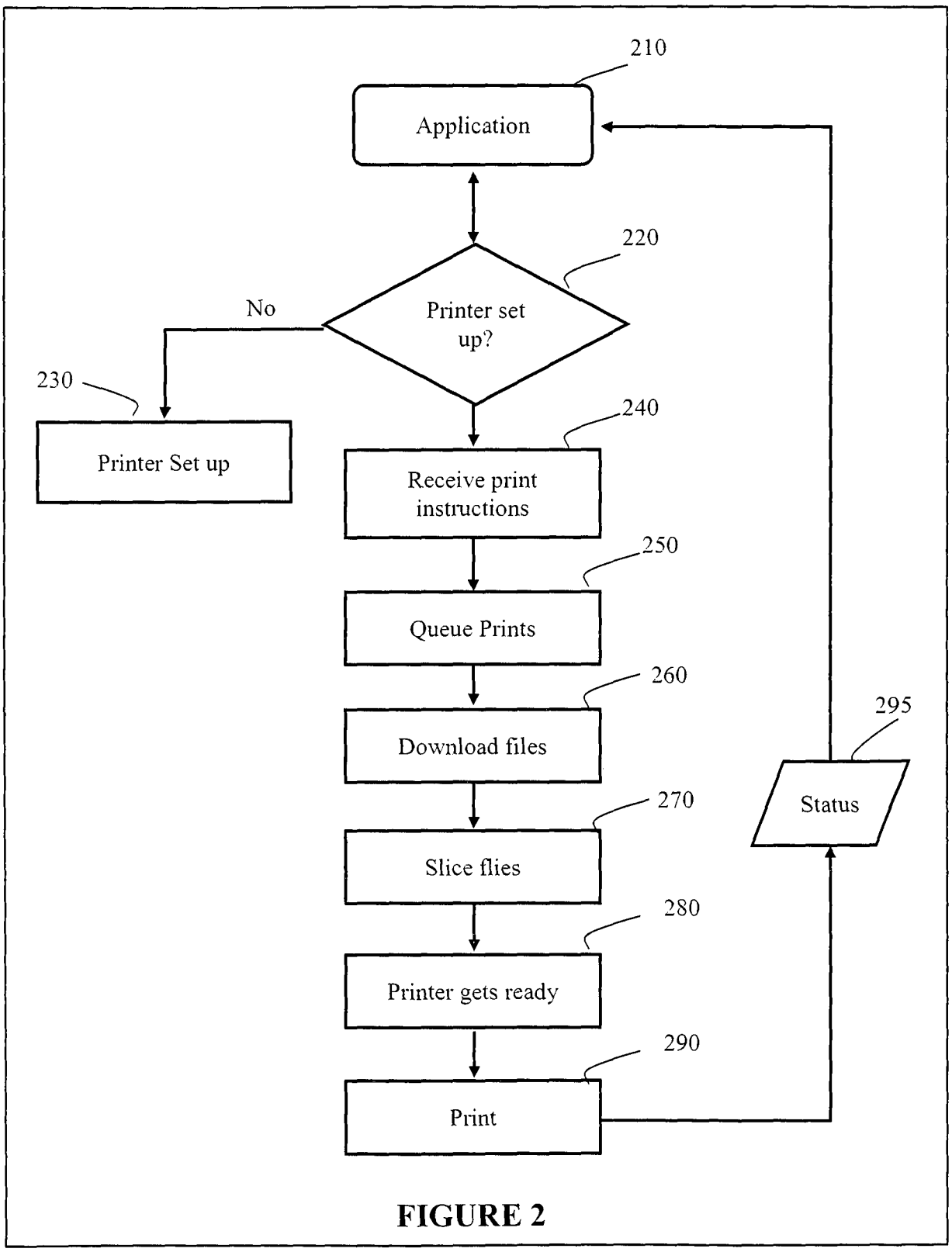
210
Application
220
Printer set up?
No
230
Printer Set up
240
Receive print instructions
250
Queue Prints
260
Download files
270
Slice flies
280
Printer gets ready
290
Print
295
Status

FIGURE 2

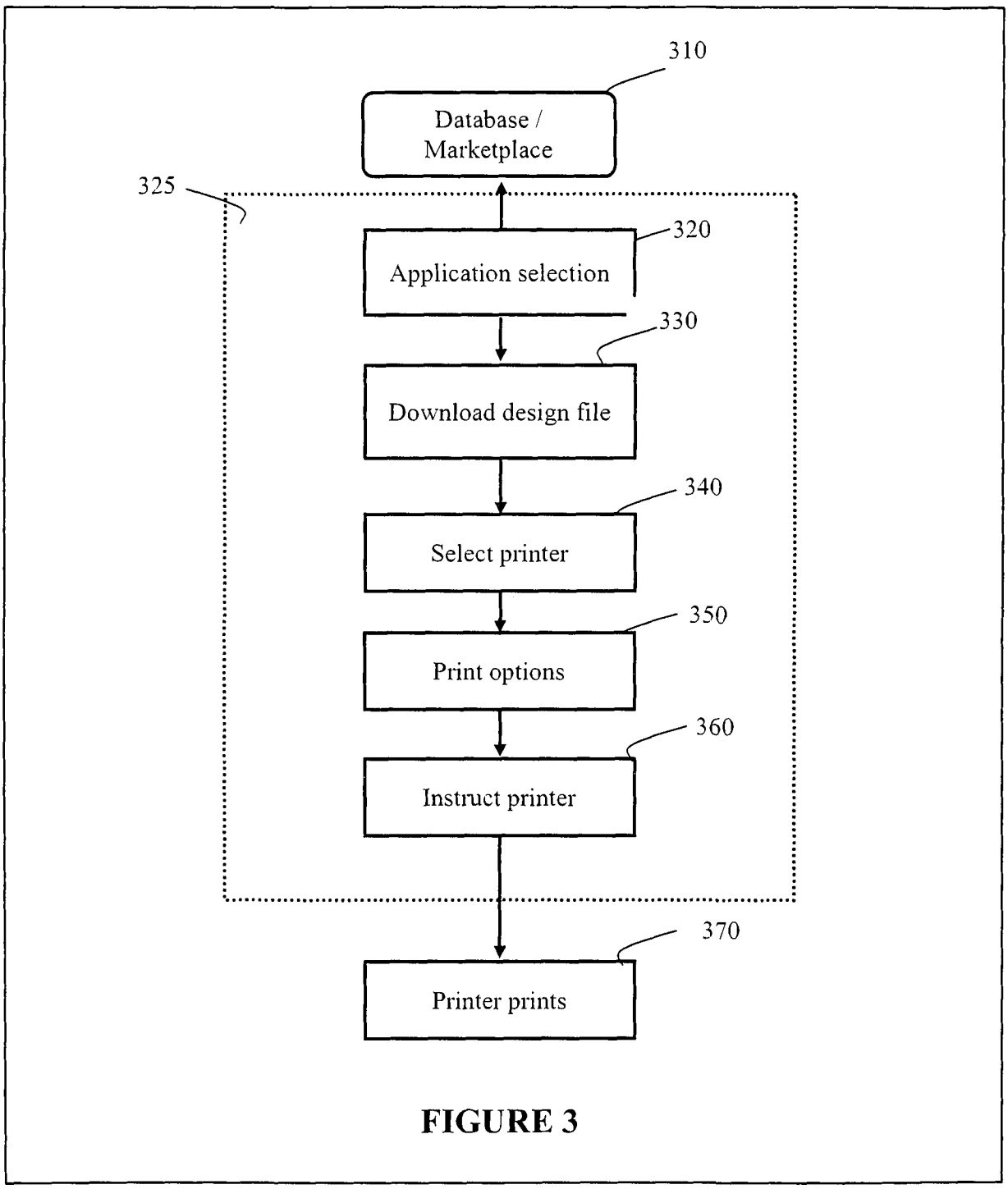
310
Database / Marketplace
325
320
Application selection
330
Download design file
340
Select printer
350
Print options
360
Instruct printer
370
Printer prints

FIGURE 3

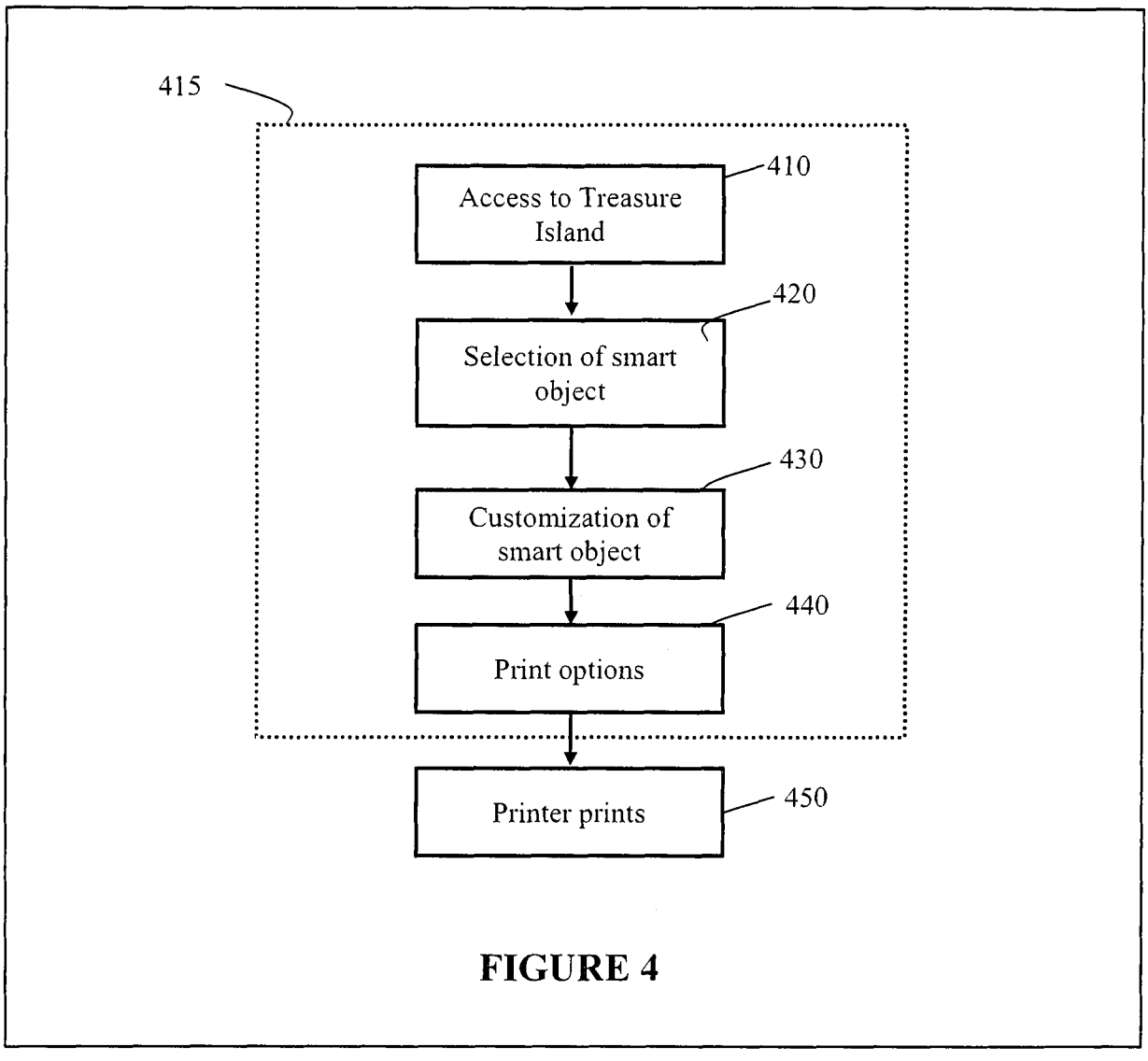
415
410
Access to Treasure Island
420
Selection of smart object
430
Customization of smart object
440
Print options
450
Printer prints

FIGURE 4

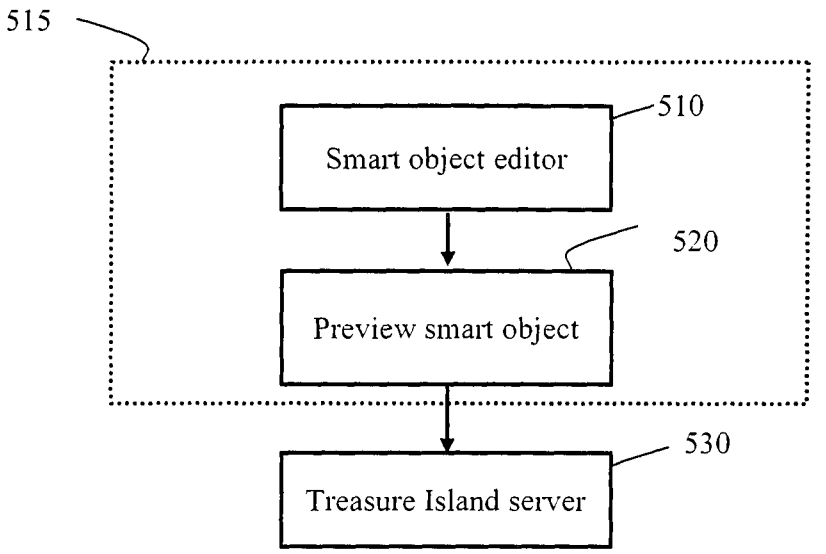
515
510
Smart object editor
520
Preview smart object
530
Treasure Island server

FIGURE 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2014/000250

A. CLASSIFICATION OF SUBJECT MATTER

G06Q 50/04 (2012.01) G05B 19/4099 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI & EPODOC: Keywords (print, fabricate, manufacture, 3d, three dimensional, item, product, part, object, design, model, template, pattern, database, repository, store, server, web, online, internet, purchase, pay, order) & like terms; GOOGLE PATENTS: Keywords (3D, print, database, repository, purchase, pay, shop, stl) & like terms; ESPACENET: Keywords (3D, three dimensional, database, repository, store, print, fabricate) & like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 July 2014	15 July 2014
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Olutope Omogbenigun AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832876

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/SG2014/000250**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/0313878 A1 (NORMAN) 22 December 2011 See the whole document, especially abstract, paragraphs [0019],[0072],[0086],[0091]-[0093],[0096],[0098],[0107],[0115],[0117], claim 1, figs. 5e,5i,5j,10	1-29
X	US 2012/0281013 A1 (MAHDAVI et al.) 08 November 2012 See the whole document, especially abstract, paragraphs [0038],[0055],[0077],[0078],[0080],[0081],[0101]-[0104]	1-29
X	WO 2013/036942 A1 (PELL, BARNEY, D.) 14 March 2013 See the whole document, especially abstract, page 2 lines 19-24, page 3 lines 14-17, page 5 lines 3-11,18-31, page 8 lines 17-19,28-31, page 9 lines 16-17, page 11 lines 15-28, page 12 lines 8-13, fig. 2	1-29

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/SG2014/000250**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2011/0313878 A1	22 December 2011	US 8515826 B2	20 Aug 2013
US 2012/0281013 A1	08 November 2012	CN 102782686 A	14 Nov 2012
		EP 2497042 A2	12 Sep 2012
		JP 2013510358 A	21 Mar 2013
		KR 20120114253 A	16 Oct 2012
		WO 2011055144 A2	12 May 2011
WO 2013/036942 A1	14 March 2013	CN 103890769 A	25 Jun 2014

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.