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FILING RECEIPT

31817
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MINNEAPOLIS, MN 55402

Date Mailed: 12/14/2015

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/260,036**

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Title

DISTRIBUTED SEMANTIC-BASED DECISION LOGIC FOR IMMERSIVE SYSTEM CLIENT SERVER OPTIMIZATION

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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PTO/SB/16 (11-08)
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U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

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All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. [Add]

Title of Invention	DISTRIBUTED SEMANTIC-BASED DECISION LOGIC FOR IMMERSIVE SYSTEM CLIENT SERVER OPTIMIZATION
Attorney Docket Number (if applicable)	127075-205862 (P93516Z)

Correspondence Address

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( ) Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:

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Signature	/Al AuYeung/			Date (YYYY-MM-DD)	2015-11-25
First Name	Al	Last Name	AuYeung	Registration Number (If appropriate)	35432

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PROVISIONAL APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

Distributed Semantic-Based Decision Logic for Immersive System Client Server Optimization

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Attorney Docket No: 127075-205862 (P93516Z)

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Date of Transmission: November 25, 2015

Distributed Semantic-Based Decision Logic for Immersive System Client Server Optimization

Technical Field

[0001] The present disclosure relates to the fields of networking and computing. In particular, the present disclosure is related to distributed semantic-based decision logic for immersive system client server optimization.

Background

[0002] The background description provided herein is for the purpose of generally presenting the context of the disclosure. Unless otherwise indicated herein, the materials described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0003] Bandwidth economy is a general constrain between clients and servers due to the high impact of data exchange on client compute resources and battery life. This happens when client devices need to send data to server in order to process it or when the cloud needs to stream processed data to a device at fast rates to enable a customer experience on the client side. In the case of 3D scene reconstruction this can happen when multiple camera sensors might share the same network switch / base station in order to upload frame updates to the cloud.

Brief Description of the Drawings

[0004] Embodiments will be readily understood by the following detailed description in conjunction with the accompanying drawings. To facilitate this description, like reference numerals designate like structural elements. Embodiments are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings.

[0005] Figure 1 illustrates an overview of a computing environment of the present disclosure, in accordance with various embodiments.

[0006] Figure 2 illustrates a block diagram of an example architecture of a computing device suitable for use to practice the present disclosure, in accordance with various embodiments.

[0007] Figure 3 illustrates an example computer-readable storage medium with instructions configured to enable a computing device to practice aspects of the present disclosure, in accordance with various embodiments.

Detailed Description

[0008] This disclosure describes techniques to optimize bandwidth utilization by providing a distributed logic on clients, edge devices, and/or servers in datacenter that includes semantic understanding of the physical objects as well as a prediction model of client experience and cloud process requirements. Given that sensor devices on clients, base stations, servers in data centers and display devices on client side often have available compute capabilities, the present disclosure, in embodiments, also includes the creation of a distributed model that governs and optimizes data upload and download based on semantic content recognition (e.g., content in video) and usage prediction models. Given the assumption that the exchange of model states is more cost-effective than the actual raw data exchange, the present disclosure includes the creation of a distributed scene semantic understanding logic governing data exchange based on the adequacy of both streaming content prediction models and usage prediction models.

[0009] In the description to follow, reference is made to the accompanying drawings which form a part hereof wherein like numerals designate like parts throughout, and in which is shown by way of illustration embodiments that may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present disclosure. Therefore, the following detailed description is not to be taken in a limiting sense, and the scope of embodiments is defined by the appended claims and their equivalents.

[00010] Operations of various methods may be described as multiple discrete actions or operations in turn, in a manner that is most helpful in understanding the claimed subject matter. However, the order of description should not be construed as to imply that these operations are necessarily order dependent. In particular, these operations may not be performed in the order of presentation. Operations described may be performed in a different order than the described embodiments. Various additional operations may be performed and/or described operations may be omitted, split or combined in additional embodiments.

[00011] For the purposes of the present disclosure, the phrase "A and/or B" means (A), (B), or (A and B). For the purposes of the present disclosure, the phrase "A, B, and/or C" means (A), (B), (C), (A and B), (A and C), (B and C), or (A, B and C).

[00012] The description may use the phrases "in an embodiment," or "in embodiments," which may each refer to one or more of the same or different embodiments. Furthermore, the terms "comprising," "including," "having," and the like, as used with respect to embodiments of the present disclosure, are synonymous.

[00013] As used hereinafter, including the claims, the term "module" may refer to, be part of, or include an Application Specific Integrated Circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group) and/or memory (shared, dedicated, or group) that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable components that provide the described functionality.

[00014] Figure 1 illustrates an overview of a computing environment of the present disclosure, in accordance with various embodiments. As illustrated, computing environment 100 may include a number of clients 102 coupled with server 106 via network 106. Clients 102 and server 106 may be respectively configured with client side and server side of an immersive application that include uploading/upstreaming and/or downloading/downstreaming of 3D scenes. As will be described in more detail below, the client side and server side of the immersive application may be incorporated with distributed semantic-based decision logic for optimizing the bandwidth requirement for uploading/upstream and/or downloading/downstreaming data associated with the 3D scenes. For example, in one usage scenario, one or multiple cameras may be placed in a conference room (one client side) transmitting over the network to a server in a data center, and then streaming down to a display device in a different location (another client location).

[00015] In embodiments, the client and/or server side of the application may be configured, upon establishing the streaming connection, to individually and/or cooperatively identify the use case (conference call in the above example) and the spatial characteristics of the data being upload. For example, the client and/or server side of the application may be configured to use the initial frames of the connection to calculate the 3D reconstruction parameters (object positioning, lighting, as well as texture and color). The results may be used to train the object models (e.g., the object models for representation of the activity in the room, in the above example), and initiate the tagging (recognition of elements) at this moment static objects that do not need to be streamed (e.g., table, door, etc in the above example). Instead an API with the existing static object models may be established and updated. As a result, a much more light-weight data structures (json) may be used to contain the tagged updates.

[00016] Similarly each dynamic object (e.g., a person in the conference room, in the above example) may be recognized. Models (e.g., human models, for the above example) of similar characteristics (e.g., body complexion) and texture mapping for each dynamic object (e.g., a person in the above example) may be created and/or loaded. Once the models are created and/or loaded, dynamic data (e.g., body pose in the above example) can be exchanged via the same content based API. Certain areas (such as facial expression or hand gestures in the above example) might be selected for higher fidelity, as opposed to a standard/default lower fidelity (for efficiency purpose). For these areas requiring higher fidelity, more complicated prediction models may be employed.

[00017] At this moment, the client and/or server side of the application may individually or jointly determine a tradeoff between probabilistic computation of the model for streaming and the simple delta exchange might be performed for the decision logic to define if raw data should be used for the uploading/upstreaming and/or downloading/downstreaming. In embodiments, the determination of the tradeoff may be jointly made by the clients and the server. In some embodiments, where the components (e.g., sensor devices) of the clients and/or edge devices of the client and/or server side have computing resources, some of the computations to determine the tradeoff may be distributed to these components of the clients 102 and/or edge devices of the client and/or server side. However, in other embodiments, if the components (e.g., sensor device) of the clients 102 is only able to perform a limited number of computations, most of the models may be developed on the server side and the distributed decision logic may push back to the clients 102 the generated models with prediction boundaries.

[00018] At this moment the clients 102 may check real-time sensor data with the loaded content model and only stream a portion of the raw data (e.g. facial features, for the above example) of the dynamic objects, while the rest will either receive model updates (e.g. chair rotated on a certain angle, in the above example). This behavior can be maintained to optimize and reduce the bandwidth requirement as long as the models are valid. For other dynamic situations (e.g., in the case of one of the persons standing up on the conference room and starting to draw on a blackboard, in the above example), a new model may be calculated/generated. While the new model is being calculated/generated, the client and/or server side of the application may temporarily revert back to full bandwidth uploading/upstreaming and/or downloading/downstreaming of the raw data.

[00019] In embodiments, the quality of service may be maintained on the clients 102 via model exchange with the server and model status API refresh. In embodiments, the clients 102 may also responsible of generating prediction models for consumption usage. Communicating user request or intention to for example rotate or change positioning of one or more static objects (e.g., a camera, in the above example).

[00020] Accordingly, the present disclosure introduced the novel aspects of

- User case defined scene understanding and tagging procedure.
- The tagging and recognition of elements is optimized via context awareness on the use case and users which limits the object detection pool and restricts the boundaries for model generation (e.g. possible movements that a sitting human person will perform).
- Model exchange primitives between client and server during streaming session.
- Semantic content (object) based API for distributed control decision logic in data transmission.

[00021] Thus, except for the teachings of the present disclosure incorporated, clients 102, networks 104 and server 106 may be any one of such elements known in the art. Clients 102 and Server 106 may include processor & memory, e.g., processor with one or more processor cores, volatile and/or non-volatile memory. I/O devices may include wired and/or wireless communication interfaces. I/O devices on the client side may further include any one of a number of sensors, e.g., cameras. Clients 102 may be smartphone, tablet, laptop, desktop, set-top box, game console, and so forth. Networks 104 may include private and/or public networks, such as the Internet, with any number of wired and/or wireless gateways, routers, switches and so forth. Aspects such as Video / Audio data transmissions, Algorithm for 3D voxel generation, and Algorithms for model recognition are known, and are not further described herewith.

[00022] Thus, the present disclosure different from current systems in that current systems are mostly unidirectional in terms of decision logic for data transmissions. Further. in data upload, typically, either the server of current systems requests a refresh rate update or the client pushes predefined data at specified rates. In audio & video data download, typically, there are some efforts made on the client application side of current systems to buffer content based on user model predictions. In these cases the client of current systems demands the server to stream data based on latency conditions and estimated user experience needs. There has been some work on improving both network exchange cost as well as latency requirement by looking at deploying cloudlets at the edge. Also a currently popular container service such as Docker aims at lightweight quick deployment of applications on the client.

[00023] However, all these solutions look at the data transmission problem from the infrastructure point of view. None of the services governing data exchange have actual knowledge of the kind of data as the transport protocol is abstracted from the data content. In contrast, as described earlier, the present disclosure includes a distributed logic in the shape of a stochastic process for control of prediction models at the application level that governs data exchange based on matching of data content semantic models. Client and server use a model prediction API to communicate model prediction updates rather than raw data when those are sufficient to guarantee user experience.

[00024] Maintaining a field-of-view based voxels model in the cloud server after 3D reconstruction for every object tagged, may further optimize the bandwidth for transmission. For example, though a 3D object will have multiple field of views, at an instance user will have a single field of view at the display. With model prediction API, bandwidth could be further optimized based on the view point prediction updates by transmitting only the necessary field of view based model.

[00025] Referring now to Figure 2, wherein a block diagram of an example architecture of a computing device suitable for use to practice as either a client or a server of the present disclosure, in accordance with various embodiments, is illustrated. As shown, computing device 600 may include one or more processors or processor cores 602, and persistent memory 604. In embodiments, multiples processor cores 602 may be disposed on one die. For the purpose of this application, including the claims, the terms “processor” and “processor cores” may be considered synonymous, unless the context clearly requires otherwise. Additionally, computing device 600 may include communication interfaces 610, such as, Ethernet, WiFi, Bluetooth, 3G/4G and so forth, and I/O device 608 may include cameras, display devices, keyboard, cursor control and so forth. The elements may be coupled to each other via system bus 606, which may represent one or more buses. In the case of multiple buses, they may be bridged by one or more bus bridges (not shown).

[00026] Each of these elements may perform its conventional functions known in the art. In particular, persistent memory 604 may be employed to store a copy of computing logic 622 implementing the operations described earlier, e.g., but not limited to, determining the static and dynamic models, determining the tradeoffs between using raw data and models/API with subset of data, and so forth. Computing logic 622 may be implemented in assembler instructions supported by processor(s) 602 or high-level languages, such as, for example, C or a scripting language, that can be compiled into such instructions. The programming instructions may be placed into persistent memory 604 in the factory, or in the field, through, for example, a distribution medium (not shown), such as a compact disc (CD), or through communication interface 610 (from a distribution server (not shown)). The number, capability and/or capacity of these elements 602-610 may vary from embodiments to embodiments and/or depending on whether computing device 600 is used as client 102 or server 106. The constitutions of these elements 602-610 are otherwise known, and accordingly will not be further described.

[00027] Figure 3 illustrates an example non-transitory computer-readable storage medium having instructions configured to practice all or selected ones of the operations associated with client 102 or server 106, and so forth, earlier described, in accordance with various embodiments. As illustrated, non-transitory computer-readable storage medium 702 may include a number of programming instructions 704. Programming instructions 704 may be configured to enable a device, e.g., client 102 or server 106, in response to execution of the programming instructions, to perform various operations earlier described. In alternate embodiments, programming instructions 704 may be disposed on multiple non-transitory computer-readable storage media 702 instead. In still other embodiments, programming instructions 704 may be encoded in transitory computer readable signals. The programming instruction may also include piece of software that protects or encrypts the data in the memory, storage, data being processed, and in communication channel being exposed to the hackers.

[00028] Referring back to Figure 2, for one embodiment, at least one of processors 602 may be packaged together with a computer-readable storage medium having computing 622 (in lieu of storing in system memory 604) configured to practice all or selected aspects of sensor hub operations. For one embodiment, at least one of processors 602 may be packaged together with a computer-readable storage medium having computing logic 622 to form a System in Package (SiP). For one embodiment, at least one of processors 602 may be integrated on the same die with a computer-readable storage medium having computing logic 622. For one embodiment, at least one of processors 602 may be packaged together with a computer-readable storage medium having computing logic 622 to form a System on Chip (SoC).

[00029] Although certain embodiments have been illustrated and described herein for purposes of description, a wide variety of alternate and/or equivalent embodiments or implementations calculated to achieve the same purposes may be substituted for the embodiments shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that embodiments described herein be limited only by the claims.

[00030] Where the disclosure recites “a” or “a first” element or the equivalent thereof, such disclosure includes one or more such elements, neither requiring nor excluding two or more such elements. Further, ordinal indicators (e.g., first, second or third) for identified elements are used to distinguish between the elements, and do not indicate or imply a required or limited number of such elements, nor do they indicate a particular position or order of such elements unless otherwise specifically stated.

Claims

What is claimed is:

1. A client device, comprising:

one or more processor;

a client-side portion of an application to be operated by the one or more processors to cooperate with a server-side portion of the application to understand semantics of 3D scenes being uploaded to a server or being down streamed from the server, and optimize the upload and down streaming, based at least in the semantic understanding.

2. The client device of claim 1, wherein the client-side portion of the application is to identify static or dynamic objects of the 3D scenes.

3. The client device of claim 2, wherein the client-side portion of the application is to create static or dynamic models for the static or dynamic objects of the 3D scenes.

4. The client device of claim 4, wherein the client-side portion of the application is to upload dynamic data of the dynamic objects of the 3D scenes, in lieu of raw data of the 3D scenes.

5. A server device, comprising:

one or more processor;

a server-side portion of an application to be operated by the one or more processors to cooperate with a client-side portion of the application to understand semantics of 3D scenes being uploaded to a server or being down streamed from the server, and optimize the upload and down streaming, based at least in the semantic understanding.

6. The client device of claim 5, wherein the server-side portion of the application is to identify static or dynamic objects of the 3D scenes.

7. The client device of claim 6, wherein the server-side portion of the application is to create

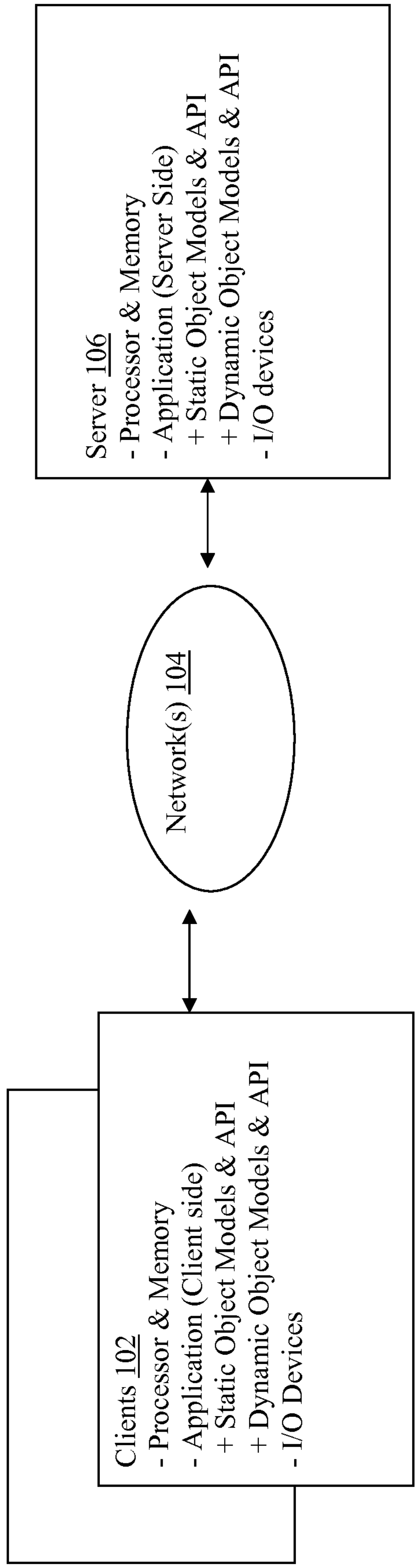
static or dynamic models for the static or dynamic objects of the 3D scenes.

8. The client device of claim 7, wherein the server-side portion of the application is to down stream dynamic data of the dynamic objects of the 3D scenes, in lieu of raw data of the 3D scenes.

Abstract

Apparatuses, methods and storage medium associated with techniques to optimize bandwidth utilization by providing a distributed logic on client, edge and/or datacenter that includes semantic understanding of the physical objects as well as a prediction model of client experience / and cloud process requirements. Other embodiments may be disclosed or claimed.

Attorney Docket No.: 127075-205862 (P93516Z)



100

Figure 1

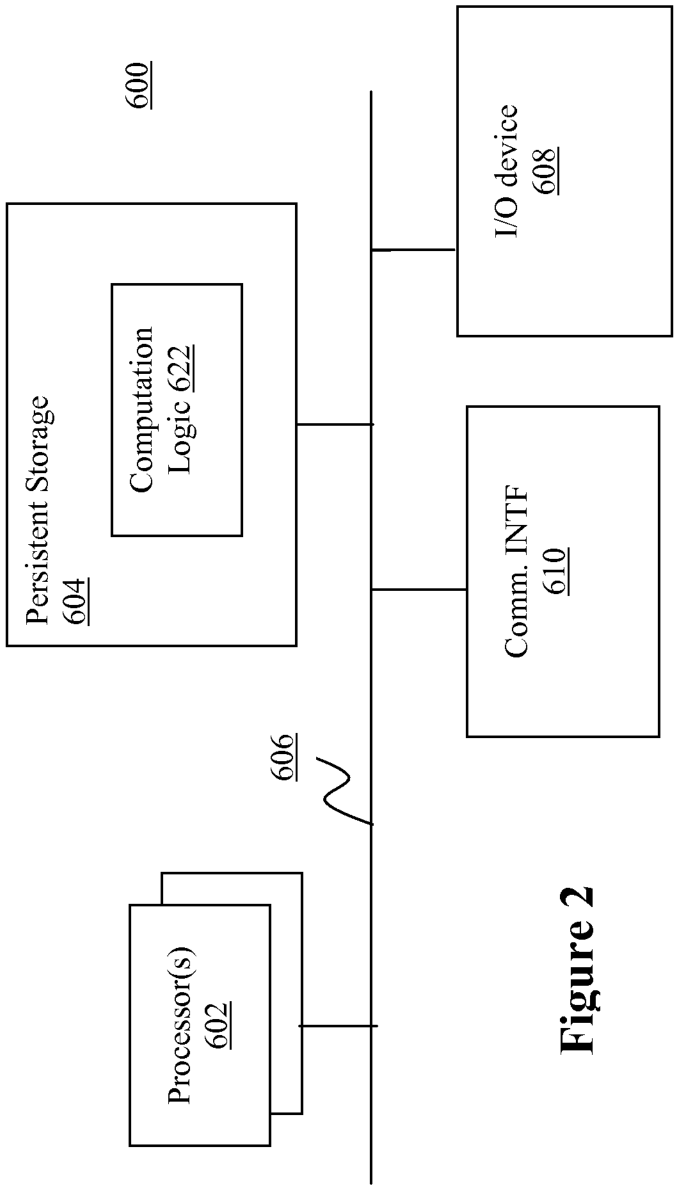

600
Persistent Storage
604
Computation
Logic 622
I/O device
608
Comm. INTF
610
606
Processor(s)
602

Figure 2

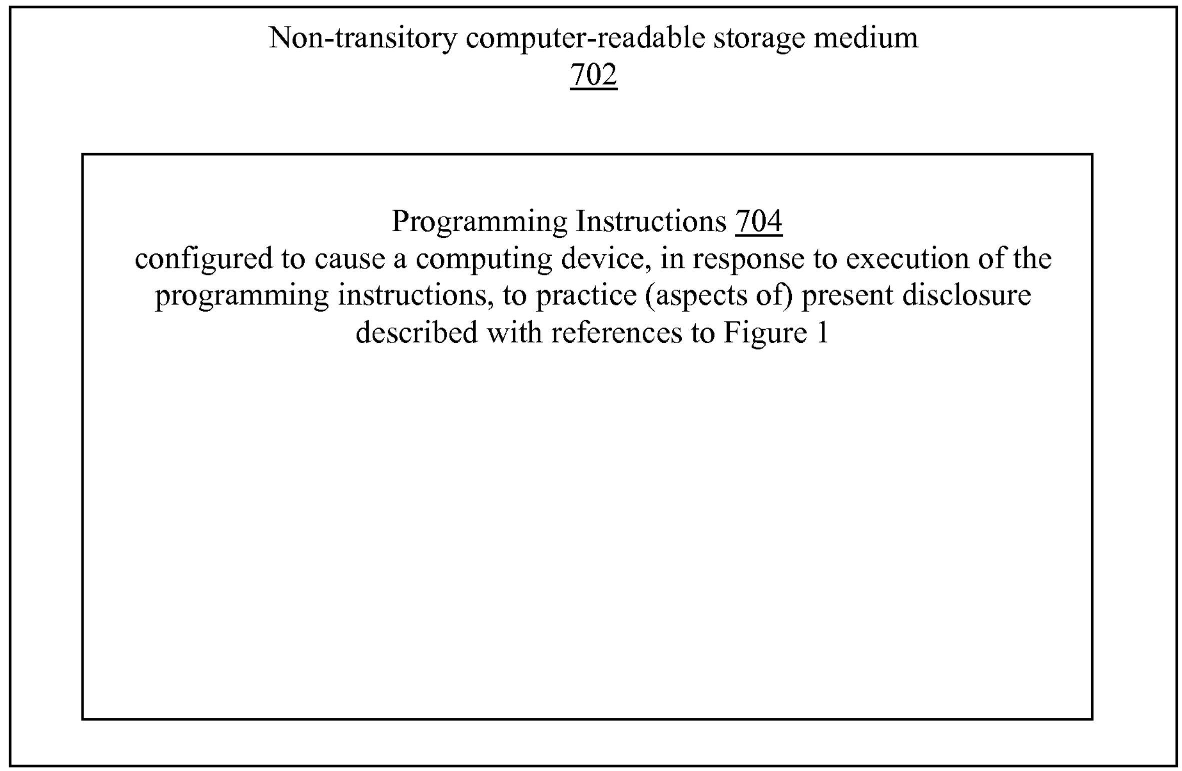

Non-transitory computer-readable storage medium
702
Programming Instructions 704
configured to cause a computing device, in response to execution of the programming instructions, to practice (aspects of) present disclosure described with references to Figure 1

Figure 3

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	DISTRIBUTED SEMANTIC-BASED DECISION LOGIC FOR IMMERSIVE SYSTEM CLIENT SERVER OPTIMIZATION
First Named Inventor/Applicant Name:	IGNACIO J. ALVAREZ
Filer:	Aloysius T.C. Auyeung/Enoy Lawless
Attorney Docket Number:	127075-205862 (P93516Z)

Filed as Large Entity

Filing Fees for Provisional

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Provisional Application Filing	1005	1	260	260
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**260**

Electronic Acknowledgement Receipt

EFS ID:	24194756
Application Number:	62260036
International Application Number:	
Confirmation Number:	7987
Title of Invention:	DISTRIBUTED SEMANTIC-BASED DECISION LOGIC FOR IMMERSIVE SYSTEM CLIENT SERVER OPTIMIZATION
First Named Inventor/Applicant Name:	IGNACIO J. ALVAREZ
Customer Number:	31817
Filer:	Aloysius T.C. Auyeung/Enoy Lawless
Filer Authorized By:	Aloysius T.C. Auyeung
Attorney Docket Number:	127075-205862 (P93516Z)
Receipt Date:	25-NOV-2015
Filing Date:	
Time Stamp:	15:39:49
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$260
RAM confirmation Number	22296
Deposit Account	504238
Authorized User	AUYEUNG, ALOYSIUS T.C.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	P93516Z_Provisional-Cover-Sheet.pdf	1477404 d54407886ba5d9cef3ed7b9b23d191714580bc5b	no	3
Warnings:					
Information:					
2		P93516Z_SPEC.pdf	113121 49b7a65fa95ea0877e68441881fd8adfe66aa4e8	yes	12

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	9
Claims	10	11
Abstract	12	12

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
Warnings:					
Information:					
3	Drawings-only black and white line drawings	P93516Z_FIGS.pdf	541838 4d717603db04b9be8a62d31e839c611a0eb4ec14	no	3
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30434 cee4d9e8ed8121daea5634229ad7091a8c01ad45	no	2
Warnings:					
Information:					

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.