

Description

This invention relates generally to displays, for example operator displays for control rooms, and more particularly to three-dimensional displays.

Process control room installations typically have several operator consoles each employing a large number of individual displays - such as cathode ray tube (CRT) displays - to reflect the status of various process parameters or to monitor the operation of a process control system. The control room operator must be very familiar with the operation of the overall control system so as to be able properly to interpret the various readings and graphics shown on the displays. Recently, it has been proposed to utilise techniques such as holographic methods to provide a three-dimensional CRT display so as to assist the operator in visualising and interpreting the graphics representing the process parameters being monitored. Typically, however, these displays are not readily updatable in real time, process variable information is not superimposable thereon, and the operator cannot easily interact with the display to modify the display. The availability of process control information superimposed on a three-dimensional display and the ability of the operator to interact with the display would be extremely helpful to the operator in grasping the status of the process being controlled and in initiating measures to correct or modify the operation of the process control system.

IEEE Spectrum, Vol. 6 No. 9, September 1969, pages 37 to 43, New York USA, E.G. Rawson: "Vibrating Varifocal Mirrors for 3-D Imaging" and Electronics International, Vol. 54 No. 15, July 1981, pages 150 to 155, New York USA, H.S. Stover: "Terminal puts three-dimensional graphics on solid ground" disclose three-dimensional imaging techniques including the use of a rapidly oscillating mirror creating a three-dimensional image from a two-dimensional CRT display under the control of a computer.

According to the invention there is provided apparatus for producing a three-dimensional display in free space, the apparatus comprising:

a projection television receiver for displaying a high intensity, high frame rate two-dimensional image thereon which is updatable in real time;

means for providing real time data indicative of the status of a system being controlled;

a computer connected to the projection television receiver and to the means for providing real time data for processing graphics image data and the real time data, and for transmitting the processed data to the projection television receiver;

a spinning lens device arranged to transform the two-dimensional image from the projection television receiver into a three-dimensional display and

to project the display into free space;

a lens control device connected to the computer and to the spinning lens device for regulating the rotation of the spinning lens device so as to be in synchronism with the data being transmitted by the computer to the projection television receiver; and

means for determining the position of a specific location in the three-dimensional display and allowing an operator to interact with the display.

A preferred embodiment of the invention described hereinbelow provides a three-dimensional display, for example for control rooms, which is updatable in real time. Information, for example process control information, can be superimposed on the display, and the operator can easily interact with the display.

The above-mentioned preferred embodiment of the present invention is described in detail below with reference to the accompanying drawing. Firstly, however, the preferred apparatus or system will be described in outline. The apparatus provides a three-dimensional display which is readily updatable in real time. The display is generated in free space in front of a control room operator by means of a spinning lens device which intercepts a two-dimensional image on a projection television receiver and transforms the image into a three-dimensional display. The image shown on the projection television receiver is controlled by a computer and may include image data for the graphics to be generated by the computer, video images of particular physical areas associated with a process being monitored, and data relating to process control variables. In this manner, process control variable information can be superimposed on the display in real time. The operator can interact with the display by means of a keyboard, a voice recognition device, or a light pen which can be located at a desired point within the display and actuated in conjunction with the voice recognition device. Thus, the operator can easily interact with the display, permitting the operator to quickly grasp the status of the process being monitored and initiate any action which might be required to correct the status. Although the preferred apparatus is intended for use as a process control room display, the apparatus can readily be adapted for use in other applications.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawing, the sole figure of which is a schematic representation of a preferred form of apparatus embodying the invention for producing a three-dimensional display in free space.

The sole figure of the drawing is a schematic diagram of a control apparatus or system 10 that

produces three-dimensional displays which, for example, can be used instead of the two-dimensional displays typically used in a control room of a process control installation.

In the illustrated control system 10, a computer 12 is utilised to generate graphics which are transmitted to a projection television receiver 14 which is connected thereto and which produces an image having a high frame rate and high intensity. Input devices connected to the computer 12 include, but are not limited to, an optical disc system 16, a video camera system 18 and a process control system 20. Image data for the graphics to be generated by the computer 12 is stored in the optical disc system 16. Typically, the image data stored in the optical disc system 16 has already been calculated or previously determined and is retrieved from the disc system 16 by the computer 12 for modification purposes and/or transmission to the television receiver 14. The video camera system 18 may be used to obtain image information about particular parameters such as the physical layout of the plant or facility which the control system 10 is monitoring. Such image information might include the height of piles of raw material within the plant, the depth of beds in recovery boilers, etc., if a power generation plant is involved. The foregoing image information is transmitted to the computer 12 which, in turn, may modify the information prior to transmission to the television receiver 14. It should be noted that an output of a video camera or cameras of the video camera system 18 can be digitised and used as part of the display on the television receiver 14. In addition, wide angle camera coverage can be generated from dual (stereopticon type) video camera systems for transmission to the computer 12 for display purposes. The process control system 20 generates information as to process variables and the status of the system being controlled, and this information or data is transmitted to the computer 12 so that it can be shown on the projection television receiver in real time. In this manner, process variable information can be superimposed on the television receiver image in real time, and such process variable information can be shown as a digital display or by colour-coded overlays. It should be noted that even though the optical disc system 16, the video camera system 18 and the process control system 20 have been discussed as being input devices to the computer 12, each of these systems can also be controlled by the computer 12, i.e., the graphics image data, after modification by the computer 12, can be transmitted to the optical disc system 16 for storage purposes; the operation of the video camera system 18 can be controlled by the computer 12; and the process control variables can be changed by the computer

12.

In addition to the forgoing input devices, a keyboard 22 and a voice recognition system comprising a microphone 24 and a voice recognition device 26 are connected as inputs to the computer 12. In this manner, data can be entered into the control system 10 by the operator via the keyboard 22 and/or the voice recognition system. The use of the voice recognition system frees the operator for other work and allows several displays to be selected from one central location without the operator having to move to individual consoles.

As previously stated, the computer 12 is utilised to generate graphics which are transmitted to the projection television receiver 14. A spinning lens device 28 is positioned in front of the television receiver 14 and transforms the two-dimensional image shown thereon into a three-dimensional image and projects the image into free space in front of the spinning lens device 28. A lens control device 30 interconnects the computer 12 to the spinning lens device 28 and regulates the rotation of the spinning lens device 28 so as to be in synchronism with the image information being transmitted by the computer 12 to the projection television receiver 14. A three-dimensional viewing input device 32, which includes a light pen 34, is used to "interconnect" the resulting three-dimensional display to the computer 12. By positioning the tip of the light pen 34 at a particular desired point in the three-dimensional display and by giving a voice command for interception by the microphone 24 or by pressing a button on the pen 34, a beam of light is produced at the tip of the pen 34. The three-dimensional viewing input device 32 locates the light pen 34 by "sighting" on the emitted beam of light and transmits its location to the computer 12 which, in turn, compares this point with the calculated image for same and takes the requested action with respect to the point in question.

Operationally, the display generated in free space in front of the spinning lens device 28 may be selected for different areas of the facility or portions of the process control system being monitored and/or regulated. The image generated by the computer 12 and transmitted to the projection television receiver 14 results in a high intensity, high frame rate two-dimensional image being shown thereon. This two-dimensional image is, in turn, transformed into a three-dimensional, fully updatable display in free space by the spinning lens device 28. The operator can interact with this display through the keyboard 22, the voice recognition device 26 via the microphone 24, or the light pen 34. In this manner, the operator can change or modify the three-dimensional display, for example by rotating it, decreasing or enlarging its size to

show detail, etc. In addition, process variable information can be superimposed on the display at the location of the actual process variable measurement being monitored in real time. Such superimposed process variable information can be a digital display or may be in the form of a colour-coded overlay, such as for the level of a tank, etc. Alternatively, temperature may be displayed in different colours representing different temperature ranges. In this manner, the operator can quickly and easily obtain an overview of the overall system being controlled and take any action which might be required.

Claims

1. Apparatus for producing a three-dimensional display in free space, the apparatus (10) comprising:
 - a projection television receiver (14) for displaying a high intensity, high frame rate two-dimensional image thereon which is updatable in real time;
 - means (20) for providing real time data indicative of the status of a system being controlled;
 - a computer (12) connected to the projection television receiver (14) and to the means for providing real time data for processing graphics image data and the real time data, and for transmitting the processed data to the projection television receiver (14);
 - a spinning lens device (28) arranged to transform the two-dimensional image from the projection television receiver (14) into a three-dimensional display and to project the display into free space;
 - a lens control device (30) connected to the computer (12) and to the spinning lens device (28) for regulating the rotation of the spinning lens device (28) so as to be in synchronism with the data being transmitted by the computer (12) to the projection television receiver (14); and
 - means (32,34) for determining the position of a specific location in the three-dimensional display and allowing an operator to interact with the display.
2. Apparatus according to claim 1, wherein the position determining means (32,34) is operable to compare the value of a parameter shown at the specific location with a desired value of the parameter at the location.
3. Apparatus according to claim 1 or claim 2, wherein the position determining means (32,34) comprises a three-dimensional viewing

input device (32) connected to a light pen (34) and to the computer (12) for viewing the three-dimensional display and allowing an operator to interact with the display.

4. Apparatus according to claim 3, wherein the position determining means (32,34) is operable to determine the position of a specific location of a beam of light in the display produced by the light pen (34) and to compare the location of the beam of light with the display.
5. Apparatus according to any one of the preceding claims, wherein the means (20) for providing real time data and the computer (12) are adapted for superimposing information on the three-dimensional display.
6. Apparatus according to any one of the preceding claims, including means (22,26,34) for modifying the three-dimensional display.
7. Apparatus according to claim 6, wherein actuation of the modifying means (22,26,34) permits varying the size of the three-dimensional display.
8. Apparatus according to claim 6 or claim 7, wherein actuation of the modifying means (22,26,34) permits varying the orientation of the three-dimensional display.
9. Apparatus according to any one of the preceding claims, including an optical disc system (16) connected to the computer (12) for storing graphics image data which can be retrieved by the computer (12).
10. Apparatus according to any one of the preceding claims, including a video camera system (18) connected to the computer (12) for obtaining image information about particular parameters of the system being controlled.
11. Apparatus according to any one of the preceding claims, including a keyboard (22) for entering data into the computer (12).
12. Apparatus according to any one of the preceding claims, including a microphone (24) connected to a voice recognition device (26) for entering data into the computer (12).

Patentansprüche

1. Vorrichtung zum Erzeugen einer dreidimensionalen Anzeige im Raum, wobei die Vorrichtung (10) aufweist:



show detail, etc. In addition, process variable information can be superimposed on the display at the location of the actual process variable measurement being monitored in real time. Such superimposed process variable information can be a digital display or may be in the form of a colour-coded overlay, such as for the level of a tank, etc. Alternatively, temperature may be displayed in different colours representing different temperature ranges. In this manner, the operator can quickly and easily obtain an overview of the overall system being controlled and take any action which might be required.

Claims

1. Apparatus for producing a three-dimensional display in free space, the apparatus (10) comprising:
 - a projection television receiver (14) for displaying a high intensity, high frame rate two-dimensional image thereon which is updatable in real time;
 - means (20) for providing real time data indicative of the status of a system being controlled;
 - a computer (12) connected to the projection television receiver (14) and to the means for providing real time data for processing graphics image data and the real time data, and for transmitting the processed data to the projection television receiver (14);
 - a spinning lens device (28) arranged to transform the two-dimensional image from the projection television receiver (14) into a three-dimensional display and to project the display into free space;
 - a lens control device (30) connected to the computer (12) and to the spinning lens device (28) for regulating the rotation of the spinning lens device (28) so as to be in synchronism with the data being transmitted by the computer (12) to the projection television receiver (14); and
 - means (32,34) for determining the position of a specific location in the three-dimensional display and allowing an operator to interact with the display.
2. Apparatus according to claim 1, wherein the position determining means (32,34) is operable to compare the value of a parameter shown at the specific location with a desired value of the parameter at the location.
3. Apparatus according to claim 1 or claim 2, wherein the position determining means (32,34) comprises a three-dimensional viewing

input device (32) connected to a light pen (34) and to the computer (12) for viewing the three-dimensional display and allowing an operator to interact with the display.

4. Apparatus according to claim 3, wherein the position determining means (32,34) is operable to determine the position of a specific location of a beam of light in the display produced by the light pen (34) and to compare the location of the beam of light with the display.
5. Apparatus according to any one of the preceding claims, wherein the means (20) for providing real time data and the computer (12) are adapted for superimposing information on the three-dimensional display.
6. Apparatus according to any one of the preceding claims, including means (22,26,34) for modifying the three-dimensional display.
7. Apparatus according to claim 6, wherein actuation of the modifying means (22,26,34) permits varying the size of the three-dimensional display.
8. Apparatus according to claim 6 or claim 7, wherein actuation of the modifying means (22,26,34) permits varying the orientation of the three-dimensional display.
9. Apparatus according to any one of the preceding claims, including an optical disc system (16) connected to the computer (12) for storing graphics image data which can be retrieved by the computer (12).
10. Apparatus according to any one of the preceding claims, including a video camera system (18) connected to the computer (12) for obtaining image information about particular parameters of the system being controlled.
11. Apparatus according to any one of the preceding claims, including a keyboard (22) for entering data into the computer (12).
12. Apparatus according to any one of the preceding claims, including a microphone (24) connected to a voice recognition device (26) for entering data into the computer (12).

Patentansprüche

1. Vorrichtung zum Erzeugen einer dreidimensionalen Anzeige im Raum, wobei die Vorrichtung (10) aufweist:



einen Fernsehprojektionsempfänger (14) für die Anzeige eines zweidimensionalen Bildes mit hoher Intensität und hoher Bildfrequenz, welches in Echtzeit darstellbar (erneuerbar) ist,

eine Einrichtung (20) zum Bereitstellen von Echtzeitdaten, die den Zustand eines kontrollierten Systems anzeigen,

einen Computer (12), der mit dem Fernsehprojektionsempfänger (14) und der Einrichtung für die Bereitstellung von Echtzeitdaten verbunden ist, um grafische Bilddaten und die Echtzeitdaten zu verarbeiten und um die verarbeiteten Daten an den Fernsehprojektionsempfänger (14) zu übermitteln,

eine rotierende Linseneinrichtung (18), die so angeordnet ist, daß sie das zweidimensionale Bild von dem Fernsehprojektionsempfänger (14) in eine dreidimensionale Anzeige umformt und die Anzeige in den freien Raum projiziert,

eine Linsensteuereinrichtung (30), die mit dem Computer (12) und der rotierenden Linseneinrichtung (28) verbunden ist, um die Drehung der rotierenden Linseneinrichtung (28) so zu regeln, daß sie synchron zu den durch den Computer (12) an den Fernsehprojektionsempfänger (14) übermittelten Daten ist, und

eine Einrichtung (32, 34), um die Position eines bestimmten Ortes in der dreidimensionalen Anzeige zu bestimmen und um dem Betriebspersonal zu ermöglichen, mit der Anzeige in Dialog zu treten.

2. Vorrichtung nach Anspruch 1, wobei die Einrichtung (32, 34) zum Bestimmen der Position so betreibbar ist, daß sie den Wert eines an der bestimmten Stelle dargestellten Parameters mit einem gewünschten Wert des Parameters an dieser Stelle vergleicht.
3. Vorrichtung nach Anspruch 1 oder 2, wobei die Positionsbestimmungseinrichtung (32, 34) eine dreidimensionale Betrachtungseingabeeinrichtung (32) aufweist, die mit einem Lichtstift (34) und dem Computer (12) verbunden ist, um die dreidimensionale Anzeige zu betrachten (optisch zu erfassen) und um dem Betriebspersonal zu ermöglichen, mit der Anzeigeeinrichtung in Dialog zu treten.
4. Vorrichtung nach Anspruch 3, wobei die Positionsbestimmungseinrichtung (32, 34) so betreibbar ist, daß sie die Position einer bestimmten Stelle eines Lichtstrahles in der Anzeige bestimmt, der durch den Lichtstift (34) erzeugt wird und den Orts- bzw. Ausgangspunkt des Lichtstrahles mit der Anzeige vergleicht.

5. Vorrichtung nach einem der vorstehenden Ansprüche, wobei die Einrichtung (20) für die Bereitstellung von Echtzeitdaten und der Computer (12) so ausgelegt sind, daß sie Informationen in der dreidimensionalen Anzeige überlagern.

6. Vorrichtung nach einem der vorstehenden Ansprüche, einschließlich einer Einrichtung (22, 26, 34) zum Verändern bzw. Modifizieren der dreidimensionalen Anzeige.

7. Vorrichtung nach Anspruch 6, wobei die Betätigung der Modifizierungseinrichtung (22, 26, 34) das Verändern der Größe bzw. des Maßstabs der dreidimensionalen Anzeige ermöglicht.

8. Vorrichtung nach Anspruch 6 oder 7, wobei die Betätigung der Modifizierungseinrichtung (22, 26, 34) die Veränderung der Orientierung der dreidimensionalen Anzeige erlaubt.

9. Vorrichtung nach einem der vorstehenden Ansprüche, einschließlich eines Bildplattensystems (16), welches mit dem Computer (12) verbunden ist für die Speicherung von grafischen Bilddaten, auf welche der Computer (12) wieder zugreifen kann.

10. Vorrichtung nach einem der vorstehenden Ansprüche, einschließlich eines Videokamerasystems (18), welches mit dem Computer (12) verbunden ist, um Bildinformationen über bestimmte Parameter des überwachten bzw. gesteuerten Systems zu erhalten.

11. Vorrichtung nach einem der vorstehenden Ansprüche, einschließlich einer Tastatur (22) für die Eingabe von Daten in den Computer (12).

12. Vorrichtung nach einem der vorstehenden Ansprüche, einschließlich eines Mikrofons (24), welches mit einer Stimmerkennungseinrichtung (26) für die Eingabe von Daten in den Computer (12) verbunden ist.

Revendications

1. Appareil de production d'un affichage tridimensionnel en espace libre, l'appareil (10) comprenant :

un récepteur de télévision projetée (14) pour y afficher une image bidimensionnelle à haute intensité, à vitesse de trame élevée, qui est susceptible d'être mise à jour en temps réel ;

un moyen (20) de production, en temps réel, de données indicatives de l'état d'un sys-

tème qui doit être commandé ;

un ordinateur (12) connecté au récepteur de télévision projetée (14) et au moyen de production en temps réel de données pour le traitement de données d'images graphiques et des données en temps réel, et pour transmettre les données traitées au récepteur de télévision projetée (14) ;

un dispositif à lentille tournante (28) disposé de manière à transformer l'image bidimensionnelle, issue du récepteur de télévision projetée (14) en un affichage tridimensionnel, et à projeter l'affichage en espace libre ;

un dispositif de commande de lentille (30) raccordé à l'ordinateur et au dispositif à lentille tournante (28) pour réguler la rotation du dispositif à lentille tournante (28) de manière à être en synchronisme avec la donnée qui est transmise par l'ordinateur (12) au récepteur de télévision projetée (14) ; et,

un moyen (32, 34) de détermination de la position d'une localisation spécifique dans l'affichage tridimensionnel et permettant à un opérateur d'interagir avec l'affichage.

2. Appareil selon la revendication 1, dans lequel le moyen de détermination de position (32, 34) peut être mis en oeuvre pour comparer la valeur d'un paramètre montrée dans la localisation spécifique avec une valeur souhaitée du paramètre dans cette localisation.

3. Appareil selon la revendication 1 ou la revendication 2, dans lequel le moyen de détermination de position (32, 34) comprend un dispositif d'entrée de visualisation tridimensionnelle (32) connecté à un crayon lumineux (34) et à l'ordinateur (12) pour visualiser l'affichage tridimensionnel et permettre à un opérateur d'interagir avec l'affichage.

4. Appareil selon la revendication 3, dans lequel le moyen de détermination de position (32, 34) peut être mis en oeuvre pour déterminer la position de la localisation spécifique d'un rayon lumineux dans l'affichage produit par le crayon lumineux (34) et pour comparer la localisation du rayon lumineux avec l'affichage.

5. Appareil selon l'une quelconque des revendications précédentes, dans lequel les moyens (20) pour fournir les données en temps réel et l'ordinateur (12) sont conçus pour surimposer de l'information sur l'affichage tridimensionnel.

6. Appareil selon l'une quelconque des revendications précédentes, comprenant un moyen (22, 26, 34) pour modifier l'affichage tridimen-

sionnel.

7. Appareil selon la revendication 6, dans lequel la mise en oeuvre du moyen de modification (22, 26, 34) permet la modification de taille de l'affichage tridimensionnel.

8. Appareil selon la revendication 6 ou la revendication 7, dans lequel la mise en oeuvre du moyen de modification (22, 26, 34) permet la modification de l'orientation de l'affichage tridimensionnel.

9. Appareil selon l'une quelconque des revendications précédentes, comprenant un système de disque optique (16) connecté à l'ordinateur (12) pour mémoriser des données d'images graphiques qui peuvent être retrouvées par l'ordinateur (12).

10. Appareil selon l'une quelconque des revendications précédentes, comprenant un système de caméra vidéo (18) connecté à l'ordinateur (12) pour obtenir une information d'image concernant des paramètres particuliers du système en cours de commande.

11. Appareil selon l'une quelconque des revendications précédentes, comprenant un clavier (22) pour entrer des données dans l'ordinateur (12).

12. Appareil selon l'une quelconque des revendications précédentes, comprenant un microphone (24) connecté à un dispositif de reconnaissance de la parole (26) pour entrer des données dans l'ordinateur (12).



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