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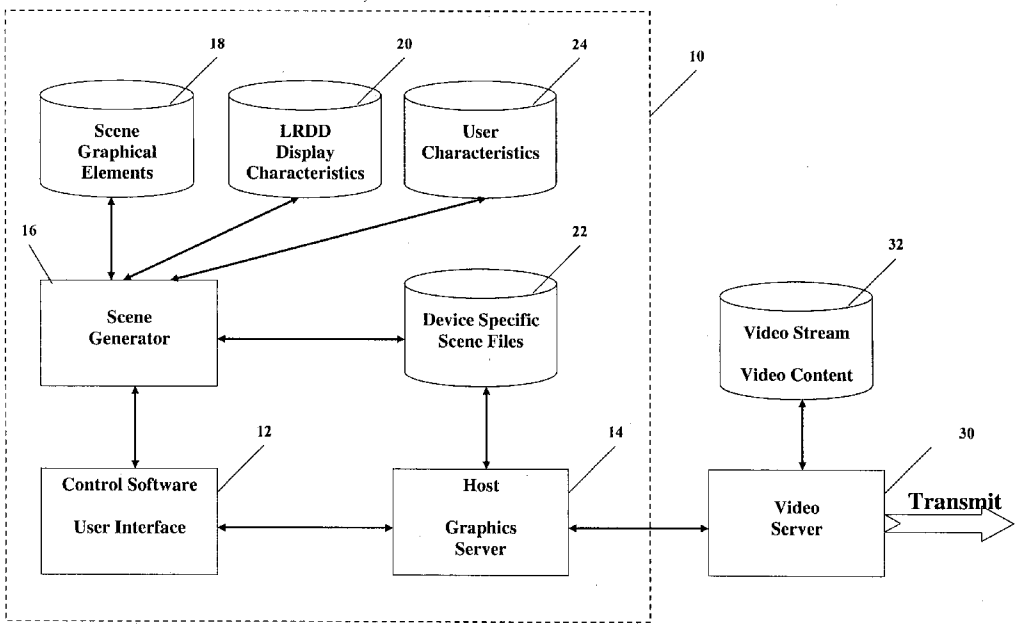


Fig. 1

(57) **Abstract:** A method for providing graphical content to be displayed on different kinds of display devices is disclosed. Each kind of display devices is associated with different graphical characteristics. The method includes generating a scene of desired graphical content and formatting, for each kind of the display devices, the scene into a scene file containing the graphical content formatted to suite that kind of display device. A system is also disclosed.

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GRAPHICS FOR LIMITED RESOLUTION DISPLAY DEVICES

FIELD OF THE INVENTION

[0001] The present invention relates to video streaming. More particularly the present invention relates to system and method for providing graphical content associated with video streaming for end user display devices with limited communication bandwidth and limited display capabilities.

BACKGROUND OF THE INVENTION

[0002] Traditional TV broadcast involves broadcasting audio and video content on-air (or through cables) to a plurality of users. This means that each user can intercept a broadcast at any given time and view the content as it is being broadcasted. The user has no control and all he (or she) can do is to decide whether to view it or change to another channel (in multiple channel broadcasting).

[0003] Video streaming is a widely used method for providing online video capabilities. Essentially video streaming deals with accessing a video (and audio) file located on a remote location (typically a webpage) and playing that file on a local end-user display online (as opposed to downloading the file and playing it off-line) while video data is being streamed to the end-user machine facilitating continuous video.

[0004] Video and audio data (we refer both to video and audio streaming as "video streaming" throughout the present specification) are streamed from a remote server to the end-user. As the multimedia stream reaches the end-user device it is played in real-time (or almost real-time) while data is being received.

[0005] Video streaming involves using compressed multimedia files. Typically the most important video codec standards in video streaming are H.261, H.263, MJPEG, MPEG1, MPEG2 and MPEG4 (the last three in particular are very popular).

[0006] Generally video streaming can be found in closed-loop intranets but video streaming is increasingly becoming a main entertainment technology over the Web and other large networks.

[0007] The quality of video streaming is dependent on bandwidth. In order to reduce the amount of data transferred compression techniques are used. In the MPEG format a Video Elementary Stream (VES) is subjected to GOP (Group of Pictures) encoding. To deal with temporal redundancy, MPEG divides the frames into groups, each referred to as a "group of pictures," or GOP. A VES is made up of I, P and B type pictures. An I picture (I stands for Intracoded picture) contains information of a whole new frame and is used as reference in the reconstruction of either P or B pictures, whereas a P (P stands for Predicted picture) picture contains information on several consecutive intermediate frames sharing information from the I picture. A P picture supports forward prediction from a previous picture. A B picture (B stands for Bi-directional prediction picture) contains only information of a single intermediate frame. A B picture is a forward, backward or bi-directional picture, referring to other I and P pictures. For example, the extent of the damage caused by a lost packet depends on its location: if the packet is inside an I picture, artifacts will be visible until the showing of the next I picture – usually about 0.5 second. If the lost packet is in P picture, the damage will be for about 3 pictures (frames) duration (typically 120 mSec), and if in B picture, only for the duration of that picture (typically 40 mSec).

[0008] As video streaming is aimed at providing a multiple of users access to video content (each user may select video content and view it separately on his own display machine), bandwidth is a main concern. As there are many viewers attempting to view various contents at the same time, the overall bandwidth determines how many user can simultaneously access the service.

[0009] As bandwidth is a main concern, video streaming techniques involve seeking to minimize the volume of video data being transferred while at the same time trying to preserve video and audio qualities.

[0010] While bandwidth is a main concern in all video streaming applications it is crucial in applications designed for small end-user devices, typically hand-held devices, which have very small displays (typically 1-3 inches (displays), such as mobile phones, PDA, hand-held game consoles, laptops with small display and similar devices. The display screen in those devices has relatively low resolution (typically 320X200, 320X240, 176X220) that substantially degrades the quality of text, graphics and

animation (hereinafter referred to as "graphical content") displayed on these devices, down to a level that renders viewing this graphical content impossible. These devices are referred to hereinafter as "limited resolution display devices" (LRDD in short).

[0011] Furthermore, LRDDs comprise different kinds of hardware, which may operate with different screen size, screen resolutions, screen color depths, available memory, CPU types, existence and type of graphic accelerators (polygon render capabilities), types of graphical software library (for example Open GL, DirectX), supported languages, type of operating system – hereinafter referred to as "display characteristics" or "graphical characteristics" (in the context of the present invention the display characteristics that is of interest deals with hardware or software characteristics that influences the display quality).

[0012] Graphical content associated with video streaming typically comprises graphic elements, which are shown and/or animated on portions of the screen over displayed video content. This can, for example, consist of a text data, subtitles, score, statistics and other information tables (in broadcasts of sport events, for example), name and title of a person being interviewed, station logo, animations and other information.

[0013] Conventionally, in TV broadcasts graphical content was generated and combined with video and was broadcasted as integrated video content to the end users, where each user would pick up the transmission and display it on his (or hers) TV screen.

[0014] With respect to LRDD the end result of conventional transmission is poor. Since the resolution on the client screen is lower than the source resolution, the text may be illegible. The present invention is aimed at improving legibility and overall visibility of graphical content.

[0015] In recent developments in video streaming (MPEG4), it was suggested to treat graphical content as a different layer, in which case graphical content is sent separately as digital information and not as combined graphics with the video content, and the end user machine receives this information and combines it on the user's display device.

[0016] Graphical content is either rendered on the host server, and transmitted rendered to the clients, or, alternatively, graphical content is sent as digital vector information to the clients where it is rendered locally (for example, Macromedia Flash ™ approach).

[0017] It is an object of the present invention to provide methods for enhanced graphical content for LRDD, reducing video-streaming data transfer while maintaining good quality content broadcast.

[0018] Presently video streaming content for LRDDs is provided regardless the hardware displaying it. LRDDs include an application for down-scaling which scales down the video content to facilitate displaying it properly on the small display screen. This simple tool shrinks video data while loosing a lot of information in the process.

[0019] An object of the present invention is to provide system and method for generating graphical content that is suited for display on a specific display device.

[0020] Another object of the present invention is to provide system and method for generating graphical content for various end-user display devices.

[0021] Yet another object of the present invention is to reduce data transmission of graphical elements without degrading display quality.

[0022] Other advantages and objects will become apparent after reading the present specification and considering the accompanying figures.

SUMMARY OF THE INVENTION

There is thus provided, in accordance with a preferred embodiment of the present invention, a method for providing graphical content to be displayed on different kinds of display devices, each kind of display devices associated with different graphical characteristics, the method comprising:

formatting the graphical content according to the graphical characteristics for each kind the display devices; and

[0023] generating, for each kind of the display devices, a scene file containing the formatted graphical content for that kind of display device.

[0024] Furthermore, in accordance with some preferred embodiments of the present invention, the method further comprises designing the graphical content.

[0025] Furthermore, in accordance with some preferred embodiments of the present invention, the method further comprises providing a list of graphical characteristics

associated with at least one of a plurality of different types of display devices and referring to the list when performing the step of formatting the graphical content.

[0026] Furthermore, in accordance with some preferred embodiments of the present invention, the graphical characteristics comprise one or more characteristics selected form a group of characteristics containing: screen size, screen resolution, screen color depth, available memory, CPU type, existence and type of graphic accelerator, type of graphical library, supported languages, type of operating system.

[0027] Furthermore, in accordance with some preferred embodiments of the present invention, the method further comprises providing a list of personal graphical preferences associated with different persons using the display devices and referring to the list of personal graphical characteristics when performing the step of formatting the graphical content.

[0028] Furthermore, in accordance with some preferred embodiments of the present invention, the method further comprises providing a client application for receiving the scene file and rendering it locally to graphical content on the specific display device.

[0029] Furthermore, in accordance with some preferred embodiments of the present invention, the client application includes one or more control features, defining logic above scene level.

[0030] Furthermore, in accordance with some preferred embodiments of the present invention, the method further comprises providing video streaming data and displaying the graphical content over the video.

[0031] Furthermore, in accordance with some preferred embodiments of the present invention, the graphical content is synchronized with the video streaming data and jointly transmitted to the specific display device.

[0032] Furthermore, in accordance with some preferred embodiments of the present invention, the graphical content is separately streamed to the specific display device separately from the video content.

[0033] Furthermore, in accordance with some preferred embodiments of the present invention, transmission of the graphical content is initiated by a server.

[0034] Furthermore, in accordance with some preferred embodiments of the present invention, transmission of the graphical content is initiated by a request from the specific display device.

[0035] Furthermore, in accordance with some preferred embodiments of the present invention, some transmission of the graphical content is initiated by a server and some transmission of the graphical content is initiated by a request from the specific display device.

[0036] Furthermore, in accordance with some preferred embodiments of the present invention, there is provided a system for providing graphical content layer to be displayed on display devices of different graphical characteristics, the system comprising:

[0037] a scene generator for formatting the graphical content according to the graphical characteristics for each kind the display devices and for generating, for each kind of the display devices, a scene file containing the formatted graphical content for that kind of display device.; and

[0038] a graphics server for transmitting the scene file to the specific display device.

[0039] Furthermore, in accordance with some preferred embodiments of the present invention, the system is further provided with control interface cooperating with the scene generator for allowing an operator to design the graphical content to be displayed over the video content.

[0040] Furthermore, in accordance with some preferred embodiments of the present invention, the system further comprises providing a database containing graphical characteristics associated with at least one of a plurality of different types of display devices.

[0041] Furthermore, in accordance with some preferred embodiments of the present invention, the system further comprises providing a database containing personal graphical preferences associated with different persons using the display devices.

[0042] Furthermore, in accordance with some preferred embodiments of the present invention, the system further comprises a client application for receiving the scene file and rendering it locally to graphical content on the specific display device.

[0043] Furthermore, in accordance with some preferred embodiments of the present invention, the system further comprises a video server for providing video streaming data.

[0044] Furthermore, in accordance with some preferred embodiments of the present invention, the video server is incorporated with graphics server.

[0045] Furthermore, in accordance with some preferred embodiments of the present invention, the video server is separated from the graphics server.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] In order to better understand the present invention, and appreciate its practical applications, the following Figures are provided and referenced hereafter. It should be noted that the Figures are given as examples only and in no way limit the scope of the invention. Like components are denoted by like reference numerals.

[0047] Fig. 1 illustrates a system for providing independent graphical data synchronized with video streaming data, designed to be displayed on a specific type of a display device, according to a preferred embodiment of the present invention.

[0048] Fig. 2 illustrates an end-user LRDD adapted to cooperate with a system for generating graphical content such as the system displayed in Fig. 1, according to a preferred embodiment of the present invention.

[0049] Fig. 3 illustrates a system for providing independent graphical data synchronized with video streaming data, designed to be displayed on a specific type of a display device, according to another preferred embodiment of the present invention.

[0050] Fig. 4 illustrates an end-user LRDD adapted to cooperate with a system for generating graphical content, such as the system displayed in Fig. 3, according to another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0051] The present invention introduces a system and method for generating graphical content to be overlaid on video content that is suited for display on a specific display device, or for stand-alone graphical applications.

[0052] At the heart of the present invention lies the realization that there is a multitude of end-user display devices, each having their own display characteristics. In order to address this problem a system according to a preferred embodiment of the present invention generates specific graphical content for a specific end-user LRDD.

[0053] A main aspect of the present invention is automatic generation of graphical content specifically designed for a specific type of LRDD. This means that graphical content will be generated differently depending on the display characteristics of a particular end-user device.

[0054] A system according to a preferred embodiment of the present invention comprises a graphical content scene generator that allows an operator to produce graphical content, using a library (database) of graphical elements, which is exported to a scene file containing vector information relating to the graphical content. Alternatively, an operator is not involved, and instead automated information is used in the generation of the scene (for example stock data).

[0055] A "scene" refers to the graphical content that is superimposed on video content. A scene file contains everything necessary to render the scene and animate it on the client display: camera (position, field of view), lights, transformation tree, materials, textures, images, 3D objects, animations, scripts for interactivity, etc. Alternatively the scene is not superimposed on video content, and is solely displayed.

[0056] In the process of generating the scene file (which is called "exporting") the scene generator refers to a database of LRDDs, which lists display characteristics of LRDDs (for example, types of LRDDs that are available, registered or on-line) and generates a file that is formatted and specifically suited for each kind of all display devices (all the devices having the same specific display characteristics). By "exporting" it is meant that the scene which is in memory is saved into a file which the client can read and render. Exporting also does all the optimizations for the client: scaling of images, vertex processing, animation sampling, etc.

[0057] If there are various LRDDs with different display characteristics that are registered for the service or appear on-line, the scene generator would automatically generate different scene files for each set of display characteristics.

[0058] According to a preferred embodiment of the present invention, a video server sends to on-line clients the video stream along with the graphical content in its vector format (the scene file), each client receiving a scene file suitable for his own LRDD display characteristics, and rendering it locally using a rendering application existing in that specific LRDD device. As each device gets a graphical content file that is tailor-made and customized, and renders it locally, there is no accidental or random data loss involved, and consequently the quality of the graphical content display is optimized. In another preferred embodiment of the present invention the graphical content is generated and transmitted to the client separately from the video streaming content, and is merged on the client device. In yet another preferred embodiment of the present invention graphical content is sent to a client device without any video streaming content, to be used for various application (for example, voting).

[0059] In essence the transmitted data according to the present invention is characterized as not being screen shots or video clips, rather data that allows graphics to be reconstructed on the end-user display device (the LRDD).

[0060] The system and method of the present invention provides, in effect, graphics engine for any viewer. Not only it is particularly suited for each type of display device, but it may also be targeted specifically to each individual who is a client of the provided service.

[0061] Reference is made to Fig. 1 illustrating a system 10 for providing independent scene files with video streaming data for specific kinds of LRDDs, according to a preferred embodiment of the present invention.

The system generally comprises a scene generator 16, for generating a scene file. An operator through control user interface 12 uses scene graphical elements database 18 to design a scene. An example of such a scene generator is Viz|Engine ™ (by Vizrt Ltd., Israel). Examples of control interfaces are: Viz|Trio™ and Viz|Content Pilot™ for live productions (e.g. news, sport event), and Viz|Multi Channel™ or Viz|Ticker 3D™ for

automated production (e.g. new ticker, automated financial graphics), all by Vizrt Ltd, Israel.

[0062] A graphics host server 14 may maintain a list of online (or registered) LRDDs for which the graphical content is generated. An example of such a graphical server is Viz|MPS™ (by Vizrt Ltd., Israel). The scene generator 16 refers to LRDD database 20 containing a list of display characteristics relating to various LRDDs, and depending on the LRDD type of the device for which the video content is prepared formats the scene to suit the graphical characteristics of a specific online or registered LRDD.

[0063] The scene is exported into a scene file database 22, which may be saved for additional future use.

[0064] The graphics host server 14 manages the scene generation process for the specific LRDD and transfers the specific scene file (or files) to a video server 30, that takes video stream content from a video stream database 32 (or live video feed) and transmits the video stream together with the scene file (that contains the graphical content in vector format, formatted for each kind of the display devices).

[0065] Fig. 2 illustrates an end-user LRDD 40 adapted to cooperate with a system for generating graphical content according to a preferred embodiment of the present invention, such as the system displayed in Fig. 1.

[0066] The combined video content is received by video client 42, which sends the scene file to rendering engine 44, which renders the scene file to graphical content so that both the video stream and the graphical content are displayed on display 46.

[0067] The graphical content is streamed along with the video content and therefore inherently synchronized. Typically, the chosen video streaming format handles latencies that may be introduced between the video content and graphical content.

[0068] The client application is used to render the scenes on the client display device, rendering the graphical content as a layer on top of the video layer. It is optimized for each specific client, and the scenes are exported to the client, thus ensuring high-quality render performance.

[0069] The client application may also includes control features, defining logic "above scene level" which is used to hard code specific properties, such as server host name, IP Address, etc.

[0070] The client application runs on the user device and communicates with the server. It is designed to be lightweight and small so as to allow portability and maintain resource efficiency.

[0071] Reference is made to Fig. 3, illustrating a system for providing independent graphical data synchronized with video streaming data, designed to be displayed on a specific type of a display device, according to another preferred embodiment of the present invention. In this embodiment the scene files generated by system 10 are transmitted to client 31 separately from the video stream. This means that the client has to synchronize the video streaming data with the scene files, as opposed to the synchronization that is taken care of, in the system shown in Fig. 1 by video server 30.

[0072] Fig. 4 illustrates an end-user LRDD adapted to cooperate with a system for generating graphical content, such as the system displayed in Fig. 3, according to another preferred embodiment of the present invention. In this embodiment the LRDD is provided with a video client 42 component, that receives the video streaming data and a graphic client 41 component that separately receives the scene files. The graphic client 41 sends the scene file to rendering engine 44, that renders the scene file to graphical content in synchronization to the video stream generated on the video client 42, so that both the video stream and the graphical content are displayed on display 46.

[0073] As the generated scene file was specifically designed for this particular type of LRDD, addressing its graphical characteristics, the graphical content is optimized in terms of quality and performance. This means, for example, that if the destination LRDD resolution is 320X200 the graphic content sent is specifically generated in this resolution. Similarly, if the supported languages of a destination LRDD are English and Hebrew, only subtitles in these languages are transmitted to that destination LRDD (in the appropriate resolution).

[0074] The system of the present invention is capable of producing scene files for different LRDD graphical characteristics, so that each type of LRDD is served the appropriate scene file for optimized display. Each end-user display device (LRDD) that

signs up for this service is registered with the server, so that the server knows its specific device kind and hence its characteristics. Alternatively, the display characteristics of each device logged on to the service, or appearing on-line are considered.

[0075] Once an operator designs a scene layout the system of the present invention generates a plurality of scene files each suitable for display on a specific LRDD, depending on its graphical characteristics.

[0076] Note that for each set of graphical characteristics a scene file may be generated. This means, for example, that there may be several users with same type of device (for example NOKIA N70) with same display resolution and CPU capabilities but with different available memory, and in that case different scene files may be generated to optimize the display quality on each specific user device.

[0077] One way to achieve synchronization between the graphical and the video content, although they are streamed separately, is by inserting sync data on the video stream. Another way will be to send time code references along the graphical content; One knows, for example, that the graphics should appear on time-code 00:00:36:12, so the scene file is sent to the client, loaded into memory and the client tracks the time-code of the video clip which it displays it. As soon as the time-code arrives, the scene animation is played back.

[0078] In a preferred embodiment of the present invention, client oriented services can be achieved.

[0079] In order to accomplish that, a list of client characteristics is maintained at client characteristics database 24 (see Fig. 1). Client characteristics comprise, for example, preferred color schemes (which may be crucial for persons with color blindness), different graphic sizes (for persons with impaired vision), and preferred language. The system of the present invention is capable of generating customized scene files not only for specific graphical characteristics associated with LRDD devices, but also for specific clients according to a list of clients characteristics.

[0080] A client may be identified by detecting or registering the type of LRDD used, in which case the system will refer to the graphical characteristics of that particular type of LRDD, stored in database 20, when generating the scene file. If the client is personally

identified, a personalized scene file is generated, also referring to the specific client characteristics stored in database 24.

[0081] The service of the present invention is resource efficient, the client is provided with a client application that is memory and CPU efficient, so as to minimize bandwidth usage.

[0082] The transmission method can be in "push" or "pull" mode. In "push" mode scenes are sent to all clients currently connected to the service (and logged to the service at the server). In "pull" mode the client, while watching a specific video stream content, such as soccer game, may generate a data request ("pull data") from the host server, such as current score, and the system will send it to him automatically.

[0083] An operator (operating the control software 12 in Fig 1) controls the graphical content layer that inserting the data according to the video content and events. For example, one may watch a football match on one's mobile phone screen (a client with LRDD) and one team scores a goal. An operator enters the score, hits enter, and a scene Generator (16 in Fig 1) generates the appropriate scene file The graphic server (14 in Fig 1), receives the trigger entered by the operator and sends the scene file to the client. One operator action, such as the above "enter" may automatically produce many different variations of scene files sent to different clients, depending on the capabilities of the various client devices.

[0084] The present invention suggests a mixed mode as well: push and pull. In one example one watches a football match on one's mobile phone display and the name of a player who has just scored is displayed on the lower third of the screen. The user may highlight the name thus requesting more information on that player, which is provided by the server. The push and pull mode is suitable for interactive applications.

[0085] Consider a cricket match. A match goes on for days, and many spectators do not watch all of it, rather watch portions of it. A client registered to the service of the present invention can have the score displayed on the client's display, and when there is a change in the score or when special events take place (the user may select specific "special events" to be alerted when these events take place) an alert is sent to the client. If interested the user can turn on his video service and watch the match.

[0086] Additional optional features may include:

[0087] Personalized advertisement, by simply referring to a user characteristics database (24 in Fig.1) identifying the client and his/hers personal preferences and using this indication directing advertisements and commercial information to his taste;

[0088] Customized TV experience, by providing a variety of skins for on-air graphics, allowing each user to personalize his viewing experience. The user may be allowed to log into a web-site associated with the service of the present invention, and edit his profile;

[0089] Interactivity and voting applications, in pop-music popularity charts, the user may be provided with a scene of a selection menu (for example, in the form of an animated 3-dimensional scene) that lets the user select his favorite singer, and a voting message is sent back by the client application to the service server. Graphical content is produced, updated in real time, reflecting the current ranking.

[0090] It should be clear that the description of the embodiments and attached Figures set forth in this specification serves only for a better understanding of the invention, without limiting its scope.

[0091] It should also be clear that a person skilled in the art, after reading the present specification could make adjustments or amendments to the attached Figures and above described embodiments that would still be covered by the present invention.

CLAIMS

1. A method for providing graphical content to be displayed on different kinds of display devices, each kind of display devices associated with different graphical characteristics, the method comprising:

generating a scene of desired graphical content; and

formatting, for each kind of the display devices, the scene into a scene file containing the graphical content formatted to suite that kind of display device.

2. The method as claimed in claim 1, further comprising designing the scene.

3. The method as claimed in claim 1, further comprising providing a list of graphical characteristics associated with at least one of a plurality of different types of display devices and referring to the list when performing the step of formatting the scene into the scene file containing the graphical content formatted to suite the graphical characteristics for each kind of display device .

4. The method as claimed in claim 3, wherein the graphical characteristics comprise one or more characteristics selected form a group of characteristics containing: screen size, screen resolution, screen color depth, available memory, CPU type, existence and type of graphic accelerator, type of graphical library, supported languages, type of operating system

5. The method as claimed in claim 3, further comprising providing a list of personal graphical preferences associated with different persons using the display devices and referring to the list of personal graphical characteristics when performing the step of formatting the scene into the scene file containing the graphical content formatted to suite the graphical characteristics for that kind of display device .

6. The method as claimed in claim 1, further comprising providing a client application for receiving the formatted scene file and rendering it locally to display the graphical content on the specific display device.

7. The method as claimed in claim 6, wherein the client application includes one or more control features, defining logic above scene level.

8. The method as claimed in claim 1, further comprising providing video streaming data and displaying the graphical content over the video.

9. The method as claimed in claim 8, wherein the scene file is synchronized with the video streaming data and jointly transmitted to the specific display device.

10. The method as claimed in claim 8, wherein the scene file is streamed to the specific display device separately from the video content.

11. The method as claimed in claim 1, wherein transmission of the scene file is initiated by a server.

12. The method as claimed in claim 1, wherein transmission of the scene file is initiated by a request from the specific display device.

13. The method as claimed in claim 1, wherein some transmission of the scene file is initiated by a server and some transmission of the scene file is initiated by a request from the specific display device.

14. A system for providing graphical content to be displayed on different kinds of display devices, each kind of display devices associated with different graphical characteristics, the system comprising a scene generator for generating a scene of

desired graphical content, and for formatting for each kind of the display devices, the scene into a scene file containing the graphical content formatted to suite the graphical characteristics for that kind of display device.

15. The system as claimed in claim 14, further provided with a graphics server for transmitting the scene file to one or more of the display devices.

16. The system as claimed in claim 15, further comprising a video server for providing video streaming data.

17. The system as claimed in claim 15, wherein the video server is incorporated with the graphics server.

18. The system as claimed in claim 15, wherein the video server is separated from the graphics server

19. The system as claimed in claim 14, further provided with control interface cooperating with the scene generator for allowing an operator to design the scene.

20. The system as claimed in claim 14, further comprising providing a database containing graphical characteristics associated with the different kinds of display devices.

21. The system as claimed in claim 20, further comprising providing a database containing personal graphical preferences associated with different persons using the display devices.

22. The system as claimed in claim 14, further comprising a client application for receiving the formatted scene file and rendering it locally to display the graphical content on the specific display device.

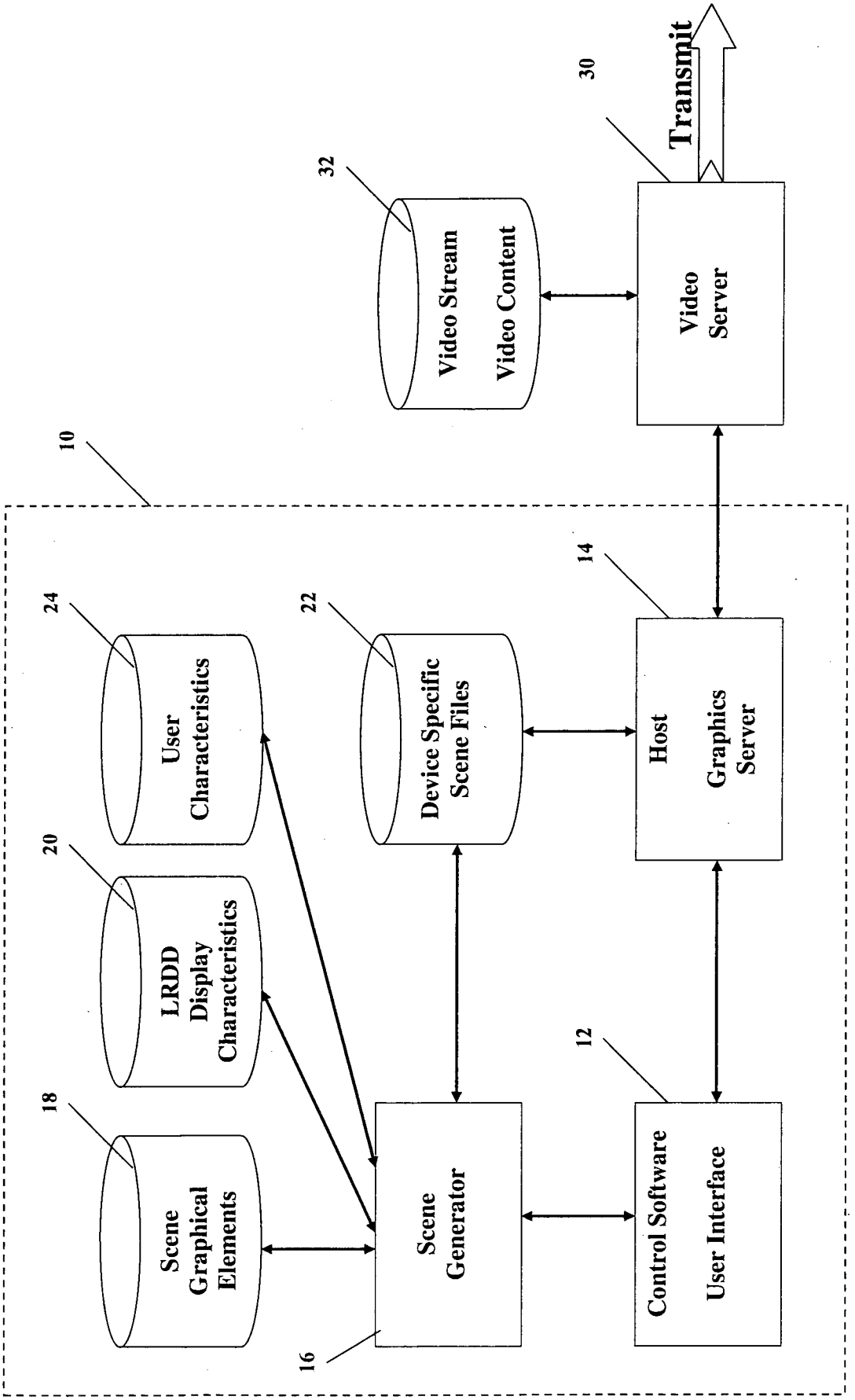

Transmit
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Control Software
User Interface

Fig. 1

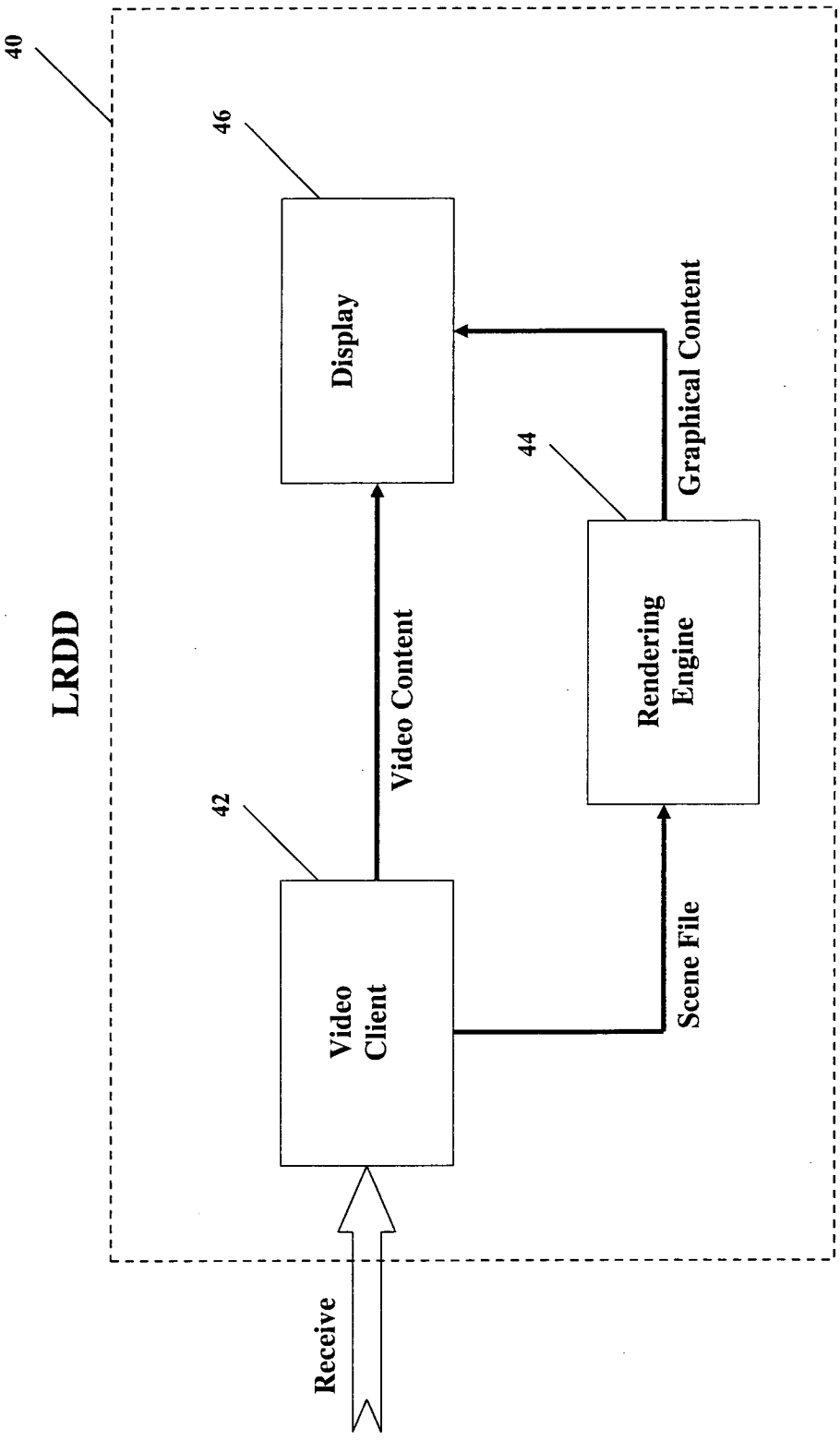

40
LRDD
46
Display
Graphical Content
44
Rendering Engine
Video Content
42
Video Client
Scene File
Receive

Fig. 2

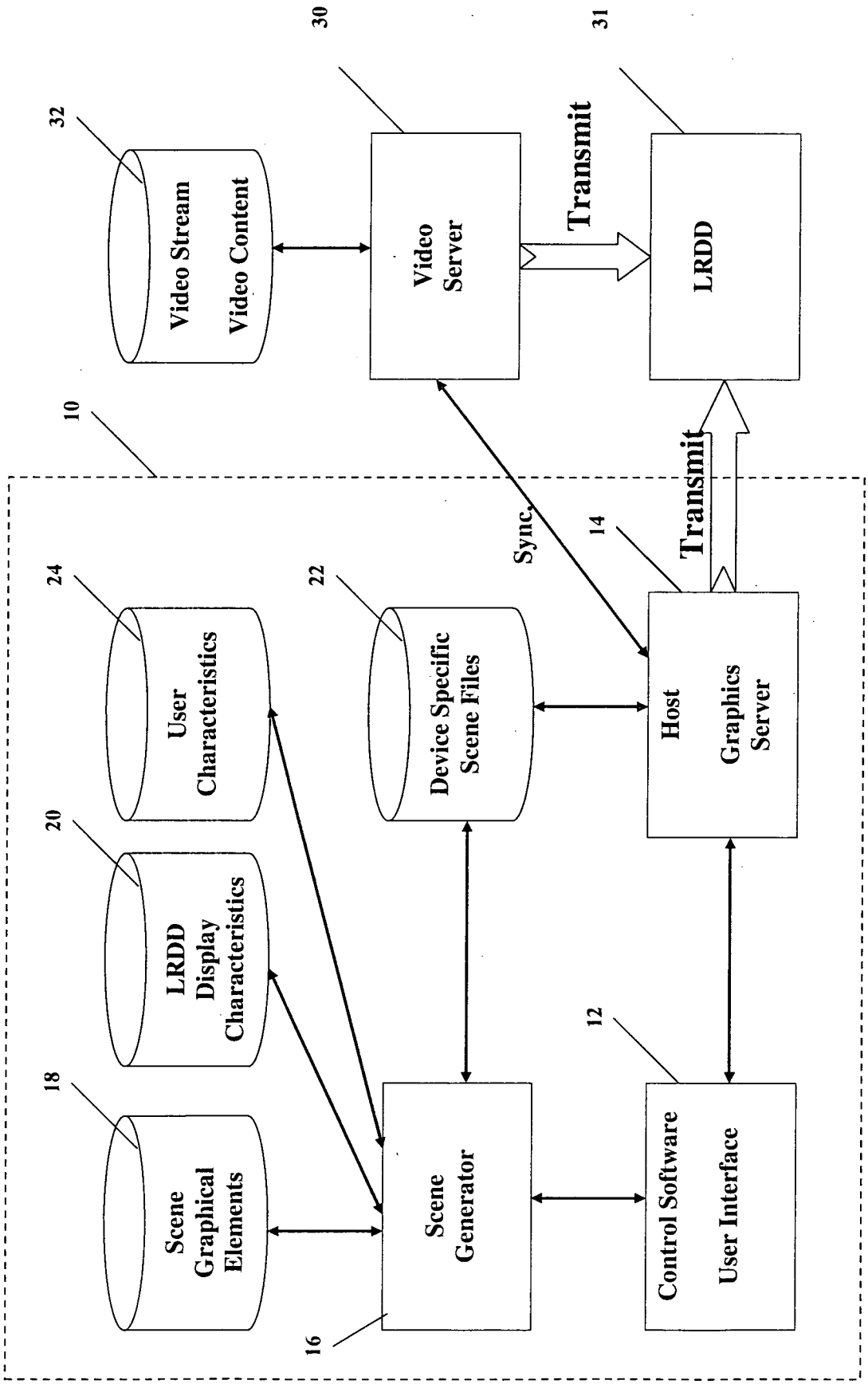

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32
Video Stream
Video Content
Video Server
Transmit
LRDD
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Sync.
Transmit
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24
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User Characteristics
Device Specific Scene Files
Host Graphics Server
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LRDD Display Characteristics
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12
Scene Graphical Elements
Scene Generator
Control Software
User Interface
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Fig. 3

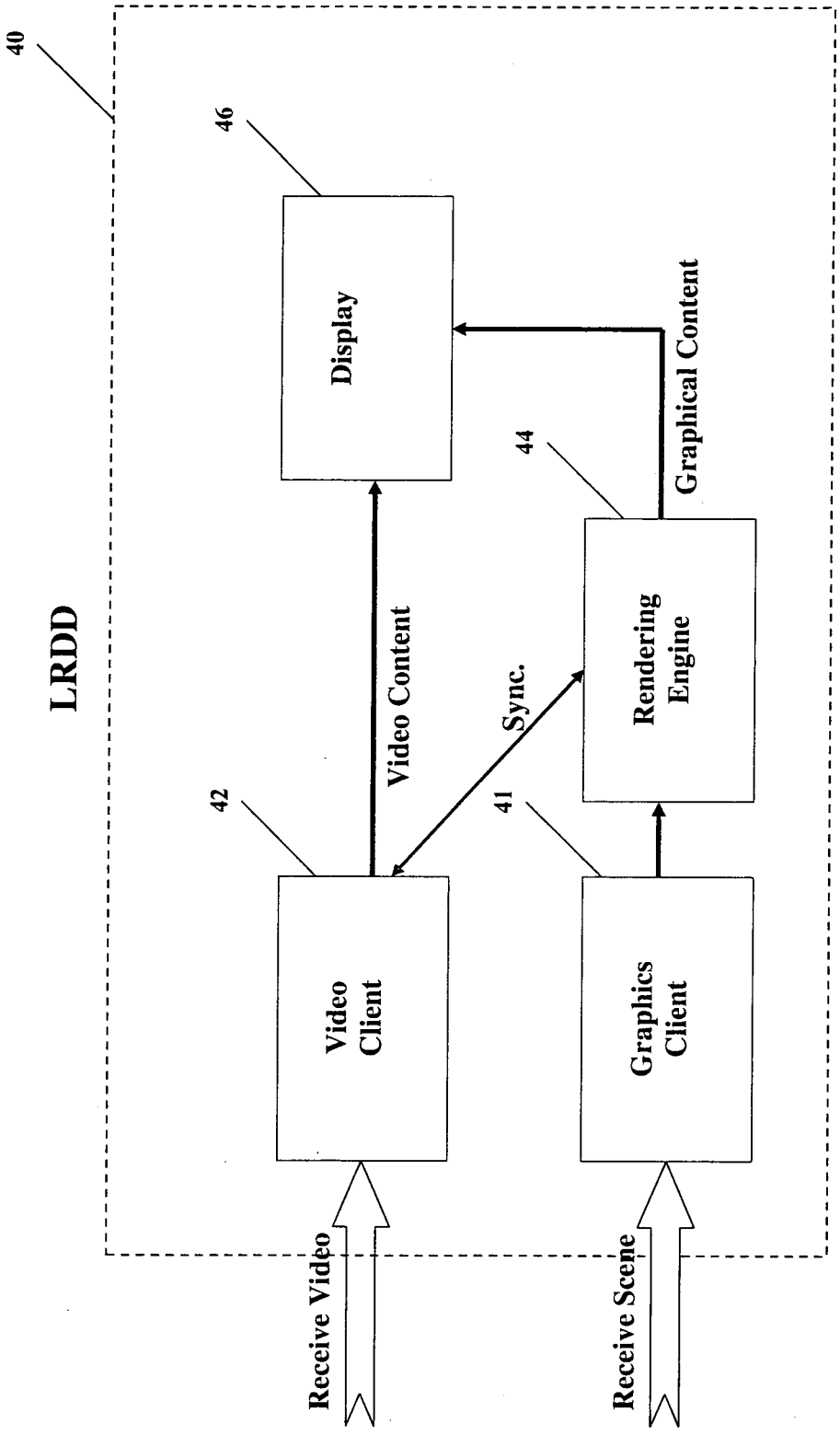

40
LRDD
46
Display
Graphical Content
44
Rendering Engine
Video Content
Sync.
42
41
Video Client
Graphics Client
Receive Video
Receive Scene

Fig. 4