SYSTEM AND METHOD FOR PROVIDING VIRTUAL REALITY SHARED SIMULATION NETWORKED TRAINING FOR MIXED OBJECTS

FIELD OF INVENTION

[0001] The present invention generally relates to virtual reality simulation systems, and more particularly to a method and system for effectively providing real-time virtual reality simulation training in a shared environment for mixed objects or entities.

BACKGROUND OF INVENTION

[0002] Owing to day-to-day variability in the types of trainings to enhance or familiarise with daily or assign tasks, simulation training has become one of the prerequisites for easing as well as assessing professional growth or advancement for some industries. Following this, there is a large number of simulation systems to accommodate the accelerating interest and demand. Albeit the enormous number of simulation systems available, one of the major challenges often faced by users is the lack of support for centralised management and monitoring for participants who are based in differing geographical locations and for simulations that require differing entities in one shared environment – i.e. aviation, naval, land transport, human. Apart from this, a great majority of the available systems do not provide interaction between simulated humans involving an object in the simulated environment, for instance interact or inter-operate on a common object/tool/asset, in real-time by hand gesture to achieve a common objective or mission particularly in joint-training or distributed simulation exercises. Such interaction can provide valuable training experience.

[0003] Hence, it has been difficult and a long-felt need for a simulation system that is fitting for a joint-training for participants of differing locations and entities, with enhanced interaction, with centralised managing of said participants and monitoring.

SUMMARY

[0004] In one aspect, there is disclosed an integrated and interoperable networked virtual reality simulation system for a group of users in shared simulated environment based in one or multiple locations comprising: a plurality of user input modules, each

of which to be operated by a user, configured for receiving input and controlling in relation to simulate at least one type of object in the virtual reality environment, the simulated object is either non-human, one part of a simulated human body or a human; or a combination thereof; in the mixed and shared simulated environment; a central ~~controller~~controlling and monitoring module being in communication with the plurality of user input modules for controlling and monitoring the operational activities of the user input modules; at least one hand movement tracking sensor being in communication to at least one of the user input modules and is positioned to track the movements of the user's hands and fingers operating the user input module; wherein the central controlling and monitoring module activate the modules, provides the environment, roles for each module, scenario intervention to the shared simulated environment; and views all the simulated objects and their interactions in various angles in the shared environment; wherein when activated by the central controlling and monitoring module, the simulated objects can interact and in communication with each other in the shared simulated environment.

[0005] Preferably, at least one body locomotion sensor being in communication to at least one of the modules and is associated to at least one human simulation.

[0006] Preferably, the human body part is human hands and fingers; in which at least one hand movement tracking sensor is attached to the user for providing movements that are tracked by the sensor and then translated into corresponding movements in the simulated environment.

[0007] Preferably, the user input module includes a virtual reality (VR) device for tracking the user's head movements and for displaying/projecting virtual reality images in relation to the shared simulation environment.

[0008] Preferably, the central ~~controller~~controlling and monitoring module is configured to modify and translate signals and input from modules and sensors into movements in the virtual reality shared simulation environment.

[0009] Preferably, the hand movement tracking sensor is adapted to track the movements of the bare hands and fingers of the user, sends signals or input to the central ~~controller~~controlling and monitoring module and; of which the central ~~controller~~controlling and monitoring module modifies the signals into movements of simulated hands and fingers in the shared simulation environment whereby during

operation other user input modules can see each other's hand and fingers movements.

[0010] Preferably, the hand movement tracking sensor is an infrared sensor positioned in a manner such that it can detect and track the movements of the user's hand and fingers.

[0011] Preferably, the hand movements include: push, hold, rotate, pick up and throw one or more objects in the virtual reality environment.

[0012] Preferably, with the facilitation of the hand sensor in tracking the hand movements, the users of the user input module can pass a virtual object between users in the virtual reality environment.

[0013] Advantageously, the central controlling and monitoring module includes a display for displaying all virtual reality images of the user input modules, separately and in combination.

[0014] Preferably, the central controlling and monitoring module and the plurality of user input modules are connected via TCP/IP protocols.

[0015] Preferably, the central controlling and monitoring module includes IOS software installation in a processor or computer and a network interface card for enabling centralized simulation and communication with the plurality of modules during operation.

[0016] Preferably, the system further includes a database for storing scene data and an image generator for generating real-time computer graphic images (CGI).

[0017] Preferably, the system further includes a physics library being in communication with all the input modules and the central ~~controller~~controlling and monitoring module for providing an interface in relation to the control of position data of virtual objects.

[0018] Preferably, the physics library comprises of physics engine connected with the network to communicate with each other and a physics manager assigning each of the virtual objects in the shared simulated environment to one of the physics engines.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will be more understood by reference to the description below taken in conjunction with the accompanying drawings herein:

[0020] FIG. 1 provides an exemplary architecture of the system in accordance with an embodiment of the present invention;

[0021] FIG. 2 depicts the simulation of mixed-environment of the system in accordance with a preferred embodiment of the present invention;

[0022] FIG. 3 depicts another simulation of mixed-environment of the system in accordance with a preferred embodiment of the present invention;

[0023] FIG. 4 portrays an example of a hand-based simulation in accordance with a preferred embodiment of the present invention;

[0024] FIG. 5 depicts an example of how the centralised monitoring and management in effect in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION

[0025] The following description of a number of specific and alternative embodiments is provided to understand the inventive features of the present invention. It shall be apparent to one skilled in the art, however that this invention may be practiced without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0026] The present invention provides a system and method adapted for providing reliable and real-time, virtual reality shared simulation training, for a plurality of users of mixed entities connected to a network. It would be understood by a person skilled in

the relevant art that the system includes known virtual reality means and devices, however the inventiveness and novelty of the present invention is in the ability to control and provide simulation of mixed entities/objects of differing locations in a shared simulation environment. Apart from that, the present invention enables interaction of the simulated object or human with virtual reality objects by deploying minimal and simplistic arrangement.

[0027] The present invention aims to address the problems associated to traffic complexity of current simulation systems, in addition to the difficulties in controlling multiple entities of differing locations in a simulated environment or group simulation. Other advantages of the present invention will become clear throughout the description.

[0028] For clarity, the term “simulated object” or “objects” used within the context of this document generally refers to the type of object (non-human or human) represented by the simulators.

[0029] Referring now to **FIG. 1**, there is provided an exemplary architecture of the system in accordance with an embodiment of the present invention. In a preferred embodiment, the system and method of the present invention is accordingly adapted to operate based on wireless communication technology or any suitable network protocol to provide the desired communication between the modules and components of the system. In accordance with a first aspect, the present invention provides an integrated and interoperable networked virtual reality simulation system for a group of users in a mixed and shared simulated environment based in one or multiple locations comprising: a plurality of user input modules (10_1, 10_n), each of which configured for receiving input and controlling in relation to at least one type of simulated object, the simulated object is either non-human, one part of a simulated human body or a human simulation; or a combination thereof; in the mixed and shared simulated environment; a central ~~controller~~controlling and monitoring module (20) being in communication with the plurality of modules for controlling and monitoring the operational activities of the modules; at least one hand movement tracking sensor (22) being in communication to at least one of the modules and is associated to at least one part of a simulated human body; for providing interaction and controlling said one part of human body; and at least one body locomotion sensor (24) being in communication to at least one of the modules and is associated to at least one human simulation. In a preferred embodiment, the central controlling and monitoring module (20) activate the modules,

provides the environment, roles for each module and scenario intervention to the shared simulated environment. Upon activation, the simulated objects are able to interact and in communication with each other in the shared simulated environment.

[0030] Still referring to **FIG. 1**, each of the user input modules include a simulator for controlling at least virtual object in the simulated environment, a virtual reality device and the sensors (22, 24). Perceptibly, the virtual reality (VR) device is accordingly adapted and configured for tracking the user's head movements and for displaying/projecting virtual reality images in relation to the shared simulation environment. In accordance with a preferred embodiment of the present invention, each user input module may be stationed for a user, or a group of users that are separated geographically, however the present invention enables them to be connected via a network hence able to interact with each other and/or other virtual reality objects or persons in a shared environment. The plurality of input modules may be operated by users of different entities/objects, including, but not limiting to; humans, vehicles, aircraft and ships) each having a respective user location and controls. Understandably, each user input module is operated by a person assigned for each character/object. It is anticipated that the user input modules and the centralized monitoring module can communicate with each other via conventional communication means – i.e. intercom, messaging systems and the likes, being connected in a network.

[0031] In the preferred embodiment, at least one sensor (22), which is the hand movement tracking sensor (22) is an infrared sensor. Suitably, the sensor (22) is positioned in a manner and distance such that it can detect the hand and finger movements of the user. Accordingly, in this arrangement the user is not required to wear gloves or materials of the likes, to track his/her hand and finger movements and then translate or imitate these movements in the virtual environment.

[0032] The locomotion sensor (24) can be a conventional locomotion sensor arrangement or module, configured to detect the movement of the user i.e. walking, running, jumping etc. These movements however can be put into effect using a conventional controller or joystick.

[0033] In the hardware aspect, each user input module ~~include~~ may include a computer adapted for storing scene data and a computerized image generator (26) generating real-time computer graphic images (CGI) as a stream of images each rendered based on the scene data corresponding to a respective point in time, subject

to the environment and parameters set by the central controlling and monitoring module (20). The CGI is displayed to one of the users associated with the stations using a display communicating with the image generator. The scene data includes object data defining a position and physical attributes of virtual objects in the shared simulated environment.

[0034] Further in accordance with a preferred embodiment of the present invention, each user input module is equipped with a physics library (not shown) adapted to interface with the scene data of each of the simulator stations and controls position data of virtual objects of the scene data based on the defined physical attributes of the virtual objects and on physical rules that cause the virtual objects to emulate real movement of objects having corresponding real physical attributes. The physics library comprises of physics engine connected to the network and a physics manager assigning each of the virtual objects in the shared simulated environment to one of the physics engines.

[0035] In the preferred embodiment, the user input modules in collaboration with the central ~~controller~~controlling and monitoring module (20) are configured to enable interactive simulation within the shared environment between the users (human and/or object) in virtual reality. It is understood that the user input modules may be configured as user's simulators for humans or non-human objects. Accordingly, being in a shared environment, each virtual reality device associated to each user, displays the related CGI rendered by the image generator (26), from scene data stored in a database (30), whereby in the preferred embodiment both image generator (26) and database (30) can be accommodated or performed by a computer. Suitably, the database is adapted for storing scene data and an image generator for generating real-time computer graphic images (CGI). It is understood that the components or hardware for each user input module (10_1, 10_n) may vary to fit the simulated training request. For example, a vehicle (air, land or water) may require s controls, gauges, indicators and electronic Interface board, while a VR goggle device for respective humans being simulated, and a display means for each user to display the shared virtual reality scenes. As for human simulation, the user input module can control movements or actions of hands, legs, and other body parts to interact with objects or other human simulation. These actions include, but not limiting to, picking up objects, typical human interactions, walking, running, crawling, jumping etc.

[0036] Now referring in **FIG. 2**, the central ~~controller~~controlling and monitoring module (CCMM) (20) includes a processor (20A) and network interface card (20B) to enable communication with the user input modules (10_1, 10_n). It is further equipped with a display that can accommodate virtual reality images for the shared environment, and as displayed by all active user input modules, individually or collectively. The processor (20A) is installed with Instructor Operator Software (IOS) to activate the simulation events and perform as a host to connect all different entities or objects in one shared environment and the centralized ~~controller~~controlling and managing module can monitor the simulated activities of all entities collectively as a group in real time without any discrepancies in terms of cause and effects of the simulation between the entities from the controls or its simulated effects as observed between the entities and the central ~~controller~~controlling and monitoring module that includes, but not limited to the following : graphic effects, for objects, particles, projectiles, weapon effects, explosion, fire, lightings; physic effects, sound effects and weather effects.

[0037] The central ~~controller~~controlling and monitoring module (CCMM) in accordance with the preferred embodiment of the present invention can view the overall scenario and images of the simulated environment with 360 degrees angle, as opposed to the view of each user input module whereby each user is able to view the scenes or images that are limited to their roles.

[0038] It is understood that to decode, encrypt-decrypt or translate all signals received or fetched from sensors (22, 24) and input from user modules (10_1, 10_n), the central ~~monitor and~~ controlling and monitoring module (20) is accordingly configured to modify and translate signals and input from modules and sensors into movements in the virtual reality shared simulation environment. The central ~~monitor and~~ controlling and monitoring module (20) in accordance with a preferred embodiment of the present invention incorporates the IOS software in selecting different roles option assigned to each user of the input module (10_1, 10_n), in which each role is suitably programmed to have different functions, purpose and capabilities in the shared environment to allow multi-role simulation training. The processor (20A) of the central ~~monitor and~~ controlling and monitoring module (20) therefore receives or fetches data in relation to the requested simulation and generates the relevant roles, purposes, scenes etc that fit the simulation request. Apart from this, it further performs an all-around – 360 degrees viewing control of the simulation in progress. As discussed earlier, the central ~~controller~~controlling and monitoring module can view the entire scenario and activities of all entities of the networked simulators as if it is a function of a moving camera

controllable by an administrator travelling from one point to another in the 3-dimensional space and able to zoom in and out from any point of the virtual space.

[0039] In the preferred embodiment, the central ~~controller~~controlling and monitoring module (20) enables seamless interoperation simulation between different entities by being connected via the network hence in communication with all user input modules (10_1, 10_n). All data and instructions can be relayed or sent directly to the respective user input modules (10_1, 10_n) irrespective of their locations.

[0040] Albeit differing locations of users, with the centralised controlling and monitoring, interaction between simulated objects and human can be achieved. For instance, in the simulated environment, a human or plurality of human entities controlled by a group of users which are geographically dispersed from each other and dispersed from the transport entities can be transported from point A to point B by the transport entities (namely vehicle, aircraft and ship simulators); even though they are being controlled by other group of users in the shared environment, and that each having separate controls to perform the task in a group of the distributed simulation.

[0041] Further in the preferred embodiment, the human entities can mount onto the transport entities (vehicle, aircraft, ships simulators) as to operate and control the virtual equipment (such as weapon or ground handling equipment for airport) that is attached to the transport entities, each equipment having different functions to meet with the objective of the simulation in real time.

Now turning to **FIG. 3**, the system in accordance with one aspect of the present invention enables teamwork simulation between different entities/objects that may be at differing locations from each other. Accordingly, all users via the user input modules connected to the simulation network is provided with a common view of the virtual environment.

[0042] In effect, and still referring to **FIG. 3**, the central ~~controller~~controlling and monitoring module (20) chooses or set the number of vehicle-based simulation (*X* number of vehicles) and human simulations (*Y* number of human simulations) as well as their roles. The module (20) then inserts the scenario and desired environmental parameters – weather etc for a predetermined duration of simulation. Once the parameters are set and all user input modules are activated, the created simulation environment is generated with a shared view by all participating and activated

modules. All entities of differing objects and human simulations therefore conduct training in a group with a shared view of the scenario on the same network.

[0043] In relation to human simulation, the system in accordance with the preferred embodiment of the present invention enables interaction with other limbs or other body parts of the human simulation. In a broad example, in an active simulation, a user through the user input module can perform animation of his hand movement, such as passing/holding/maneuvering/handling tools, handling a vehicle and checking a vehicle, as well as to guide the participating transport entities such as vehicle convoy movement. These hands movements can be observed by other users and collectively by the centralized monitoring simultaneously in real-time in the shared simulation.

[0044] With reference to **FIG. 4**, sensors (22, 24) facilitates the motion or movement of the human simulation and the specific limbs. With a combination of VR goggle and these sensors being integrated to the system, the various movements of the human simulation and gestures of its limbs can be generated or created in virtual reality mode hence viewable by all users within the shared simulation. At least one sensor – tracking motion sensor (22) is attached to the limb, whereby in one embodiment the sensor (22) is attached at the forehead of the user or any part that is able to detect the hand movement of the user's hand, sending motion/movement data to the user input module to create the same movements in virtual reality mode which are viewable by the central ~~controller~~controlling and monitoring module (20) and all other users. The present invention therefore eliminates the use of special type gloves or specially customised VR hand devices that can be prohibitively expensive.

[0045] In another embodiment, the tracking data from the sensor (22) may be relayed to the central ~~controller~~controlling and monitoring module (20) for modification prior to being translated to actions in the shared simulation environment. Examples of hand movements captured by the tracking sensor (22) include: push, hold, rotate, pick up and throw one or more objects in the virtual reality environment. The second sensor, being the locomotion sensor (24) is attached to the user in a manner such that it is able to detect and send signals in relation to the body movement of the user to be translated into virtual movements in the shared simulation. The locomotion sensor (24) therefore is configured to capture the footsteps movement data prior to translating said data into the three dimensional (3D) human model's movement that they would be representing in the virtual environment to simulate the walking, running, jumping

actions etc., in which these actions can be viewed by other users that are participating in the training.

[0046] As shown in **FIG. 5**, a centralised management and monitoring of simulation entities by a single administrator of the system can be provided, whereby with centralised management and monitoring, efficiency can be sharpened, while reducing the cost in providing manpower for monitoring. The performance for each user can be captured and analysed more centrally instead of relying on multiple reviews from multiple administrators.

[0047] It should be noted that a non-human or transport entity/object (vehicle, aircraft, ship simulators) can transport virtual objects from point A to point B, then a human entity collect it virtually by the hand movement tracking sensor and then load it to another transport entity (vehicle, aircraft, ship) which then carry it to point C, all being done in one simulated operation. In an example, the system is deployed in a baggage or cargo collection system training for airports. Suitably, the scenario includes a human baggage handler and a baggage carrier/transporter with a human rider, each of which is represented by a user via the user input module. Accordingly, there are three users representing the respective objects in the shared virtual environment. With the system of the present invention, the user that represent the human baggage handler wears a VR goggle and using the hand movement tracking sensor (22) the movements of the hand and fingers of the user can be imitated in the virtual environment. Similarly, the user that represents the human rider wears a VR goggle and is equipped with at least one hand movement tracking sensor (22). The baggage transporter is then represented by another user via the user input module and assigned to move the bags from the aircraft (in this case Point A) to a designated point or location (Point B), with the help of the human baggage handler. The human baggage handler is assigned to carry and place the bags from the aircraft into the baggage transporter. After this process, the human rider drives the baggage/luggage transporter to transfer the baggage to the designated area. During the whole process, the system in accordance with the present invention allows, but not limiting to, the following interactions:

- between the human rider with the human baggage handler;
- between the human rider with the transport – luggage transporter

[0048] Referring to **FIG. 1**, subject to the type of role and type of object (human or non-human) to be represented in the virtual environment, the module may be equipped with the required components, devices and controllers to put the simulation into effect. For instance, in one embodiment and with reference to **FIG. 1**, the user module is equipped with a multi-display device, controls, gauges/indicators (for transport based objects) and a user interface. Understandably, the user interface varies based on the task and role of the user.

[0049] It is further understood that the programming of the system may be achieved by various known programming protocols and procedures such as C++ programming and the likes to as to assist in fulfilling the purpose of the present invention. Similarly, the signal exchange, translation, encoding-decoding, encrypt-decrypting and signal conditioning are implemented using known in the art electronic components or modules.

[0050] The system of the present invention may be implemented in various industries, particularly for providing professional staff training, skilled training, or even for knowledge sharing. The type of industries that may find the system beneficial include, but not limiting to military, airport, rehabilitation, medical/surgery, science, education, oil & gas, and any private or government organisations that are in the emergency and rescue field.

[0051] As would be apparent to a person having ordinary skilled in the art, the afore-described methods and components may be provided in many variations, modifications or alternatives to existing systems. The principles and concepts disclosed herein may also be implemented in various manner which may not have been specifically described herein but which are to be understood as encompassed within the scope of the following claims.

CLAIMS

1. An integrated and interoperable networked virtual reality simulation system for a group of users in shared simulated environment based in one or multiple locations comprising:

a plurality of user input modules, each of which to be operated by a user, configured for receiving input and controlling in relation to simulate at least one type of object in the virtual reality environment, the simulated object is either a non-human entity, one part of a simulated human body or a human entity~~;~~ , or a combination thereof~~;~~ , in the ~~mixed and~~ shared simulated environment;

a central ~~controller~~ controlling and monitoring module being in communication with the plurality of user input modules for controlling and monitoring the operational activities of the user input modules;

at least one hand movement tracking sensor being in communication to at least one of the user input modules and is positioned to track the movements of the user's hands and fingers operating the user input module;

wherein the part of the simulated human body is human hands and fingers; and the hand movement tracking sensor is an infrared sensor attached to the user for detecting and tracking the movements of the user's hand and fingers that are then translated into corresponding movements in the shared simulated environment;

wherein the central controlling and monitoring module activates the user input modules, provides the environment, roles for each module and scenario intervention to the shared simulated environment; and views all the simulated objects and their interactions in various angles in the shared environment;

~~—————~~wherein the plurality of user input modules are operable by users of mixed entities, such that, when activated by the central

controlling and monitoring module, the simulated objects ~~can~~ interact and are in communication with each other in the shared simulated environment;

wherein with the facilitation of the hand movement tracking sensor in tracking the hand and fingers movements, the users of the user input modules are able to pass a virtual object between users in the shared simulated environment.

2. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein at least one body locomotion sensor being in communication to at least one of the modules and is associated to at least one human simulation.

~~3. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the human body part is human hands and fingers; in which at least one hand movement tracking sensor is attached to the user for providing movements that are tracked by the sensor and then translated into corresponding movements in the simulated environment.~~

~~4.~~3. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the user input module includes a virtual reality (VR) device for tracking the user's head movements and for displaying/projecting virtual reality images in relation to the shared simulation environment.

~~5.~~4. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the central ~~controller~~ controlling and monitoring module is configured to modify and translate signals and input from modules and sensors into movements in the virtual reality shared simulation environment.

~~6.~~5. The integrated and interoperable networked virtual reality simulation system as claimed in Claim ~~2~~1, wherein the hand movement tracking sensor is adapted to track the movements of the bare hands and fingers of the user, sends signals or input to the central ~~controller~~controlling and monitoring

module and; of which the central ~~controller~~controlling and monitoring module modifies the signals into movements of simulated hands and fingers in the shared simulation environment whereby during operation other user input modules can see each other's~~'~~ hand and fingers movements.

~~7. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the hand movement tracking sensor is an infrared sensor positioned in a manner such that it can detect and track the movements of the user's hand.~~

~~8.~~6. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 5, wherein the hand movements include: push, hold, rotate, pick up and throw one or more objects in the virtual reality environment.

~~9. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein with the facilitation of the hand sensor in tracking the hand movements, the users of the user input module are able to pass a virtual object between users in the virtual reality environment.~~

~~10.~~7. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the central controlling and monitoring module includes a display for displaying all virtual reality images of the user input modules, separately and in combination.

~~11.~~8. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the central controlling and monitoring module and the plurality of user input modules are connected via TCP/IP protocols.

~~12.~~9. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the central controlling and monitoring module includes IOS software installation in a processor or computer and a network interface card for enabling centralized simulation and communication with the plurality of modules during operation.

~~13.~~10. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the system further includes a database for storing scene data and an image generator for generating real-time computer graphic images (CGI).

~~14.~~11. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 1, wherein the system further includes a physics library being in communication with all the input modules and the central ~~controller~~controlling and monitoring module for providing an interface in relation to the control of position data of virtual objects.

~~15.~~12. The integrated and interoperable networked virtual reality simulation system as claimed in Claim 11, wherein the physics library comprises of physics engines connected with the network to communicate with each other and a physics manager assigning each of the virtual objects in the shared simulated environment to one of the physics engines.