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(54) DIGITAL COMMUNICATION OF CAPTURED THREE-DIMENSIONAL OBJECT OVER A NETWORK

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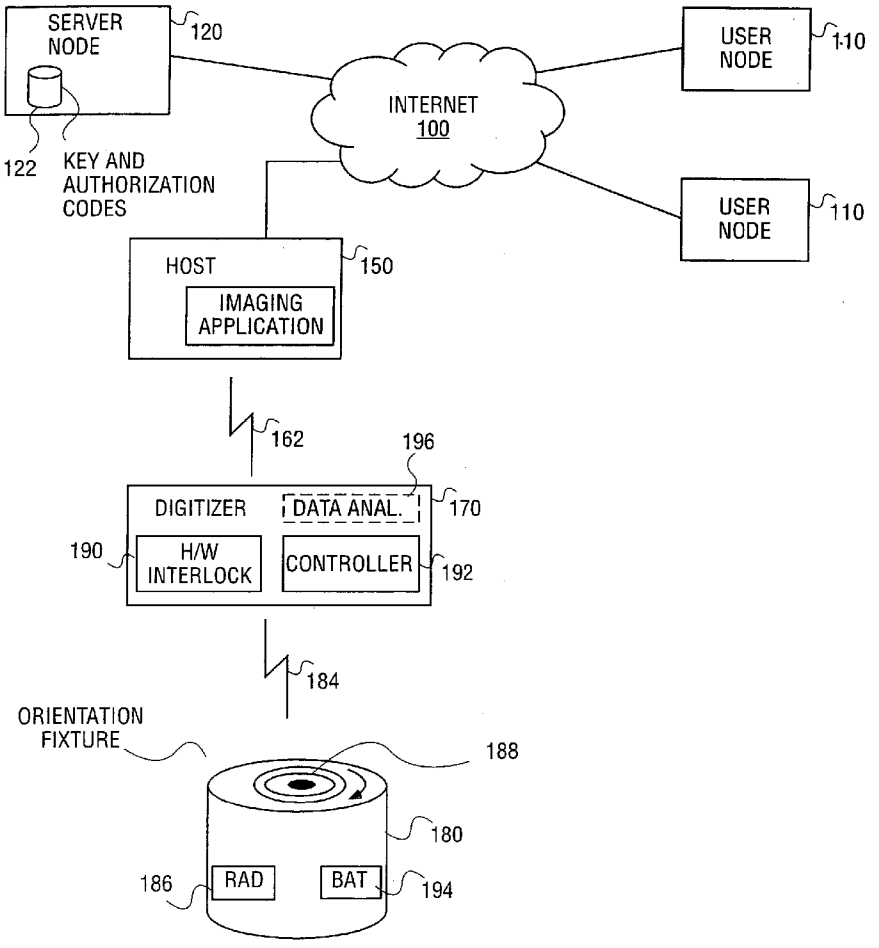
(57) **ABSTRACT**

The three-dimensional imaging system providing distribution over a distributed network. A low-cost convenient three-dimensional imaging system having a digitizer and orientation fixture which automatically acquires and calibrates to each other. Automatic acquisition and calibration provide vastly improved ease of use. The system interfaces with a distributed network, such that authorization for operation and/or access to data captured may be controlled at a remote node on the distributed network.



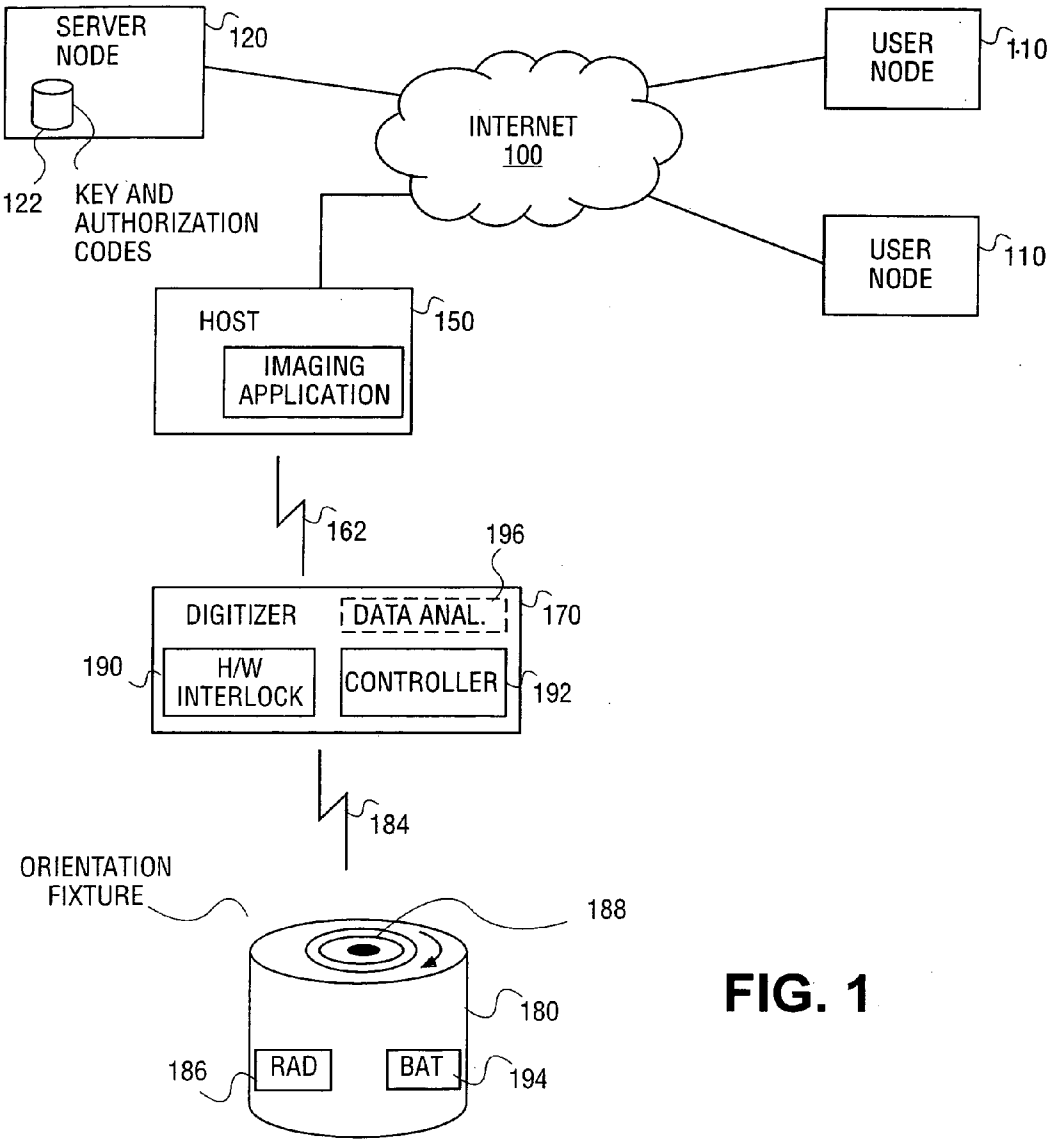

SERVER NODE
120
122
KEY AND AUTHORIZATION CODES
INTERNET 100
USER NODE
110
USER NODE
110
HOST
150
IMAGING APPLICATION
162
196
DIGITIZER
DATA ANAL.
170
190
H/W INTERLOCK
CONTROLLER
192
184
ORIENTATION FIXTURE
188
180
186
RAD
BAT
194

FIG. 1

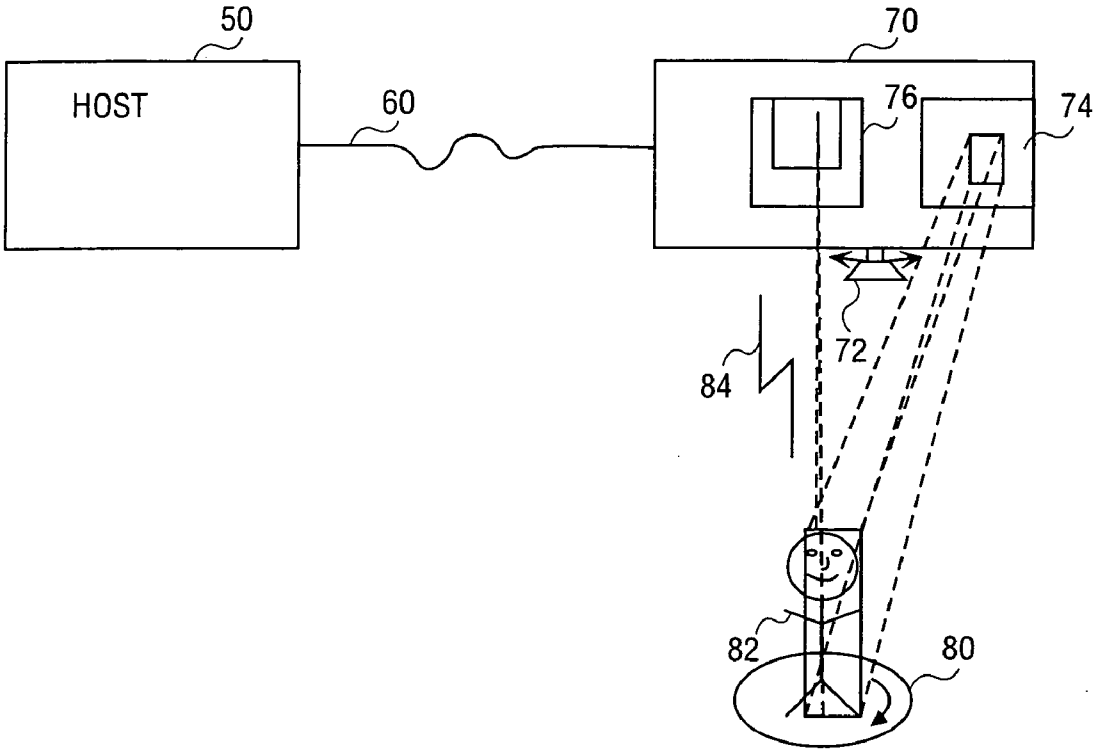


FIG. 2

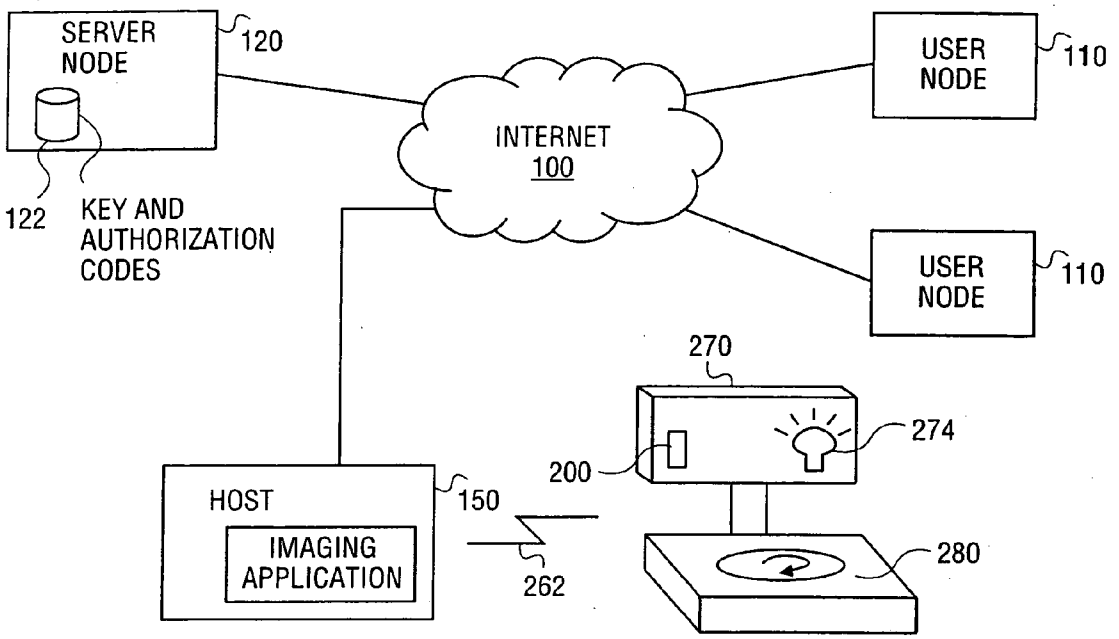

SERVER NODE
120
122
KEY AND AUTHORIZATION CODES
INTERNET
100
USER NODE
110
USER NODE
110
270
274
200
HOST
150
IMAGING APPLICATION
262
280

FIG. 3

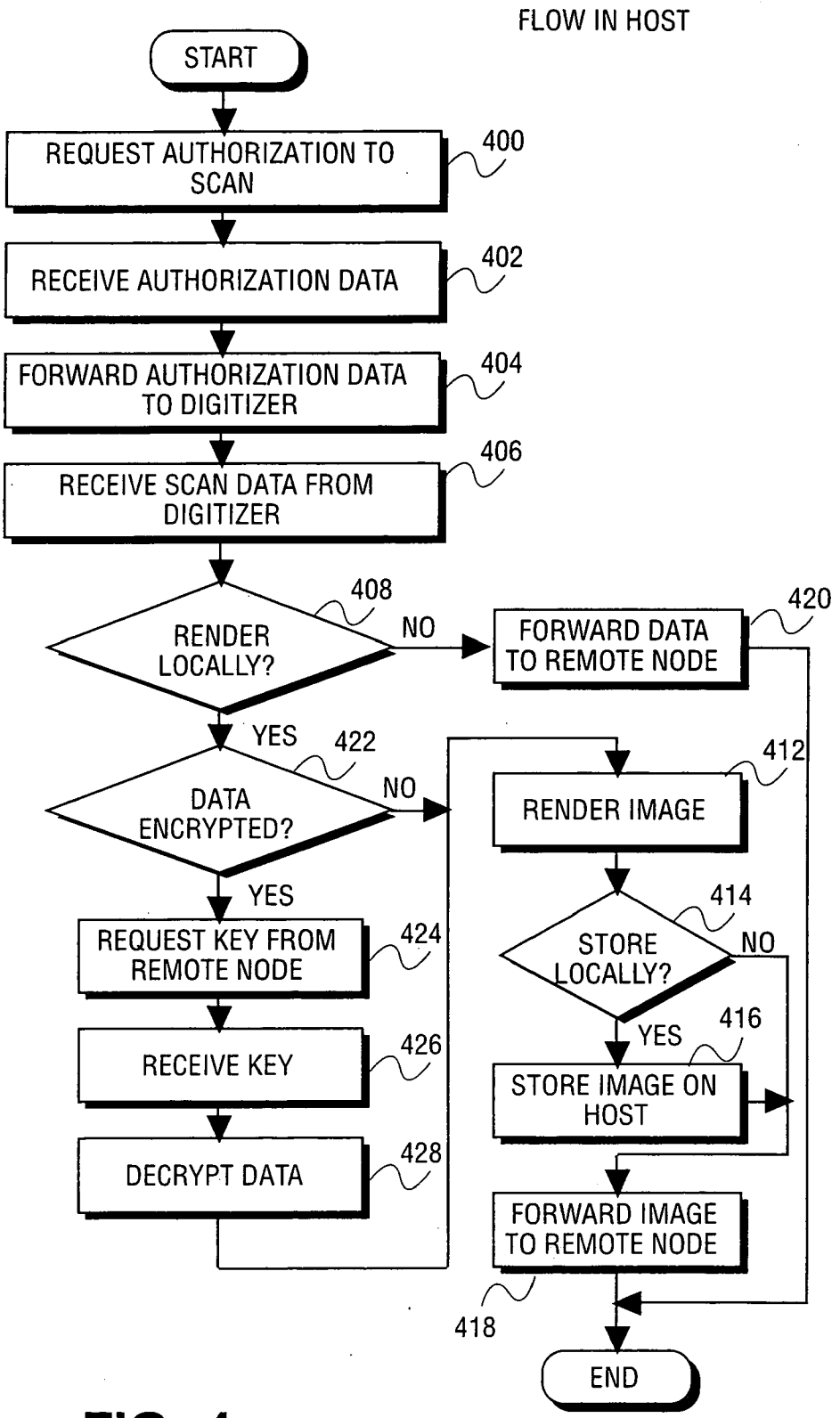

FLOW IN HOST
START
REQUEST AUTHORIZATION TO SCAN
400
RECEIVE AUTHORIZATION DATA
402
FORWARD AUTHORIZATION DATA TO DIGITIZER
404
RECEIVE SCAN DATA FROM DIGITIZER
406
RENDER LOCALLY?
408
NO
FORWARD DATA TO REMOTE NODE
420
YES
DATA ENCRYPTED?
422
NO
RENDER IMAGE
412
YES
REQUEST KEY FROM REMOTE NODE
424
STORE LOCALLY?
414
NO
RECEIVE KEY
426
YES
416
STORE IMAGE ON HOST
DECRYPT DATA
428
FORWARD IMAGE TO REMOTE NODE
418
END

FIG. 4

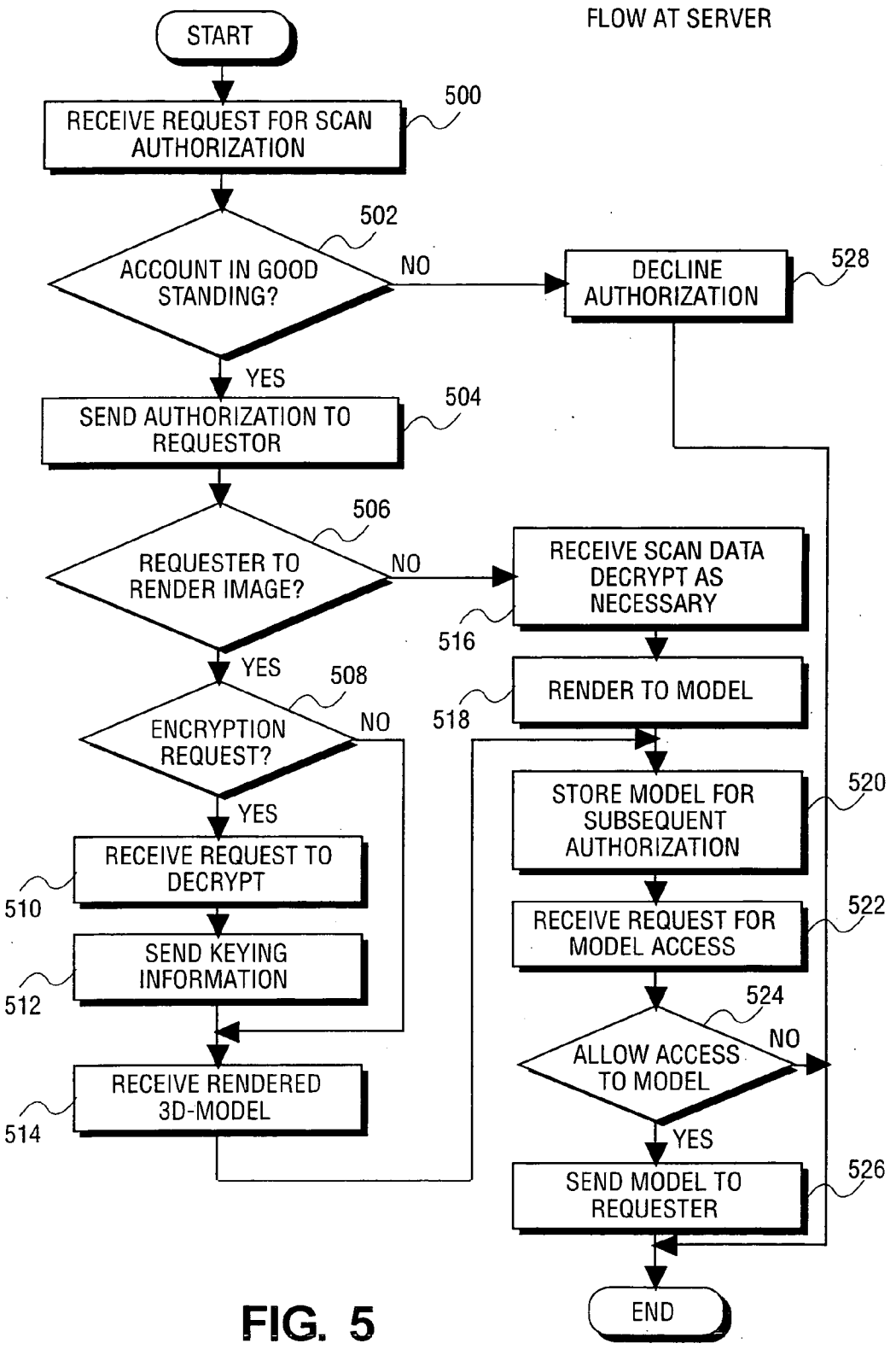

FLOW AT SERVER
START
RECEIVE REQUEST FOR SCAN AUTHORIZATION
500
ACCOUNT IN GOOD STANDING?
502
NO
DECLINE AUTHORIZATION
528
YES
SEND AUTHORIZATION TO REQUESTOR
504
REQUESTER TO RENDER IMAGE?
506
NO
RECEIVE SCAN DATA DECRYPT AS NECESSARY
516
YES
ENCRYPTION REQUEST?
508
NO
RENDER TO MODEL
518
YES
RECEIVE REQUEST TO DECRYPT
510
STORE MODEL FOR SUBSEQUENT AUTHORIZATION
520
SEND KEYING INFORMATION
512
RECEIVE REQUEST FOR MODEL ACCESS
522
RECEIVE RENDERED 3D-MODEL
514
ALLOW ACCESS TO MODEL
524
NO
YES
SEND MODEL TO REQUESTER
526
END

FIG. 5

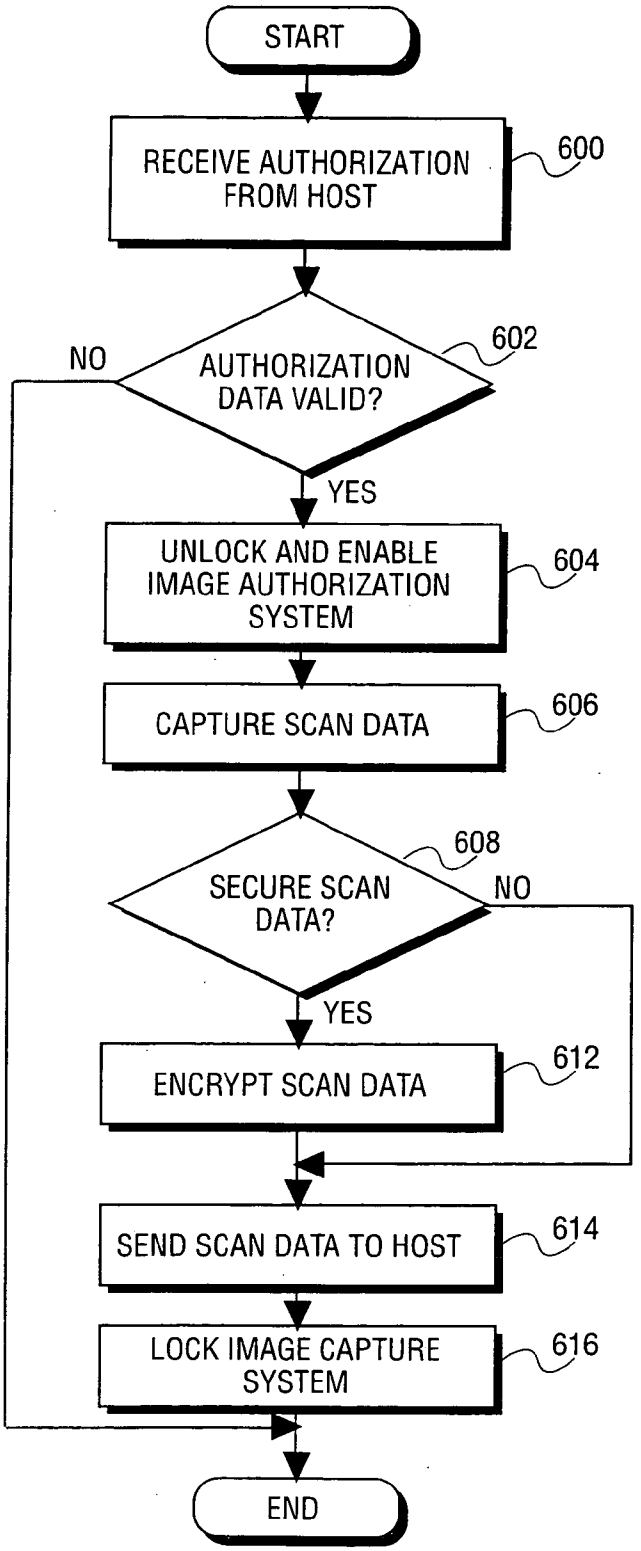

FLOW AT DIGITIZER
START
RECEIVE AUTHORIZATION FROM HOST
600
AUTHORIZATION DATA VALID?
602
NO
YES
UNLOCK AND ENABLE IMAGE AUTHORIZATION SYSTEM
604
CAPTURE SCAN DATA
606
SECURE SCAN DATA?
608
NO
YES
ENCRYPT SCAN DATA
612
SEND SCAN DATA TO HOST
614
LOCK IMAGE CAPTURE SYSTEM
616
END

FIG. 6

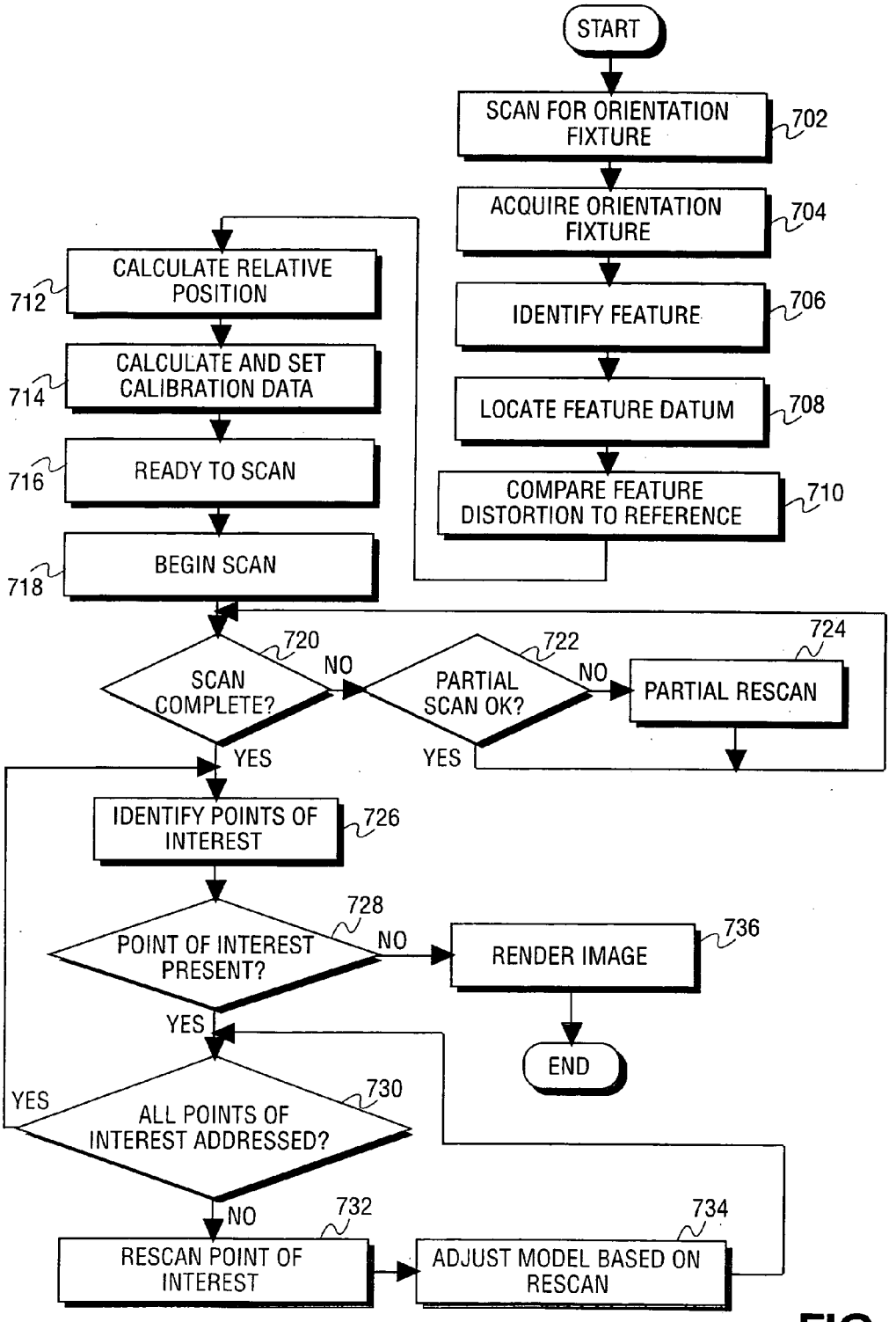

START
SCAN FOR ORIENTATION FIXTURE
702
ACQUIRE ORIENTATION FIXTURE
704
IDENTIFY FEATURE
706
LOCATE FEATURE DATUM
708
COMPARE FEATURE DISTORTION TO REFERENCE
710
CALCULATE RELATIVE POSITION
712
CALCULATE AND SET CALIBRATION DATA
714
READY TO SCAN
716
BEGIN SCAN
718
SCAN COMPLETE?
720
NO
YES
PARTIAL SCAN OK?
722
NO
YES
PARTIAL RESCAN
724
IDENTIFY POINTS OF INTEREST
726
POINT OF INTEREST PRESENT?
728
NO
YES
RENDER IMAGE
736
END
ALL POINTS OF INTEREST ADDRESSED?
730
YES
NO
RESCAN POINT OF INTEREST
732
ADJUST MODEL BASED ON RESCAN
734

FIG. 7

DIGITAL COMMUNICATION OF CAPTURED THREE-DIMENSIONAL OBJECT OVER A NETWORK

[0001] This patent application is a continuation of pending U.S. patent application Ser. No. 09/660,811, filed Sep. 13, 2000, entitled, DIGITAL IMAGING SYSTEM HAVING DISTRIBUTION CONTROLLED OVER A DISTRIBUTED NETWORK.

BACKGROUND

[0002] 1. Field of the Invention

[0003] The invention relates to three-dimensional imaging. More specifically, the invention relates to capture and distribution of three-dimensional digital images.

[0004] 2. Background

[0005] Various non-contact methods for creating three-dimensional models of three-dimensional objects exist. There are four broad categories of non-contact three-dimensional digitizers. The first category is referred to as silhouette digitizers because the imaging device repeatedly takes the silhouette of the object as the object is rotated before the imaging device or the imaging device is rotated about the object. This type of digitizer is relatively ineffective at dealing with concavities in a three-dimensional object because the silhouette is unchanged by the concavity.

[0006] The second category is timing digitizers. Timing digitizers use a signal source such as a radar source. By determining the amount of time required for the signal to bounce back from the different points on the target object, surface features of the object are revealed. However, such digitizing methods are extremely expensive to implement.

[0007] A third category is projected pattern digitizers, in which a pattern of some sort is projected onto the object to be digitized and the dimensions of the object are determined from the interaction of the pattern with the object. Projected pattern digitizers fall into three main subcategories. The subcategories include contour digitizers which use spatial distortion from a projected pattern of contour lines to determine surface features of a three-dimensional object. A next subcategory is interference projected pattern digitizers, which use two sources and then based on the localized interference pattern of the two sources, determine the surface features of the three-dimensional object to be digitized. A third subcategory is referred to as color projected pattern digitizers because this category uses a projected color pattern and resulting color gradients to determine relevant information about the object to be digitized.

[0008] A final broad category is stereoscopic digitizers which employ multiple cameras to capture images of the object from different angles. From the picture, such systems perform feature identification. Then a correlation between the features in the different pictures is established to yield three-dimensional data.

[0009] Common to all of these various methods are high cost and that each typically mandates a highly constrained environment often requiring a lab-like setting in which to perform the imaging in order to attain necessary alignments. This cost and difficulty of use render such systems impractical for use by the average user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The invention is illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment in this disclosure are not necessarily to the same embodiment, and such references mean at least one.

[0011] **FIG. 1** is a block diagram of a system of one embodiment of the invention.

[0012] **FIG. 2** is a block diagram of a system of one embodiment of the invention.

[0013] **FIG. 3** is a block diagram of an alternative embodiment of the invention.

[0014] **FIG. 4** is a flow diagram of operation of the host in one embodiment of the invention.

[0015] **FIG. 5** is a flow diagram of operation at a server node in one embodiment of the invention.

[0016] **FIG. 6** is a flow diagram of operation in a digitizer in one embodiment of the invention.

[0017] **FIG. 7** is a flow diagram of setup and data capture in a digitizer of one embodiment of the invention.

DETAILED DESCRIPTION

[0018] **FIG. 1** is a block diagram of a system of one embodiment of the invention. The distributed network **100** such as the Internet provides an interconnection between a plurality of user nodes **110**, a server node **120** and a host **150**. Server node **120** may be any conventional server or a collection of servers to handle traffic and requests over the distributed network. User nodes may be discrete computers running a web browser, a corporate network, another server site, or any other node on the distributed network. Host **150** may be a computer (laptop, desktop, hand-held, server, workstation, etc.), an internet appliance or any other device through which data may be forwarded across the distributed network.

[0019] The host **150** may communicate over a wired link such as a universal serial bus (USB) or wireless link **162** to a digitizer **170**. The digitizer **170** may be any of the myriad noncontact digitizers. One suitable digitizer is described in copending patent application Ser. No. 09/660,809, entitled DIGITIZER USING INTENSITY GRADIENT TO IMAGE FEATURES OF THREE-DIMENSIONAL OBJECTS and assigned to the assignee of the instant application.

[0020] In one embodiment, digitizer **170** is physically independent of an orientation fixture **180**. For user convenience, it is desirable to minimize space permanently allocated to the system and minimize setup time. Most users will not be able to allocate sufficient space to leave the system configured for use at all times. The user will therefore be required to reintroduce some portion of the system prior to each use. The need to swap cables and otherwise rewire serves as a significant deterrent to widespread consumer adoption.

[0021] As used herein, "physically independent" means that no mechanical or wired electrical connection must exist between the physically independent units during operation. By way of example and not limitation, two devices coupled

together by an electrical signaling wire either directly or through a host computer, are not physically independent, whereas two devices that have no physical coupling and communicate over a wireless link are deemed "physically independent." Connection to a common power source, e.g., two outlets in a house, is not deemed to destroy physical independence.

[0022] Orientation fixture **180** repositions an object to be digitized by digitizer **170** such that different aspects of the object are exposed relative to the digitizer at different points in time. In one embodiment the orientation fixture **180** is a turntable. One suitable turntable is described in copending application Ser. No. 09/660,810 entitled WIRELESS TURNTABLE and assigned to the assignee of the instant application. Orientation fixture **180** may also be a robotic arm or other robotic device, or may be a turntable in conjunction with a robotic arm or other robotic device. Other mechanisms that are capable of exposing different aspects of an object relative to the digitizer are deemed to be within the ambit of orientation fixtures.

[0023] As previously noted the orientation fixture is physically independent of the digitizer. One premise of the system is relative ease of setup to facilitate wide acceptance. Thus, with the physical independence it is desirable that the digitizer **170** and orientation fixture **180** be able to "find" each other. To that end, the digitizer **170** may be equipped to sweep an area looking with its sensing apparatus for a feature of the orientation fixture **180**. The orientation fixture **180** may include a feature such as indicia, for example, acquisition indicia **188**, or may contain some other physically observable structure that permits the digitizer to identify and acquire the orientation fixture **180** without the user introducing or removing a separate reference object. Acquiring the orientation fixture may permit, for example, any of automatic calibration of the digitizer, automatic determination of the relative position of the digitizer and orientation fixture, and fixture's orientation or condition. In one embodiment, imaging the feature provides an indication of focal distance as the perspective of the feature varies in a known way with distance. Calibration may be performed by imaging the feature and comparing the results to a set of reference data corresponding to the feature. In this manner the digitizer settings can be automatically optimized to provide the best available accuracy under existing conditions. Alternatively, the calibration can be performed based on a reference target or path entirely within the digitizer.

[0024] Alternatively, the orientation fixture may have a localized radiation source **186**, which permits the digitizer **170** to sweep and identify the location of the orientation fixture based on the localized radiation from radiation source **186**. It is also within the scope and contemplation of the invention to have the orientation fixture **170** position itself relative to the digitizer, such that the orientation fixture controls the acquisition by the digitizer **170** of the orientation fixture **180** and the object to be oriented thereby. In the system of such embodiment the orientation fixture would likely be a mobile robotic unit.

[0025] In one embodiment, the digitizer communicates with the orientation fixture across a wireless link **184** to coordinate the orientation of the object with image capture by the digitizer. The wireless link may be infrared ("IR"), radio frequency ("RF") , optical signaling, or any other mode of wireless communication. In one embodiment the orientation fixture **180** includes a self contained power source **194** such as a battery. The self-contained power source **194** may also be a solar panel, fuel cell, or any other suitable power source.

[0026] In one embodiment of the invention, digitizer **170** captures information about an object positioned by orientation fixture **180** from which a three-dimensional model can be derived. Controller **192** in digitizer **170** controls the coordination between the data capture by digitizer **170** and aspect change by the orientation fixture **180**. It is within the scope and contemplation of the invention for the controller to reside in the host, the digitizer, the orientation fixture or in an independent unit. References to the controller herein are deemed to include without limitation all of these options. The digitizer **170** may also include a data analyzer **196** that reviews captured data to find errors, anomalies or other points of interest that warrant further investigation, including possibly rescanning the corresponding area. After any corrective action, the data captured by digitizer **170** is passed to the host **150**, which renders the three-dimensional model from the data. The host **150** may perform compression or any other manipulation of the data known in the art. The three-dimensional model may then be sent over distributed network **100** to remote nodes such as user nodes **110** or a server node **120**. This provides maximum ease of distribution across the distributed network **100**.

[0027] In some cases, control of distribution of information captured by the digitizer is desirable, for example, to facilitate administration of user fees. To that end, in one embodiment the digitizer is provided with a hardware interlock **190** which prevents the system from operating without first receiving authorization. Such authorization may be provided by the server node **120** sending authorization data across the distributed network. Alternative locking mechanisms such as software or firmware-based locking mechanisms may also be employed either within the digitizer **170** or the host **150**. Further security of the system can be affected by requiring an imaging application **152** on the host **150** to provide a valid digital signature in addition to the authorization data before enabling capture and/or transfer of captured data from the digitizer **170** to the host **150**.

[0028] Some embodiments of the digitizer **170** may encrypt the data captured prior to sending it to the host **150**. In that event, unless the host is able to decrypt the data to render it, it may forward it on to the server node **120** across the distributed network and subsequent rendering of the image or three-dimensional model would occur on the server node **120**. In this manner, the local user does not have access to the data from which the three-dimensional model may be derived unless a key is provided. In still another embodiment, the host **150** may include encryption capabilities and encrypt the rendered image before forwarding it on to the server node **120**. Keying information may be provided to the digitizer and/or the host by the server node **120**. The server node may maintain keying information and authorization data in a local database **122**. Once the three-dimensional data is safely controlled by the server node **120**, access to the data may be made available for free or at cost to the user nodes **110** or back to the host **150**.

[0029] The digitizer may also include a field programmable gate array ("FPGA") or other reconfigurable logic

unit. In such case, the server node periodically may reprogram the FPGA to implement an updated or enhanced algorithm for processing or security purposes, for example, as subsequently developed.

[0030] **FIG. 2** is a block diagram of a subsystem of one embodiment of the invention. The subsystem of **FIG. 2** may be inserted in place of host **150**, digitizer **120** and orientation fixture **180** of **FIG. 1**. Digitizer **70** is coupled to a host **50**. This coupling may be by a bus **60** such as the Universal Serial Bus (USB), IEEE 1394 bus, or any other suitable data transfer system. It is also within the scope and contemplation of the invention for the digitizer to communicate with the host mode via a wireless interconnection. Host **50** may be a personal computer, a work station, an internet appliance, or any other device that provides sufficient intelligence and processing power to render images from the data obtained by the digitizer. The digitizer **70** captures image data and may forward it to the host **50** for rendering. In this way, the processing on the digitizer **70** may be limited, permitting lower cost construction. It is also within the scope and contemplation of the invention for the digitizer to render the image and deliver it directly to a distributed network. It is further within the scope and contemplation of the invention for the digitizer to deliver the data to a distributed network for rendering on a remote node.

[0031] The digitizer **70** includes a projector to project a stripe of white light through a projection window **74** onto a remote object such as a person **82** on a turntable **80** remote from the digitizer. The digitizer also contains an image sensing array (ISA) aligned with an image capture window **76** which captures the image of the object **82** within a focal zone. In one embodiment, the ISA is a linear charge coupled device (CCD) or complementary metal oxide semiconductor (CMOS) sensor, and the focal zone is a line on the target object. In some embodiments, the digitizer includes a base **72** about which the upper unit, including the projector and the ISA, can rotate in either direction. This permits the focal line to be swept back and forth across a target object through an arc. This sweeping reduces the loss of detail in the captured image that results from shadowing on the object from the perspective of an immobile focal line. The digitizer **70** also includes a wireless interface to communicate with a turntable **80** via a wireless link **84**.

[0032] Turntable **80** may be the type described in co-pending application entitled WIRELESS TURNTABLE, Ser. No. 09/660,810, assigned to the assignee of the instant application. Via wireless link **84**, the digitizer sends commands to the turntable **80** and receives from the turntable indications of the angular position of the turntable surface relative to a home position. When the digitizer is activated, it searches for the turntable **80** by sending a signal to which the turntable **80** is required to respond. If the turntable responds, the digitizer looks for a predetermined pattern that is expected to be present on the turntable surface. For example, the pattern may be concentric circles on the turntable surface. In such case, based on the image captured, the digitizer can both find the turntable and determine its distance from the digitizer. Then after the response is received, the digitizer sends a "go home" signal to the turntable. In some embodiments, the digitizer sends acceleration and rotation profiles to the turntable to control its rotation. Each profile may be retained in firmware on the digitizer or downloaded from host **50**.

[0033] Generally speaking, the projection portion of the digitizer **70** is retained in fixed relation to the imaging portion. The projection portion produces a light stripe as noted previously on the object **82**. By either sweeping the light stripe back and forth through the focal line or by mechanically blocking the stripe at a known rate, the intensity gradient can be created. In one embodiment, the blocking is from 0% to 100% during a cycle. Because the ISA integrates the illumination over time, the outline of a three-dimensional surface is reflected in the data captured by the ISA. This is because protruding features will remain illuminated longer. Accordingly, more photons are captured by the ISA corresponding to those features. After repeating this process one stripe at a time as the object is rotated by turntable **80** or through the course of sweeping the entire digitizer back and forth as it rotates about the base, cost effective three-dimensional imaging is effected. The digitizer may also be used to capture high resolution scans of two dimensional objects by sweeping back and forth across the object. This feature is particularly desirable in the context of digitizing works of art.

[0034] **FIG. 3** is a block diagram of an alternative embodiment of the invention. Again, in this embodiment user nodes **110** are coupled to a distributed network **100**. Also coupled to distributed node **100** is server node **120** and host **150**. However, rather than being physically independent in this embodiment, the digitizer **270** and orientation unit **280** are coupled together to form a single integral unit. The unit communicates with the host by wireless link **262**. Alternatively, the unit may be wired to the host by a USB or any other suitable wired communication link. A digitizer may use a linear image sensor **200** to image an object on the orientation fixture **280**. A light source **274** may provide the lighting used by the image sensing array to discern the three-dimensional data. By integrating the digitizer and orientation unit, setup of the system is simplified. The digitizer may be rotatably coupled so that it can sweep its focal zone back and forth across an object positioned by the orientation fixture **280**. This embodiment is particularly suitable for small-scale objects such as jewelry, in which the desired focal distance is relatively short. The other features discussed above in connection with **FIG. 1** may equally be applied to embodiments as shown in **FIG. 3**.

[0035] **FIG. 4** is a flow diagram of operation of the host in one embodiment of the invention. At functional block **400**, host requests authorization to scan from a remote node (such as the server node). At functional block **402**, the host node receives authorization data across the distributed network. At functional block **404**, the host forwards authorization data to the digitizer. At functional block **406** the host receives scan data from the digitizer.

[0036] At decision block **408** a determination is made whether the three-dimensional model should be rendered locally. If the rendering should not occur locally the data is forwarded to a remote node at functional block **420**. The forwarded data may be encrypted or unencrypted, compressed or not compressed, and the forwarding protocol may be cell-based, packet-based or any other transmission protocol commonly used on distributed networks.

[0037] If the rendering should occur locally, a determination is made at decision block **422** if the data is encrypted. If the data is not encrypted at decision block **422**, the image

or three-dimensional model is rendered from the data at functional block **412**. A determination is then made at decision block **414** whether the rendered model should be stored locally. If it is determined that the model should be stored locally, the model is stored on the host at functional block **416**. If it is determined that the model should not be stored locally, the rendered model is forwarded to the remote node at functional block **418**. In some cases, if the image is stored locally, it may not be forwarded to the remote node. In one embodiment of the invention, the authorization data indicates if local storage is permitted. If local storage is not permitted, the imaging application may be made responsible for electronic shredding of any temporary buffer space used in forwarding the scanned data.

[**0038**] If at decision block **422** it is determined that the data is encrypted, a request is made across the distributed network for keying information (or other information that permits decryption) from the remote node at functional block **424**. The request may include payment for access privileges. Once the keying information is received at functional block **426**, the host is able to decrypt the data at functional block **428**. The flow then continues at functional block **412** as above described.

[**0039**] **FIG. 5** is a flow diagram of operation at a server node in one embodiment of the invention. At functional block **500** the server node receives a request for scan authorization. A determination is made at decision block **502** if the requesting account is in good standing. If it is not, authorization is declined at functional block **526**. If the account is in good standing, the authorization data is sent to the requester at functional block **504**. A determination is made at decision block **506** if the requester is to render the image. If the requester is to render the image, a determination is made at decision block **508** whether encryption is required. Requiring encryption may be at the option of the server node as part of the use authorization. If encryption is required, the server receives a request to decrypt at functional block **510**. The server node may then send keying information (or other information that permits decryption) to the requester at functional block **512**. If no encryption is required or after the keying information has been sent, the server node may receive the rendered three-dimensional model at functional block **514**.

[**0040**] If at decision block **506** the requester is not to render the image, the server node receives the scan data and decrypts as necessary at functional block **516**. The server then renders the three-dimensional model at functional block **518**. After the three-dimensional model is rendered by the server or received by the server, the model is stored for subsequent distribution at functional block **520**. Once stored, the server may provide the model to any arbitrary node or the distributed network.

[**0041**] At functional block **522**, the request is received for access to a model. At decision block **524** a determination is made whether to allow access to the model to the requester. Such a determination may be made based on predetermined access privilege to different models, including whether the requester was the creator of the model, access privilege level established by the creator, or based on some payment for such access. If it is determined that access to the model should be allowed, the model is sent to the requester at functional block **526**. The model may be sent in any form and may be encrypted for security. In some embodiments the requestor may be given the option of the file type sent. Otherwise, access to the request is declined.

[**0042**] **FIG. 6** is a flow diagram of operation in a digitizer in one embodiment of the invention. At functional block **600**, authorization data is received from the host. The determination is made at functional block **602** if the authorization data is valid. Authorization data may include a code and, for example, a digital signature for the imaging application to ensure that an authorized imaging application is operating on the host. If the authorization data is valid, the image capture system is unlocked and enabled at functional block **604**. At functional block **606**, the digitizer captures scan data for the object positioned by the orientation fixture. A determination is then made at decision block **608** whether the scan data should be secured. If the scan data should be secured, the digitizer may encrypt the data at functional block **612**. If the data need not be secured or after encryption, the scan data may be sent to the host at functional block **614**. At functional block **616**, the image capture system is relocked.

[**0043**] In one embodiment the server node is able to control both the enablement of the imaging subsystem to operate and access to the data subsequently captured. This permits remote control of a widely distributed network of imaging subsystem having broad user appeal due to low cost and ease of operation.

[**0044**] **FIG. 7** is a flow diagram of setup and data capture in a digitizer in one embodiment of the invention. At functional block **702**, the digitizer scans for the orientation fixture. In one embodiment, this may take the form of the digitizer sweeping an arc around it looking for a distinctive feature. At functional block **704**, the digitizer acquires the orientation fixture. At functional block **706**, the digitizer identifies a feature on the digitizer from which it can derive certain information. A featured datum is located at functional block **708**. The featured datum provides a reference from which, e.g., the center of the turntable, may be located. At functional block **710**, feature distortion is compared to a saved reference value, for example, this distortion may either be of the feature or of the entire orientation fixture. Based on this comparison, the relative position is calculated at functional block **712**. At functional block **714**, the same distortion can be used to calculate and set calibration data to optimize the accuracy of subsequent scans based on existing conditions. At functional block **716**, the digitizer becomes ready to scan.

[**0045**] At functional block **718**, the digitizer begins to scan and capture data from which a three-dimensional model of the object being scanned may be derived. At decision block **720**, a determination is made if the scan is complete. If the scan is not complete, a determination is made at decision block **722** if the partial scan is corrupt, anomalous, or otherwise unusable. If the data is not usable, a partial rescan may be performed for that region of the object at functional block **724**. If at decision block **720** the scan is complete, the scan data is analyzed to identify points of interest. At functional block **726**, those points of interest may include anomalous data, errors, features for which greater resolution is desirable, or any other facet of the object that warrants further investigation or review. A determination is made at decision block **728** whether any points

of interest are present. If there are points of interest present, a determination is made at decision block **730** if all points of interest have been addressed. If all points of interest have not been addressed at functional block **732**, the system rescans a portion of the object corresponding to a point of interest. This rescan may be conducted at a higher resolution than the original scan, the same resolution as the original scan, or even using an alternative image capture method. At functional block **734**, the model is adjusted based on the rescan. Flow then returns to decision block **730** to determine if all points of interest have been addressed. If they have, the system returns to identify points of interest at functional block **726**. In this manner, if the rescan adjustment creates additional points of interest, those will subsequently be picked up and addressed. If at decision block **728** no points of interest are present, the system renders the image at functional block **736**.

[**0046**] In the foregoing specification, the invention has been described with reference to specific embodiments thereof. It will, however, be evident that various modifications and changes can be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

What is claimed is:

1. A system comprising:

a capture module to drive a capture unit to capture three-dimensional data about a physical object; and

a communications module integrated with the capture module to communicate the three-dimensional (3D) data over a distributed network.

2. The system of claim 1, wherein the distributed network is the Internet.

3. The system of claim 1, wherein the three-dimensional data comprises three-dimensional geometry and surface image data that represents the physical object.

4. The system of claim 1, wherein the capture module automatically captures three-dimensional data from multiple aspects of the physical object.

5. The system of claim 1, further comprising a modeling module to automatically assemble and render a three-dimensional model based on the three-dimensional data.

6. The system of claim 1, wherein the communications module automatically sends a representation of the three-dimensional data over the distributed network responsive to an external event.

7. The system of claim 1, further comprising:

the three-dimensional capture unit.

8. The system of claim 1, wherein the communication is managed by a server node attached to the distributed network.

9. The system of claim 1, wherein the 3D data is stored for some period of time on more than one resource on the distributed network.

10. The system of claim 1, wherein the communication of the 3D data can be performed by more than one node attached to the distributed network.

11. A method comprising:

driving a capture of three dimensional data about a physical object from a capture module; and

communicating the three-dimensional data captured over a distributed from a communication module integrated with the capture module.

12. The method of claim 11 wherein the three-dimensional data comprises both three-dimensional geometry and surface image data that represents the physical object.

13. The method of claim 11 further comprising:

rendering a three-dimensional model from the three-dimensional data.

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