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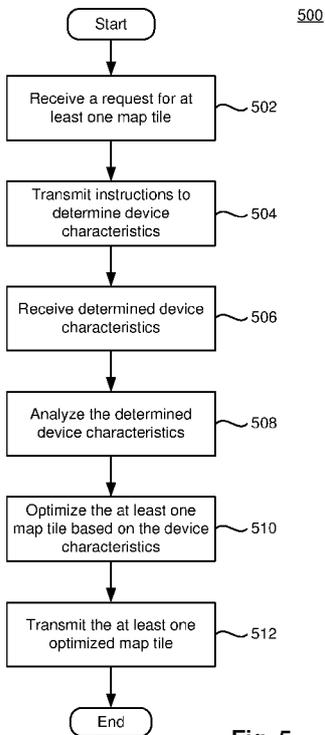


Fig. 5

(57) Abstract: Disclosed are systems, methods and computer program products for dynamically optimizing map service performance and, particularly, tile quality and detail. An example system includes a server configured to receive from a user device a request for at least one map tile and transmit instructions to the user device to determine characteristics of the user device. The server then receives the characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed. The server then optimizes the at least one tile based on the characteristics of the user device and transmits to the user device the at least one map tile that is optimized based on the characteristics of the user device for display on the user device.



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SYSTEM AND METHOD FOR DYNAMICALLY OPTIMIZING MAP TILE QUALITY AND DETAIL**Cross-Reference**

[0001] The present application claims convention priority to Russian Patent Application No. 2014117560, filed April 30, 2014, entitled "SYSTEM AND METHOD FOR DYNAMICALLY OPTIMIZING MAP TILE QUALITY AND DETAIL" which is incorporated by reference herein in its entirety.

Technical Field

[0002] The disclosure relates generally to the field of mapping systems, and more specifically to the systems, methods and computer program products for dynamically optimizing map service performance.

Background

[0003] Digital map systems are utilized by a wide variety of devices, such as mobile phones, desktop computers, hand held Global Positioning System (GPS) units, etc. Map data may be stored on a remote server before being accessed by and displayed on the various devices. The devices may use either a stand-alone application or a web browser to access the map data.

[0004] The different devices accessing the map data vary greatly in their characteristics, such as the software being used to access the map data, the processing power of the device, the random access memory (RAM) capacity of the device, the speed and throughput of the internet connection, etc. The server providing the map data to these devices does so with consistent quality and detail, with disregard for the specific characteristics of the device requesting the map data. Thus, the device's performance in rendering the map data depends on the device's characteristics. For example, a device with a slow internet connection, a high processor load, and little memory will load the map data slowly and ineffectively, whereas a device with a fast internet connection, a low processor load, and a lot of available memory will load the map data quickly and effectively. As such, the disparity in the characteristics between devices results in an inconsistent and sometimes disappointing digital map service experience by the users of these devices. Therefore, there exists an unmet need in the art for systems and

methods for dynamically optimizing map service performance in devices based on the respective devices' characteristics.

Summary

[0005] Disclosed are systems, methods and computer program products for dynamically optimizing map service performance and, particularly, tile quality and detail.

[0006] According to one aspect, an example system includes a server that may be configured to receive from a user device a request for at least one map tile and transmit instructions to the user device to determine characteristics of the user device. The server may then receive the characteristics of the user device, which may include one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed. The server may then optimize the at least one tile based on the characteristics of the user device and transmits to the user device the at least one map tile that is optimized based on the characteristics of the user device for display on the user device.

[0007] In one aspect, the level of quality of the map tile may be optimized based on the characteristics of the user device.

[0008] In another aspect, the level of quality of the map tile may comprise a graphical resolution of the map tile.

[0009] In another aspect, the graphical resolution of the map tile may be optimized based on the internet connection speed.

[0010] In another aspect, optimizing the at least one tile based on the characteristics of the user device further comprises: configuring the map tile to have a maximum graphical resolution if the internet connection speed is fast; configuring the map tile to have a medium graphical resolution if the internet connection speed is moderate; and configuring the map tile to have a low graphical resolution if the internet connection speed is slow.

[0011] In another aspect, a level of detail of the map tile may be optimized based on the characteristics of the user device.

[0012] In another aspect, the level of detail of the map tile may comprise an amount of information shown on the map tile.

[0013] In another aspect, the amount of information shown on the map tile may be optimized based on the available memory.

[0014] In another aspect, optimizing the at least one tile based on the characteristics of the user device may further comprise configuring the map tile to have a maximum amount of informational detail if the amount of available memory is large; configuring the map tile to have a medium amount of informational detail if the amount of available memory is moderate; and configuring the map tile to have a small amount of informational detail if the amount of available memory is low.

[0015] In another aspect, the server may be further configured to transmit to the user device instructions to determine characteristics of the user device on a periodic basis.

[0016] According to another aspect, a system for optimizing map quality may include a user device having a processor configured to: initiate on the user device a program associated with a map service; transmit to a server a request for at least one map tile; determine characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed; transmit the determined characteristics to the server; receive from the server the at least one map tile that is optimized based on the characteristics of the user device; and display the at least one received map tile on the user device.

[0017] According to yet another aspect, an example method for optimizing map quality may comprise receiving from a user device a request for at least one map tile; transmitting instructions to the user device to determine characteristics of the user device; receiving the characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed; optimizing the at least one tile based on the characteristics of the user device; and transmitting to the user device the at least one map tile that is optimized based on the characteristics of the user device for display on the user device.

[0018] According to yet another aspect, a method for optimizing map quality comprises initiating on a user device a program associated with a map service; transmitting to a server a request for at least one map tile; determining characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed; transmitting the determined characteristics to the server; receiving from the server the at least one map tile that is optimized based on the characteristics of the user device; and displaying the at least one received map tile on the user device.

[0019] According to yet another aspect, an example computer program product stored on a non-transitory computer-readable storage medium, the computer program product comprising computer-executable instructions for optimizing map quality, including instructions for receiving from a user device a request for at least one map tile; transmitting instructions to the user device to determine characteristics of the user device; receiving the characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed; optimizing the at least one tile based on the characteristics of the user device; and transmitting to the user device the at least one map tile that is optimized based on the characteristics of the user device for display on the user device.

[0020] According to yet another aspect, an example computer program product stored on a non-transitory computer-readable storage medium, the computer program product comprising computer-executable instructions for optimizing map quality, including instructions for initiating on a user device a program associated with a map service; transmitting to a server a request for at least one map tile; determining characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed; transmitting the determined characteristics to the server; receiving from the server the at least one map tile that is optimized based on the

characteristics of the user device; and displaying the at least one received map tile on the user device.

[0021] The above simplified summary of example aspects serves to provide a basic understanding of the invention. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects of the invention. Its sole purpose is to present one or more aspects in a simplified form as a prelude to the more detailed description of the invention that follows. To the accomplishment of the foregoing, the one or more aspects of the invention include the features described and particularly pointed out in the claims.

Brief Description of the Drawings

[0022] The accompanying drawings, which are incorporated into and constitute a part of this specification, illustrate one or more example aspects of the invention and, together with the detailed description, serve to explain their principles and implementations.

[0023] **Fig. 1** is a diagram illustrating an example aspect of a system for dynamically optimizing map service performance according to one aspect of the invention.

[0024] **Fig. 2** is a diagram illustrating an example aspect of a web browser displaying a map request entry webpage of a system for dynamically optimizing map service performance according to one aspect of the invention.

[0025] **Fig. 3** is a diagram illustrating an example aspect of a map webpage of a system for dynamically optimizing map service performance according to one aspect of the invention.

[0026] **Fig. 4** is a flow diagram illustrating an example method for dynamically optimizing map tiles according to one aspect of the invention.

[0027] **Fig. 5** is a flow diagram illustrating an example method for dynamically optimizing map tiles according to one aspect of the invention.

[0028] **Fig. 6** is a flow diagram illustrating an example method for dynamically optimizing map scaling animation according to one aspect of the invention.

[0029] Fig. 7 is a flow diagram illustrating an example method for dynamically optimizing map scaling animation according to one aspect of the invention.

[0030] Fig. 8 is a diagram illustrating an example aspect of a general-purpose computer system on which are implemented the systems and methods for dynamically optimizing map service performance in accordance with aspects of the invention.

Detailed Description

[0031] Example aspects of the present invention are described herein in the context of systems, methods and computer program products for dynamically optimizing map service performance. Those of ordinary skill in the art will realize that the following description is illustrative only and is not intended to be in any way limiting. Other aspects will readily suggest themselves to those skilled in the art having the benefit of this disclosure. Reference will now be made in detail to implementations of the example aspects as illustrated in the accompanying drawings. The same reference indicators will be used to the extent possible throughout the drawings and the following description to refer to the same items.

[0032] Fig. 1 depicts an example system 100 for dynamically optimizing map service performance according to one aspect of the invention. The system 100 may include various electronic user devices 102, such as a mobile device, a desktop computer, a laptop, etc. In one aspect, a device 102 may include a map application module 112. The device 102 may be connected to a network 110, such as the Internet, via a wired or wireless connection. Also connected to the network 110 may be a map server 104. In one aspect, the map server 104 may host one or more map services that provide geographic map data to various user devices, such as device 102. In one aspect, the map server 104 may include a map service module 114, a map tile database 116, and an evaluation module 118. The functionality of each of the modules of the device 102 and the map server 104 will be described in greater detail below.

[0033] The term “module” as used herein means a real-world device, apparatus, or arrangement of modules implemented using hardware, such as by an application specific integrated circuit (ASIC) or field-programmable gate array (FPGA), for example, or as a combination of hardware and software, such as by a microprocessor system and a set of

instructions to implement the module's functionality, which (while being executed) transform the microprocessor system into a special-purpose device. A module can also be implemented as a combination of the two, with certain functions facilitated by hardware alone, and other functions facilitated by a combination of hardware and software. In certain implementations, at least a portion, and in some cases, all, of a module can be executed on the processor of a general purpose computer (such as the one described in greater detail in Fig. 8 below). Accordingly, each module can be realized in a variety of suitable configurations, and should not be limited to any particular implementation exemplified herein.

[0034] The map application module 112 of the device 102 shown in Fig. 1 may be a web browser or any application that allows a user to access a map service, such as the map service provided by the map server 104, via the network 110. For example, **Fig. 2** illustrates an example aspect of such a web browser with a user interface 200 displaying a map request entry webpage 202 of a system for dynamically optimizing map service performance according to one aspect of the invention. The map request entry webpage 202 may be hosted and provided by the map service module 114. As shown in Fig. 2, the map request entry webpage 202 may include a number of text fields for entering specific location information, such as street address 204, city 206, state 208, and postal code (e.g., zip code) 210. After entering the desired location to be mapped, the user may then request a map from the map server 104 by selecting a "submit" button 212. A map image may then be generated at the map server 104, transmitted to the user's device 102, and eventually displayed on the web browser user interface 200 in a map webpage.

[0035] **Fig. 3** illustrates an exemplary map webpage 300 on the web browser user interface 200. As shown in Fig. 3, the map webpage 300 may display the results of the map request from Fig. 2. The displayed information may consist of a map image 302, which depicts the requested location and surrounding area. The requested location may be identified on the map image 302 by an address icon 304, and the address icon 304 may be located in the center of map image 302. The requested location and address icon 304 may also be displayed in a map legend window 306 within map webpage 300.

[0036] The map webpage 300 may also display buttons or other user interface objects that may be selected to control the manner in which the map image 302 is displayed. For example, as shown in Fig. 3, zoom control objects 310 may be provided to allow the user to “zoom in” or “zoom out” and thereby affect the displayed scale of map image 302 accordingly, typically while retaining the desired location marked by address icon 304 at the center of the image. The user may also change the scale of the map image 302 with a peripheral control device, such as by scrolling a mouse wheel. The map scaling from one zoom level to another may be animated such that a user perceives a gradual “zooming in” or “zooming out” animation (at a predetermined frame rate) when changing the scale of the map image 302. Also, direction buttons or other similar user interface objects, such as “right arrow” direction button 308, may be provided to allow the user to “pan” the image, such as by displaying more of the map information that was previously hidden because it was beyond the “eastern” boundary of map image 308, while shifting and hiding a corresponding portion of the previously displayed “western” portion of the map information. As shown in Fig. 3, such image control objects may be displayed outside the boundary area of the map image 302 or alternatively may be displayed within the map image 302. The user may also “click and drag” the map image 302 to “pan” the image in any desired direction.

[0037] When image control objects (e.g., zoom control objects 310 or direction button 308 shown in Fig. 3) are selected, the device 102 may transmit a request (e.g., an HTTP request) to the map server 104, which may then respond to the request with a new image containing the new map information to be displayed at the selected zoom level.

[0038] Specifically, in the exemplary system, as shown in Fig. 1, the map application module 112 may send a request containing location information for a requested map image to the map server 104. The request may consist of location data received via the web browser user interface 200 through the map request entry webpage 202, as illustrated in Fig. 2. For example, a user may enter the following desired location to be mapped: 1201 Main St., Springfield, New York, 14850. The user may then request a map of the location by selecting a “submit” button 212, and this selection event eventually causes the request to be transmitted (directly or indirectly) from the map application module 112 to the map server 104.

[0039] The map service module 114 of the map server 104 may receive the request and in response may transmit instructions to the map application module 112 of the device 102 to assess various characteristics of the device 102. For example, the instructions may require the device 102 to assess its static characteristics (e.g., processor type, total memory, graphics subsystem) and dynamic characteristics (e.g., current device processor load, current number of operations executed by the processor, available memory, internet connection speed/bandwidth). Upon receipt of the instructions, the map application module 112 may assess the device characteristics and transmit a message including the assessment of the characteristics to the map service module 114. In accordance with one aspect, the map service module 114 may transmit instructions to the map application module 112 to reassess the characteristics of the device 102 on a periodic basis. Alternatively or in addition, the map application module 112 may prompt the device 102 to reassess the characteristics in response to any number of events that may potentially affect the characteristics of the device 102, such as a new application being loaded into memory (e.g., user launched a different application), detection of a new background process (e.g., an e-mail application checks a server for new e-mails), the user switching the device 102 to a different type of internet connection (e.g., from 3GPP to WiFi).

[0040] Upon receipt of the message including the assessment of the characteristics, the map service module 114 may transmit the assessment of the characteristics to the evaluation module 118, which evaluates the characteristics and makes certain determinations based on the evaluation of the characteristics.

[0041] For example, in accordance with one aspect, the evaluation module 118 may determine a suitable level of quality (e.g., map tile resolution) and a suitable level of detail (e.g., map tile information) of the map tiles based on the characteristics of the device. The map tile database 116 may store map tiles that constitute the whole of the map at each zoom level, and that form the map image 302 displayed to the user within the map webpage 300. After receiving a request from a user to display a certain map location, the map service module 114 may retrieve from the map tile database 116 map tiles that correspond to the requested location at the requested zoom level. Each map tile may include a level of detail (e.g., map tile

information) showing and identifying various features on the map tile, such as landscape features relevant to its scale, including cities, towns, villages, buildings, roads, railways, walkways, lakes, rivers, woodlands, points of interest, relief or terrain, three-dimensional quality of the surface, specific landforms, etc., as well as labels identifying the features. Each map tile may also include a level of quality (e.g., map tile resolution) related to graphical resolution of the various features.

[0042] After the evaluation module 118 receives the assessment of the characteristics of the device 102, it may determine, based on one or more of the characteristics, the quality and detail levels of the map tiles to be transmitted to the device 102. For example, in accordance with one aspect, the evaluation module 118 may adjust the quality level (e.g., map tile resolution) of the map tiles based on the current internet connection speed of the device 102. According to one aspect, the map tile resolution may be measured using a device pixel ratio (DPR). DPR is the ratio between logical pixels (e.g., a pixel on a web page or an image pixel) and physical pixels (e.g., pixels on the screen of the device). For example, if a physical linear resolution (e.g., physical pixels) is double that of a logical resolution (e.g., logical pixels), then the DPR will be 2. According to one aspect, a full map tile with a DPR of 1 may have a size of about 1 megabit (Mb), a full map tile with a DPR of 2 may have a size between 3 Mb and 4 Mb, and a full map tile with a DPR of 3 may have a size between 4 Mb and 9 Mb. Consequently, assuming for example that 1 second is a normal time for rendering one map tile, an internet connection speed of about 10 megabits per second (Mbps) (i.e., 1.25 megabytes per second (MBps)) is sufficient for a DPR of 1 and 2, but not acceptable for a DPR of 3.

[0043] For example, the evaluation module 118 may allow a maximum map tile resolution (e.g., DPR of 3 to 4) if the internet connection speed is fast (e.g., 10 Mbps), a medium map tile resolution (e.g., DPR of 2) if the internet connection speed is moderate (e.g., 5 to 10 Mbps), and a minimum map tile resolution (e.g., DPR of 1) if the internet connection speed is slow (e.g., 0 to 5 Mbps).

[0044] As another example, the evaluation module 118 may adjust the level of detail (e.g., map tile information) shown on the map tiles based on the current available memory of the

device 102. For example, the evaluation module 118 may allow a maximum amount of detail (e.g., showing all buildings, labels, points of interest) on the map tile if the amount of available memory is large (e.g., 70-100%), a medium amount of detail (e.g., partially showing buildings, some labels, no points of interest) on the map tile if the amount of available memory is moderate (e.g., 40-70%), and a small amount of detail (e.g., showing no buildings, no labels, no points of interest) on the map tile if the amount of available memory is low (e.g., 0-40%). It should be noted that the evaluation module 118 may assign a level of quality (e.g., map tile resolution) and/or a level of detail (e.g., map tile information) with any number of intermediate gradations based on any one or more of the characteristics of the device 102.

[0045] After the evaluation module 118 determines the suitable map tile quality and detail levels based on the characteristics of the device 102, it may instruct the map service module 114 to apply the determined map tile quality and detail levels to any map tiles destined for the device 102. The map service module 114 may receive the instructions, apply the determined map tile quality and detail levels to the map tiles that it retrieved from the map tile database 116 for the device 102, and transmit the adjusted map tiles to the device 102. The map application module 112 may receive the adjusted map tiles, and display the adjusted map tiles to the user in the form of a map image 302 within the map webpage 300.

[0046] Further, in accordance with one aspect, the evaluation module 118 may also determine a suitable frame rate of scaling animation. For example, after the evaluation module 118 receives the assessment of the characteristics of the device 102, it may determine, based on one or more of the characteristics, a frame rate (e.g., frames per second (FPS)) of the scaling animation (i.e., zoom animation) appropriate for the device 102. For example, in accordance with one aspect, the evaluation module 118 may assign a target frame rate based on the current processor load of the device 102. For example, the evaluation module 118 may assign a maximum frame rate (e.g., 30 FPS) for the scaling animation if the processor load is low (e.g., 0-20%), a medium frame rate (e.g., 5 FPS) for the scaling animation if the processor load is moderate (e.g., 20-50%), and minimum frame rate (e.g., no animation – immediate display of desired zoom level) for the scaling animation if the processor load is high (e.g., 50-100%). It should be noted that the evaluation module 118 may assign a target frame rate having any

number of intermediate gradations based on any one or more of the characteristics of the device 102.

[0047] After the evaluation module 118 determines the target frame rate for the scaling animation based on the characteristics of the device 102, it may instruct the map service module 114 to transmit to the device 102 the assigned target frame rate with instructions to have the device 102 simulate in the background a map scaling animation at the target frame rate. The map application module 112 may receive the instructions along with any requested map tiles, apply the assigned target frame rate to any scaling operations performed by the user, and simulate the scaling animation as instructed. During (e.g., in real-time) or after the simulation by the map application module 112, the map service module 114 may observe the performance of the scaling animation. For example, the map service module 114 may monitor the frame rate at which the device 102 was able to run the scaling animation. Based on the observation, the evaluation module 118 may determine whether the assigned target frame rate requires any adjustment. If so, the evaluation module 118 may adjust the target frame rate (e.g., raise or lower target FPS). For example, if the device 102 simulated the scaling animation at a frame rate that was lower than the target frame rate, then the evaluation module 118 may lower the target frame rate; whereas if the device 102 simulated the scaling animation at a frame rate that was equal to or greater than the target frame rate, then the evaluation module 118 may increase the target frame rate. Thereafter, the evaluation module 118 may instruct the map application module 112 to perform another simulation of the scaling animation using the adjusted target frame rate. This process may be repeated continuously while the user is navigating the map image 302 to ensure that the assigned target frame rate matches the actual frame rate of the map scaling animation simulation.

[0048] Accordingly, in this manner, the user of the device 102 is provided with a map service experience that is optimized based on the characteristics of the device 102.

[0049] **Fig. 4** is a flow diagram illustrating an example method for dynamically optimizing map tiles according to one aspect of the invention. The process described in this flow diagram may be implemented in a device accessing a map service, such as a user device 102. As shown

in Fig. 4, the process may begin in block 402, where a device may initiate a program associated with a map service. For example, the device 102 may activate the map application module 112 that would contact map service module 114 to request access to a map service. In block 404, the map application module 112 may transmit a request to the map service module 114 for at least one map tile. In block 406, the map application module 112 may receive instructions to determine its device characteristics, such as one or more of a processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, internet connection speed, etc. In block 408, the map application module 112 may determine the characteristics of the device 102. In block 410, the map application module 112 may transmit to the map service module 114 the determined characteristics of the device 102. In block 412, the map application module 112 may receive from the map service module 114 at least one map tile that is optimized based on the characteristics of the device 102, and the process may end.

[0050] Fig. 5 is a flow diagram illustrating an example method for dynamically optimizing map tiles according to one aspect of the invention. The process described in this flow diagram may be implemented in a server hosting a map service, such as map server 104. As shown in Fig. 5, the process may begin in block 502, where a server may receive a request for at least one map tile. For example, the map service module 114 of the map server 104 may receive a request from the map application module 112 of the device 102 for at least one map tile. In block 504, the map service module 114 may transmit instructions to the map application module 112 to determine characteristics of the device 102, such as one or more of a processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, internet connection speed, etc. In block 506, the map service module 114 may receive the determined device characteristics from the map application module 112. In block 508, the evaluation module 118 may analyze the device characteristics and may provide instructions to the map service module 114 to adjust (e.g., optimize) the map tiles based on the analysis of the device characteristics. In block 510, the map service module 114 may optimize the at least one map tile based on the analysis of the device characteristics. In block 512, the map service module 114 may transmit the at least one

optimized map tile to the map application module 112 for display on the device 102, and the process may end.

[0051] Fig. 6 is a flow diagram illustrating an example method for dynamically optimizing map scaling animation according to one aspect of the invention. The process described in this flow diagram may be implemented in a server hosting a map service, such as map server 104. As shown in Fig. 6, the process may begin in block 602, where a server may receive a request to access a map service. For example, the map service module 114 of the map server 104 may receive a request from the map application module 112 of the device 102 to access the map service hosted by the map server 104. In block 604, the map service module 114 may transmit instructions to the map application module 112 to determine characteristics of the device 102, such as one or more of a processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, internet connection speed, etc. In block 606, the map service module 114 may receive the determined device characteristics from the map application module 112. In block 608, the evaluation module 118 may analyze the device characteristics. In block 610, the evaluation module 118 may select a target frame rate for a map scaling animation based on the analysis of the device characteristics. In block 612, the map service module 114 may transmit the target frame rate to the map application module. In block 614, the map service module 114 may transmit instruction to the map application module 112 to simulate the map scaling animation at the target frame rate. In block 616, the map service module 114 may monitor in real-time the performance of the scaling animation simulation. For example, the map service module 114 may monitor in real-time a number of frames per second at which the device 102 is able to simulate the map scaling animation. In block 618 the evaluation module 118 may determine whether the performance of the map scaling animation simulation was satisfactory. For example, the evaluation module 118 may determine whether the assigned target frame rate requires any adjustment based on the performance of the simulation. If the map scaling animation simulation was not satisfactory, then in block 620, the evaluation module 118 may adjust the target frame rate based on the performance (e.g., lower or raise the target frame

rate), and the process may proceed to block 612. If the map scaling animation simulation was satisfactory, then the process ends.

[0052] Fig. 7 is a flow diagram illustrating an example method for dynamically optimizing map scaling animation according to one aspect of the invention. The process described in this flow diagram may be implemented in a device accessing a map service, such as device 102. As shown in Fig. 7, the process may begin in block 702, where a device may initiate a program associated with a map service. For example, the device 102 may activate the map application module 112 that would contact map service module 114 to request access to a map service. In block 704, the map application module 112 may transmit a request to the map service module 114 to access the map service. In block 706, the map application module 112 may receive instructions from the map service module 114 to determine its device characteristics, such as one or more of a processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, internet connection speed, etc. In block 708, the map application module 112 may determine the characteristics of the device 102. In block 710, the map application module 112 may transmit to the map service module 114 the determined characteristics of the device 102. In block 712, the map application module 112 may receive from the map service module 114 a target frame rate for use in the map scaling animation. In block 714, the map application module 112 may receive instructions to simulate in the background the map scaling animation at the target frame rate. In block 716, the evaluation module 118 of the map server 104 may determine whether the results of the map scaling animation simulation were satisfactory. For example, the evaluation module 118 may determine whether the assigned target frame rate requires any adjustment based on the performance of the simulation. If the map scaling animation simulation was not satisfactory, then in block 720, the map application module 112 may receive an adjusted target frame rate based on the performance (e.g., lower or higher target frame rate), and the process may proceed to block 714. If the map scaling animation simulation was satisfactory, then the process ends.

[0053] Fig. 8 depicts one example aspect of a computer system 5 that may be used to implement the disclosed systems and methods for dynamically optimizing map service

performance according to one aspect of the invention. The computer system 5 may include, but not limited to, a personal computer, a notebook, tablet computer, a smart phone, a mobile device, a network server, a router, or other type of processing device. As shown, computer system 5 may include one or more hardware processors 15, memory 20, one or more hard disk drive(s) 30, optical drive(s) 35, serial port(s) 40, graphics card 45, audio card 50 and network card(s) 55 connected by system bus 10. System bus 10 may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus and a local bus using any of a variety of known bus architectures. Processor 15 may include one or more Intel® Core 2 Quad 2.33 GHz processors or other type of microprocessor.

[0054] System memory 20 may include a read-only memory (ROM) 21 and random access memory (RAM) 23. Memory 20 may be implemented as in DRAM (dynamic RAM), EPROM, EEPROM, Flash or other type of memory architecture. ROM 21 stores a basic input/output system 22 (BIOS), containing the basic routines that help to transfer information between the modules of computer system 5, such as during start-up. RAM 23 stores operating system 24 (OS), such as Windows® 7 Professional or other type of operating system, that is responsible for management and coordination of processes and allocation and sharing of hardware resources in computer system 5. Memory 20 also stores applications and programs 25. Memory 20 also stores various runtime data 26 used by programs 25.

[0055] Computer system 5 may further include hard disk drive(s) 30, such as SATA HDD, and optical disk drive(s) 35 for reading from or writing to a removable optical disk, such as a CD-ROM, DVD-ROM or other optical media. Drives 30 and 35 and their associated computer-readable media provide non-volatile storage of computer readable instructions, data structures, applications and program modules/subroutines that implement algorithms and methods disclosed herein. Although the exemplary computer system 5 employs magnetic and optical disks, it should be appreciated by those skilled in the art that other types of computer readable media that can store data accessible by a computer system 5, such as magnetic cassettes, flash memory cards, digital video disks, RAMs, ROMs, EPROMs and other types of memory may also be used in alternative aspects of the computer system 5.

[0056] Computer system 5 further includes a plurality of serial ports 40, such as Universal Serial Bus (USB), for connecting data input device(s) 75, such as keyboard, mouse, touch pad and other. Serial ports 40 may be also be used to connect data output device(s) 80, such as printer, scanner and other, as well as other peripheral device(s) 85, such as external data storage devices and the like. System 5 may also include graphics card 45, such as nVidia® GeForce® GT 240M or other video card, for interfacing with a display 60 or other video reproduction device, such as touch-screen display. System 5 may also include an audio card 50 for reproducing sound via internal or external speakers 65. In addition, system 5 may include network card(s) 55, such as Ethernet, WiFi, GSM, Bluetooth or other wired, wireless, or cellular network interface for connecting computer system 5 to network 70, such as the Internet.

[0057] In various aspects, the systems and methods described herein may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the methods may be stored as one or more instructions or code on a non-transitory computer-readable medium. Computer-readable medium includes data storage. By way of example, and not limitation, such computer-readable medium can comprise RAM, ROM, EEPROM, CD-ROM, Flash memory or other types of electric, magnetic, or optical storage medium, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a processor of a general purpose computer.

[0058] In the interest of clarity, not all of the routine features of the aspects are disclosed herein. It will be appreciated that in the development of any actual implementation of the invention, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, and that these specific goals will vary for different implementations and different developers. It will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skill in the art having the benefit of this disclosure.

[0059] Furthermore, it is to be understood that the phraseology or terminology used herein is for the purpose of description and not of restriction, such that the terminology or phraseology of the present specification is to be interpreted by the skilled in the art in light of

the teachings and guidance presented herein, in combination with the knowledge of the skilled in the relevant art(s). Moreover, it is not intended for any term in the specification or claims to be ascribed an uncommon or special meaning unless explicitly set forth as such.

[0060] The various aspects disclosed herein encompass present and future known equivalents to the known modules referred to herein by way of illustration. Moreover, while aspects and applications have been shown and described, it would be apparent to those skilled in the art having the benefit of this disclosure that many more modifications than mentioned above are possible without departing from the inventive concepts disclosed herein.

Claims

1. A method for optimizing map quality, comprising:
 - receiving from a user device a request for at least one map tile;
 - transmitting instructions to the user device to determine characteristics of the user device;
 - receiving the characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed;
 - optimizing the at least one tile based on the characteristics of the user device; and
 - transmitting to the user device the at least one map tile that is optimized based on the characteristics of the user device for display on the user device.
2. The method of claim 1, wherein a level of quality of the map tile is optimized based on the characteristics of the user device.
3. The method of claim 2, wherein the level of quality of the map tile comprises a graphical resolution of the map tile.
4. The method of claim 3, wherein the graphical resolution of the map tile is optimized based on the internet connection speed.
5. The method of claim 4, wherein optimizing the at least one tile based on the characteristics of the user device further comprises:
 - configuring the map tile to have a maximum graphical resolution if the internet connection speed is fast;
 - configuring the map tile to have a medium graphical resolution if the internet connection speed is moderate; and

configuring the map tile to have a low graphical resolution if the internet connection speed is slow.

6. The method of claim 1, wherein a level of detail of the map tile is optimized based on the characteristics of the user device.

7. The method of claim 6, wherein the level of detail of the map tile comprises an amount of information shown on the map tile.

8. The method of claim 7, wherein the amount of information shown on the map tile is optimized based on the available memory.

9. The method of claim 8, wherein optimizing the at least one tile based on the characteristics of the user device further comprises:

configuring the map tile to have a maximum amount of informational detail if the amount of available memory is large;

configuring the map tile to have a medium amount of informational detail if the amount of available memory is moderate; and

configuring the map tile to have a small amount of informational detail if the amount of available memory is low.

10. The method of claim 1, further comprising:

transmitting to the user device instructions to determine characteristics of the user device on a periodic basis.

11. A system for optimizing map quality, comprising:

a server computer configured to:

receive from a user device a request for at least one map tile;

transmit instructions to the user device to determine characteristics of the user device;

receive the characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed;

optimize the at least one tile based on the characteristics of the user device; and

transmit to the user device the at least one map tile that is optimized based on the characteristics of the user device for display on the user device.

12. The system of claim 11, wherein a level of quality of the map tile is optimized based on the characteristics of the user device, wherein the level of quality of the map tile comprises a graphical resolution of the map tile, and wherein the graphical resolution of the map tile is optimized based on the internet connection speed.

13. The system of claim 12, wherein optimizing the at least one tile based on the characteristics of the user device further comprises:

configuring the map tile to have a maximum graphical resolution if the internet connection speed is fast;

configuring the map tile to have a medium graphical resolution if the internet connection speed is moderate; and

configuring the map tile to have a low graphical resolution if the internet connection speed is slow.

14. The system of claim 11, wherein a level of detail of the map tile is optimized based on the characteristics of the user device, wherein the level of detail of the map tile comprises an amount of information shown on the map tile, wherein the amount of information shown on the map tile is optimized based on the available memory.

15. The system of claim 14, wherein optimizing the at least one tile based on the characteristics of the user device further comprises:

configuring the map tile to have a maximum amount of informational detail if the amount of available memory is large;

configuring the map tile to have a medium amount of informational detail if the amount of available memory is moderate; and

configuring the map tile to have a small amount of informational detail if the amount of available memory is low.

16. A method for optimizing map quality, comprising:

initiating on a user device a program associated with a map service;

transmitting to a server a request for at least one map tile;

determining characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed;

transmitting the determined characteristics to the server;

receiving from the server the at least one map tile that is optimized based on the characteristics of the user device; and

displaying the at least one received map tile on the user device.

17. The method of claim 16, wherein a level of quality of the map tile is optimized based on the characteristics of the user device.

18. The method of claim 17, wherein the level of quality of the map tile comprises a graphical resolution of the map tile.

19. The method of claim 18, wherein the graphical resolution of the map tile is optimized based on the internet connection speed.

20. The method of claim 19, wherein receiving from the server the at least one map tile that is optimized based on the characteristics of the user device further comprises:

receiving the map tile at a maximum graphical resolution if the internet connection speed is fast;

receiving the map tile at a medium graphical resolution if the internet connection speed is moderate; and

receiving the map tile at a low graphical resolution if the internet connection speed is slow.

21. The method of claim 16, wherein a level of detail of the map tile is optimized based on the characteristics of the user device.

22. The method of claim 21, wherein the level of detail of the map tile comprises an amount of information shown on the map tile.

23. The method of claim 22, wherein the amount of information shown on the map tile is optimized based on the available memory.

24. The method of claim 23, wherein receiving from the server the at least one map tile that is optimized based on the characteristics of the user device comprises:

receiving the map tile with a maximum amount of informational detail if the amount of available memory is large;

receiving the map tile with a medium amount of informational detail if the amount of available memory is moderate; and

receiving the map tile with a small amount of informational detail if the amount of available memory is low.

25. The method of claim 16, further comprising:

receiving from the server instructions to determine characteristics of the user device on a periodic basis.

26. The method of claim 16, further comprising:
detecting an event affecting at least one of the characteristics of the user device;
determining the characteristics of the user device upon detection of the event; and
transmitting the determined characteristics to the server.
27. The method of claim 26, wherein the event includes one or more of a new application being loaded into memory, a new background process, and a change to a different type of internet connection.
28. A system for optimizing map quality, comprising:
a user device having a processor configured to:
initiate on the user device a program associated with a map service;
transmit to a server a request for at least one map tile;
determine characteristics of the user device, the characteristics including one or more of processor type, total memory, graphics subsystem type, current processor load, current number of operations executed by the processor, available memory, and internet connection speed;
transmit the determined characteristics to the server;
receive from the server the at least one map tile that is optimized based on the characteristics of the user device; and
display the at least one received map tile on the user device.
29. The system of claim 28, wherein a level of quality of the map tile is optimized based on the characteristics of the user device, wherein the level of quality of the map tile comprises a graphical resolution of the map tile, and wherein the graphical resolution of the map tile is optimized based on the internet connection speed.

30. The system of claim 28, wherein a level of detail of the map tile is optimized based on the characteristics of the user device, wherein the level of detail of the map tile comprises an amount of information shown on the map tile, wherein the amount of information shown on the map tile is optimized based on the available memory.

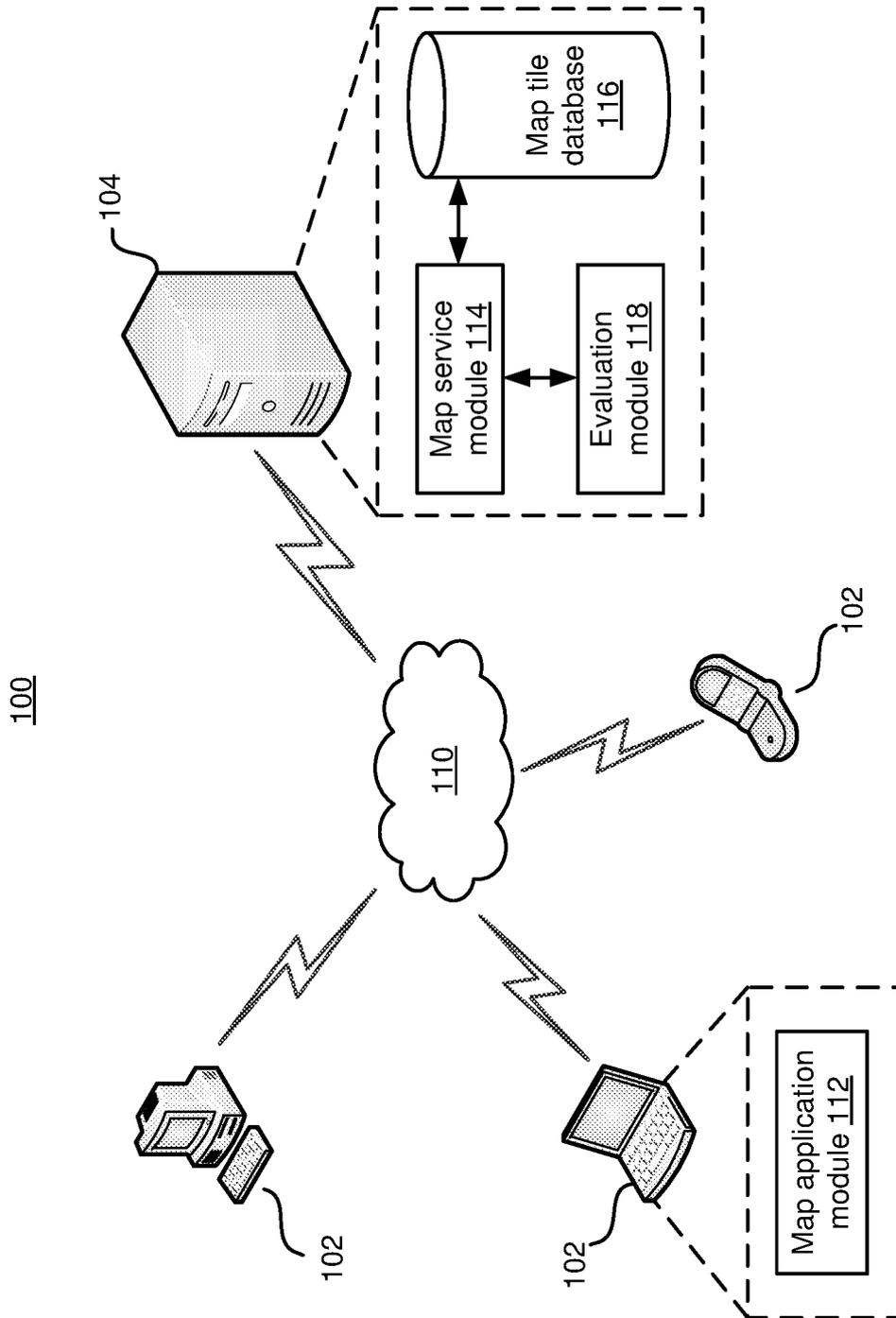


Fig. 1

200

202

Enter Location:

Street Address: 204

City: 206

State: 208

Postal Code: 210

212

The diagram shows a rectangular frame (200) containing a smaller rectangular frame (202). Inside frame 202, the text "Enter Location:" is at the top. Below it are four input fields, each with a label to its left and a reference numeral to its right: "Street Address:" (204), "City:" (206), "State:" (208), and "Postal Code:" (210). At the bottom of the form is a rectangular button labeled "SUBMIT" (212).

Fig. 2

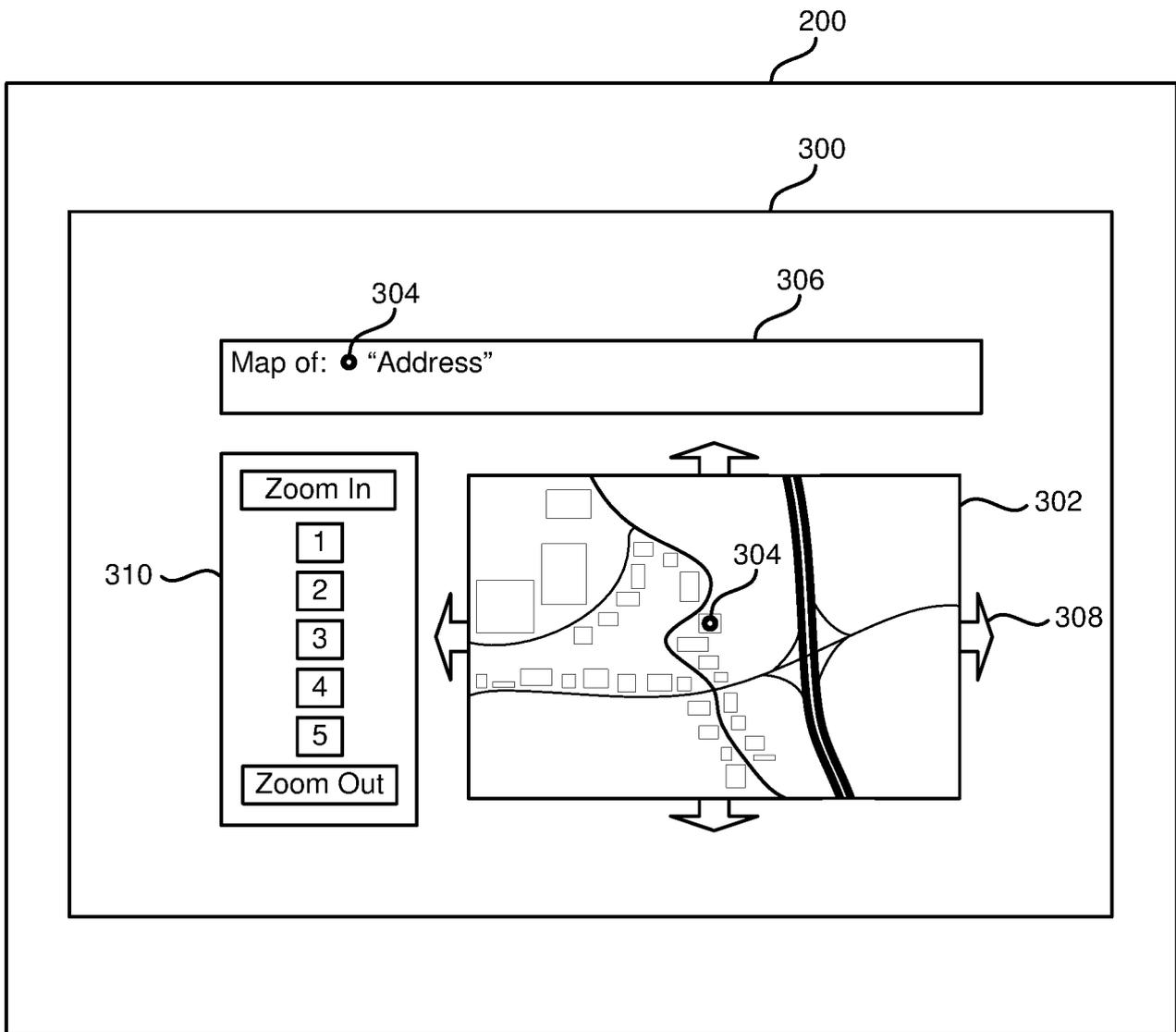


Fig. 3

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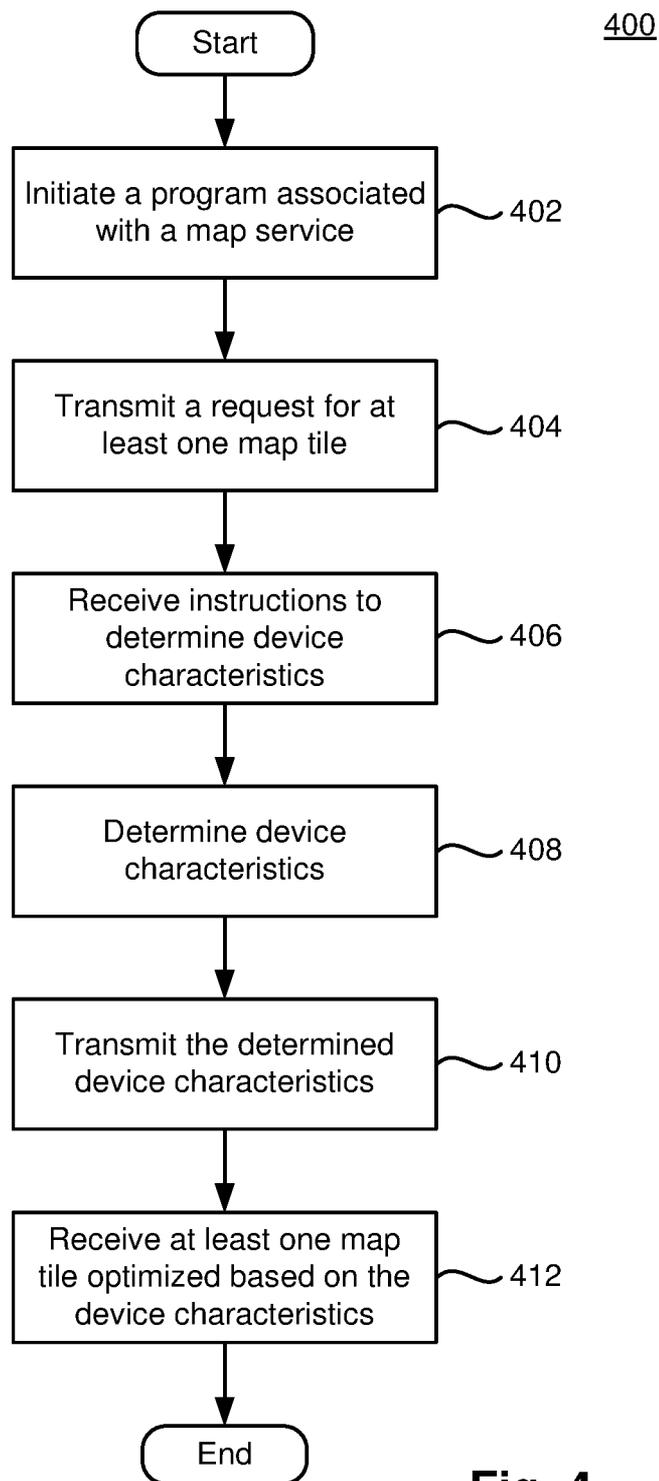


Fig. 4

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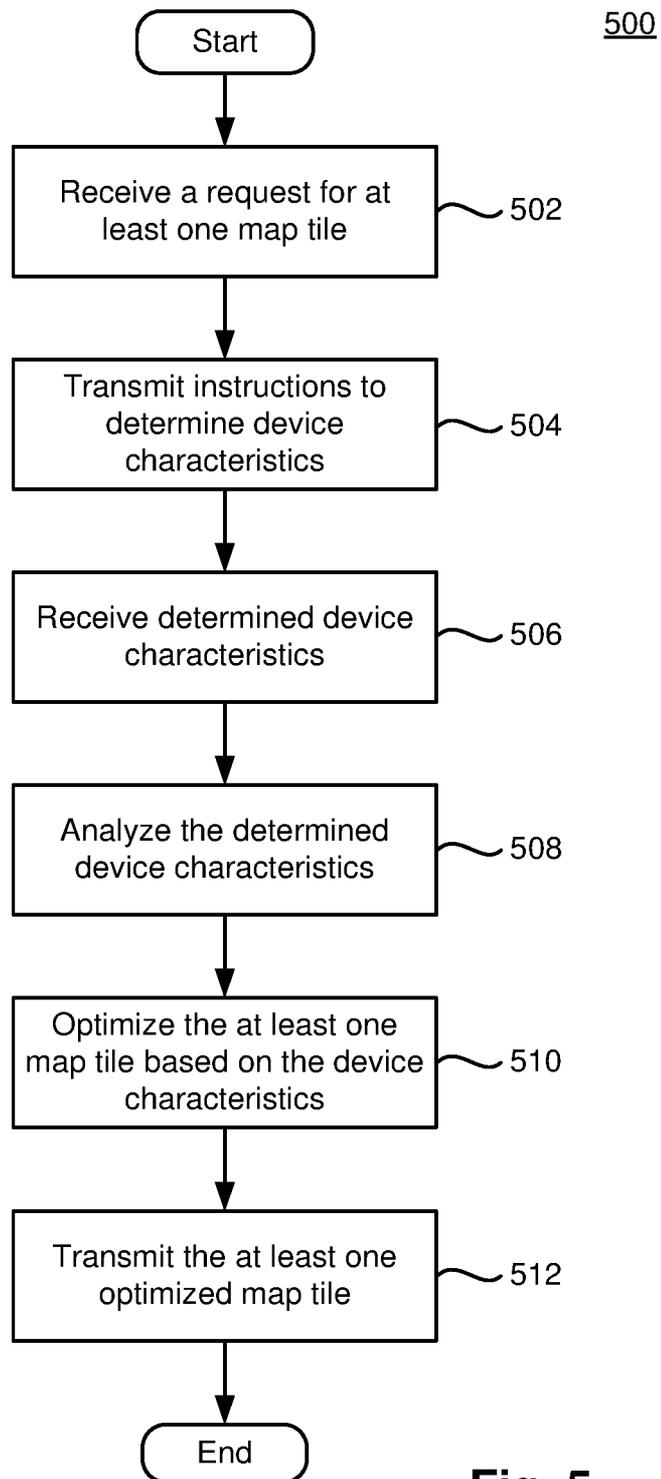


Fig. 5

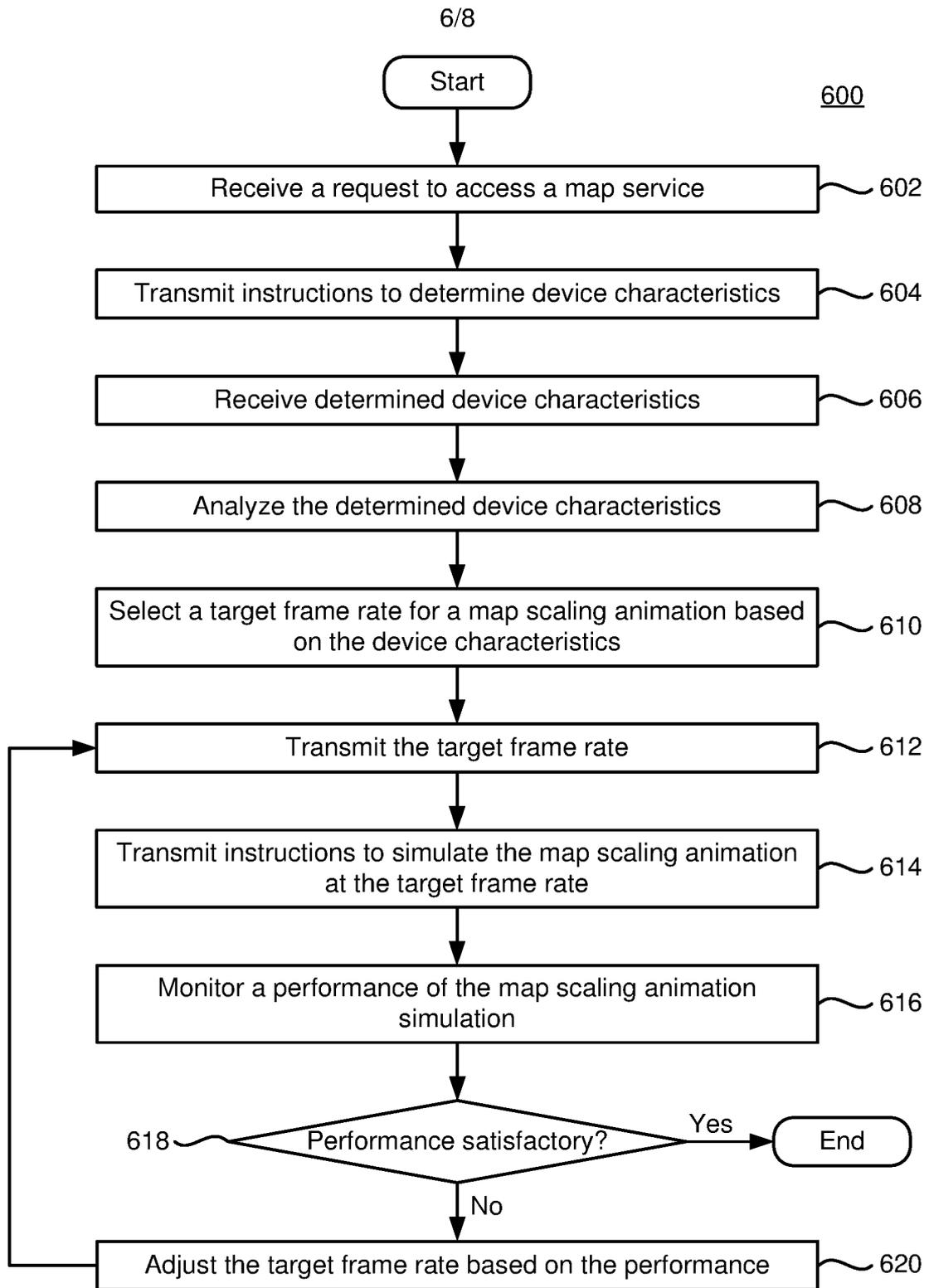


Fig. 6

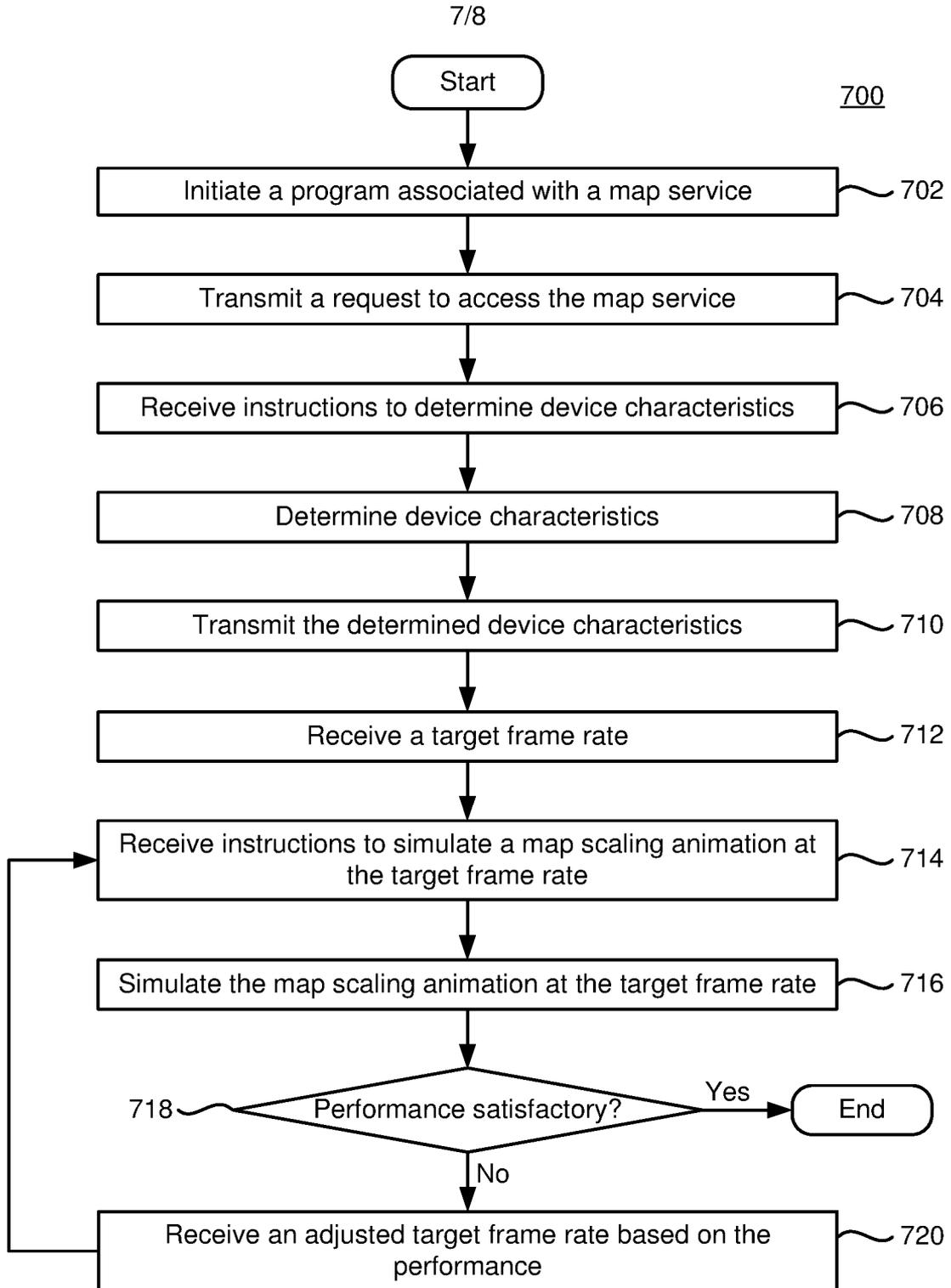


Fig. 7

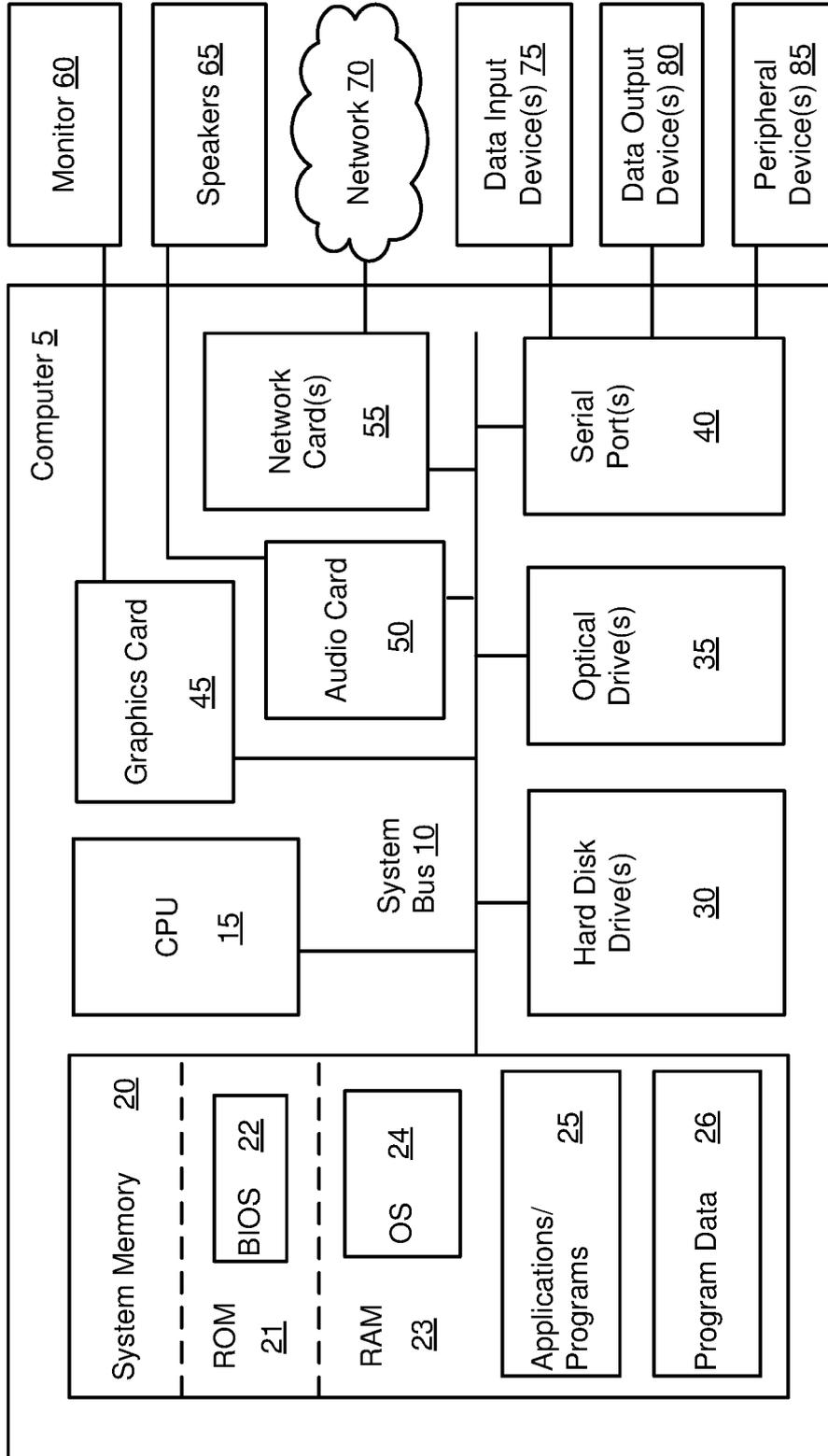


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2014/066976

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06T 13/80(2015.01)

CPC - G01S 19/14 (2014.12)

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)

IPC(8) - G06F 17/30902; G01S 19/14; G06T 11/40 (2014.12)

USPC -345/472, 520; 709/219

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

CPC - G06F 17/30902; G01S 19/14; G06T 11/40 (2014.12)

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

Orbit, Google Patents, Google.

Search terms used: geographic, map, GPS, device characteristics, features, resources, resolution, level of detail, internet speed

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0228474 A1 (PATERSON et al) 9 September 2010 (09.09.2010) entire document	1-3, 6, 7, 11, 16-18, 21, 22, 28
Y		4, 5, 8-10, 12-15, 19, 20, 23-27, 29, 30
Y	US 2010/0050221 A1 (McCUTCHEN et al) 25 February 2010 (25.02.2010) entire document	4, 5, 12, 13, 19, 20, 29
Y	US 2013/0307847 A1 (DEY et al) 21 November 2013 (21.11.2013) entire document	8-10, 14, 15, 23-27, 30
A	US 8,681,176 B1 (MAURER et al) 25 March 2014 (25.03.2014) entire document	1-30

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 15 March 2015	Date of mailing of the international search report 13 APR 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774