(72) Inventors: VERDIER, Alain; Technicolor R&D France, 975, avenue des Champs Blancs, ZAC des Champs Blancs, CS 176 16, F-35 576 Cesson Sévigné (FR). ORHAND, Anita; Technicolor R&D France, 975, avenue des Champs Blancs, ZAC des Champs Blancs, CS 176 16, F-35 576 Cesson Sévigné (FR). DRAZIC, Valter; Technicolor R&D

(54) Title: METHOD AND DEVICE FOR INSERTING A 3D GRAPHICS ANIMATION IN A 3D STEREO CONTENT
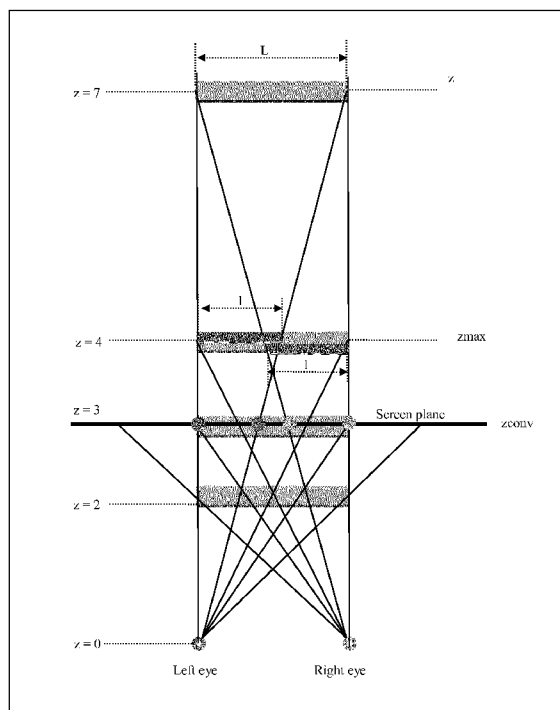
(57) Abstract: The invention concerns a method and a device for inserting 3D graphic animation in a 3D image, each 3D graphic element of the graphic animation being defined in size and in depth for the insertion in a determined insertion zone of said 3D image. The method comprises the step of determining for the graphic element to be inserted a depth range with a maximum allowed depth value;, replacing the out of range depth values by the maximum allowed depth value when depth values of the graphic element are out of range and compensating the depth difference between the depth values of the graphic element and the maximal allowed depth value in reducing the graphic element in size proportionally to the reduction of depth for the graphic element.

Figure 2

WO 2013/120742 A1

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Method and device for inserting a 3D graphics animation in a 3D stereo content

The present invention relates to a method and device for inserting a 3D graphics animation in a 3D stereo content. The invention applies mainly to post-production environment as it concerns graphic insertion but also to consumer products including STB, BD-player, TV sets, Smart phones, Tablets with 3D capabilities. The invention can be used every time a 3D Graphics content is generated to be displayed on a 3D display.

The invention aims at resolving the problem of depth perception conflicts when overlaying animated graphics on top of 3D video layer. Indeed, if the occlusion clues do not match the depth cues, it creates a visual discomfort, cause of headache or nausea. When the 3D graphics is animated in the depth direction it is even more likely that a conflict would occur.

There are a great number of patents and articles describing how to avoid overlap when mixing two stereo contents: most of the time, one is video (real image, primary), the other is graphics (virtual image, secondary). Usually, it is proposed to shift one of the two contents so there is no more overlap. Sometimes it is suggested to compress the depth range because it is not always possible to keep the two incoming contents within the comfort range (convergence/accommodation issue). WO2008038205A2(Philips) and US20110199459NV describe such method.

The invention aims to improve the use case where there is an animation that makes a graphic element to appear or disappear. With 2D display it is quite simple, because in 2D display a visual perception conflict can never occur, a 2.5D animation (3D animated but projected onto a single 2D window) gives good results: the graphics disappear because of the depth that goes to infinite during the 3D animation. On 3D display, it is likely that the element will conflict with other objects of the real scene, at least with the background (probably not at infinite) but also likely from time to time with other objects of the real scene that might be at screen level or even popping out of the screen.

It is an object of the invention to address the above mentioned problems of overlapping of graphic animation with objects of the 3D scene.

The invention consists in a method of inserting graphic animation in a 3D image, each 3D graphic element of the graphic animation being defined in size and in depth for the insertion in a determined insertion zone of said 3D image.
The method comprises a step of determining for the graphic element to be inserted a maximal allowed depth value corresponding to the minimum depth value of the image in the determined insertion zone so that the graphic element is not overlapped by the corresponding part of the 3D image in said predetermined insertion zone further, the method comprises a step of ,when a depth value of the graphic element to be inserted is superior to the maximal allowed depth value, keeping the depth value of the graphic element by the maximal allowed depth value and compensating the depth difference between the depth value of the graphic element to be inserted which is superior to the maximal allowed depth value and the maximal allowed depth value in reducing the graphic element in size proportionally to the reduction of depth for the graphic element.

The use of the invention will show-up a change in the graphics size in the 2D space while the disparity is kept constant.

In a preferred embodiment, the method comprises furthermore the step of determining a bounding box arounding the graphic element so that the size and the depth value of the bounding box replace the size and depth value of the graphic element.
In a preferred embodiment a bounding box arounding different graphic elements moving together is defined.

In a preferred embodiment the maximum allowed depth value is determined so that the overlapping of graphic element by objects of the 3D image is avoided.

In a preferred embodiment the maximum allowed depth value is selected by a spectator.

In a preferred embodiment the method of inserting graphic animation in a 3D image is applied to post production environment.

In a preferred embodiment the method of inserting graphic animation in a 3D image applies to consumer products.

In a preferred embodiment the maximum allowed depth for at least a graphic element to be inserted is determined so that overlapping of the 3D image is avoided.

The invention concerns, too, a device for inserting graphic animation in a 3D image, each graphic element of the graphic animation being defined in size and in depth for the insertion in a determined insertion zone of said 3D image.

The device comprises means for determining for the graphic element to be inserted a maximal allowed depth value corresponding to the minimum depth value of the image in the determined insertion zone so that the graphic element is not overlapped by the corresponding part of the 3D image in said predetermined insertion zone; means for keeping the depth value of the graphic element by the maximal allowed depth value when a depth value of the graphic element to be inserted is superior to the maximal allowed depth value, and means for compensating the depth difference between the depth value of the graphic element to be inserted which is superior to the maximal allowed depth value and the maximal allowed depth value in reducing the graphic element in size proportionally to the reduction of depth for the graphic element.

The invention has the advantage that there are no more visual perception conflicts on appearing or disappearing graphics. By the way it preserves the original stereo video content as no shift is done to prevent overlapping of the video content.

The features and advantages of the invention will be further explained upon reference to following drawings in which

Figure 1 illustrates an implementation of the invention;
and Figure 2 illustrates plane and associated depth to explain the invention.

The invention proposes a method that changes the geometrical transformation issued from the initial animation scenario into a different one keeping the graphics element within a safe depth range assuring no overlap with real scene depth budget while giving the impression to have the graphic element going from/to the infinite (size = 0). This is achieved by updating the scale parameters together with the translation parameters. Scale parameters are defined as the maximal length and maximal width of the graphic element. Translation parameter is the depth value. The graphic element is thus defined in size with the scale parameters.

The 3D graphics are usually modeled by a 3D modeling tool. Different modeling tools such as Blender, Cinema4D, Maya and AutoDesk are well known.

These authoring tools can export a model of the virtual scene in format as per example, xml, x3d, vrml, dae, dxf, fbx or obj.

The model is basically described as a tree containing a number of elements, each of them is defined as a basic shape associated to a color or texture and a transformation function such as translation, rotation or scaling.

Implementation of the invention, as represented by figure 1, takes as inputs:
- a model file which contains the specification of the 3D graphics.
- an animation file: contains the specification of the animation, basically the transform between entry point and ending point such as translation, rotation or scaling , the number of frames and the speed of the animation.
- the incoming stereo video .

It outputs the composited video formed by the combination of the 3D graphics and the incoming stereo video.

It contains the following modules:

- a x3d file parser module : this module reads the file and build the graphics object element by element, using OpenGL functions (vertex building and transform operations).

- A disparity estimator module : this module computes a sparse disparity map and issue the minimum value over a programmable area. This area can be the full screen but more likely the part of the screen where the graphics is supposed to be inserted.

- An animation builder module: this module check whether the animated graphics depth will overlap with the real video or not. If not, the parameters included in the animation file are used as is, otherwise the parameters are changed.

- A graphics renderer module: this is the module responsible for the rendering. It takes the animation script from the animation builder and executes OpenGL operations accordingly.

- A composition module permits to combine the corrected graphic element to the 3D stereo video image

As the estimator runs on the incoming left and right 2D images, it does not provide directly the depth value but rather a value of disparity between left and right pictures. The relation that links the disparity value to the depth value is well known for a person skilled in the art.

If we know the setting of virtual graphics in term of focal length, baseline and depth of convergence plane we can get the resulting disparity for every graphic element. If we know the farer depth z (obtained after vertex building and transformation) then we can get the equivalent disparity and compare with the one provided by the disparity estimator.

6

The correction method is the method used by the Animation Builder to change the initial animation script so as to prevent for visual perception conflicts. For every frame the Animation Builder shall check over the resulting disparity for the graphics.

In case the depth (disparity) is bigger than the one from the depth (disparity) estimator, then a correction is needed.

As illustrated with figure 2, instead of pushing backward the graphic element, it is rather reduced in size determined by the length and the width of the graphic element and kept at the maximum allowed depth corresponding to zmax (z=4) on the figure. The depth range is thus limited by the maximum depth value zmax.

The following diagram shows how to get the illusion of an object going far away by reducing the size of the object. The relation between size on the screen zconv (z=3) and actual size and depth z (z=7) is the following :

$$l/L=Zmax/Z$$

With:

- L: initial object length size
- l: corrected length size
- Zmax: maximum allowed depth

The width of the object will be adapted on the same way.

The two rectangles at zmax (z=4) represent a smaller object that would have been perceived with the same size on the 2D screen from respectively the left (circle at z=0) and right eye (circle at z=0) compared to the original object located at a depth of z (z=7) Obviously only one object shall be rendered, centered with respect to the object located at zmax but with a scale factor of zmax/z.

In an embodiment of the invention, for example, at post-production level, graphic inserts can add a logo or indicate a score/player name in case of sports or also name/title for a singer.

At consumer device level, this can be the user interface that requires graphic insertion, either to browse a menu, or to get additional data linked to the content (EPG) or to the user preference as for example: widget for social network, weather forecast, stock market.

In an embodiment of the invention, a script relative to the graphic insertion and its own depth can determine the depth of this insertion depending of various functions or various scenarios. In an embodiment of the invention, the graphic should disappear in the horizon.

In another embodiment, the depth of a graphic can evolve in function of the time. It means that the depth is a linear (or not) and function of the time.

The method consists to render an animated 3D graphics element by changing the element size instead of the depth value, if the depth value is over the maximum allowed depth. Thus a compensation of the depth difference between the depth of the graphic element and the maximal allowed depth value is done in reducing the graphic element in size proportionally to the reduction of depth for the graphic element.

The determination of a bounding box arounding the graphic element will permit to consider the depth value, the length value and the width value of the bounding box at the place of the graphic element. There is a possibility for defining a bounding box for different graphic elements moving together inside of the bounding box and to consider the insertion of this bounding box at the place of the different graphic elements.

The depth, length and width values are respectively maxima value of the depth, length and width values of the graphic element or a volume surrounding the different graphic elements or a volume surrounding part of the graphic elements.

8

The depth, length and width values of the graphic element or of the bounding box are determined data imported with the data corresponding to the graphic element.

The maximal depth value of a 3D element corresponds to the depth value of the pixel representing the most distant point of the element. As the element being defined in size by its length, width and depth values, modification of the maximal depth value are calculated so that the proportion in size of the graphic element is respected.

Thus if a scenario indicates that a graphic element is moving in a 3D image, as soon as the maximal depth value reach the given limits, the size of this element will be modified in proportion to the depth value for the graphic element indicated by the scenario.

The depth value is fixed relative to the 3D depth of the screen displaying the 3D image to a spectator.

CLAIMS

1. Method of inserting graphic animation in a 3D image, each 3D graphic element of the graphic animation being defined in size and in depth for the insertion in a determined insertion zone of said 3D image;

   characterized in that the method comprises the steps of

   • Determining for the graphic element to be inserted a maximal allowed depth value corresponding to the minimum depth value of the image in the determined insertion zone so that the graphic element is not overlapped by the corresponding part of the 3D image in said predetermined insertion zone;

   • When a depth value of the graphic element to be inserted is superior to the maximal allowed depth value, keeping the depth value of the graphic element by the maximal allowed depth value;

   • and compensating the depth difference between the depth value of the graphic element to be inserted which is superior to the maximal allowed depth value and the maximal allowed depth value in reducing the graphic element in size proportionally to the reduction of depth for the graphic element.

2. The method of claim 1 characterized in that it comprises furthermore the step of determining a bounding box arounding the graphic element so that the size and the depth value of the bounding box replace the size and depth value of the graphic element.

3. The method of claim 2 characterized in that the size of the graphic element is determined by the maximal length and width values of the graphic element.

4. The method of claims 1to 3, characterized in that the insertion is applied to post production environment.

5. The method of claims 1to 5 characterized in that the insertion is applied to consumer products.

6. Device for inserting graphic animation in a 3D image, each 3D graphic element of the graphic animation being defined in size and in depth for the insertion in a determined insertion zone of said 3D image

characterized in that the method comprises :

- means for determining for the graphic element to be inserted a maximal allowed depth value corresponding to the minimum depth value of the image in the determined insertion zone so that the graphic element is not overlapped by the corresponding part of the 3D image in said predetermined insertion zone;
- means for keeping the depth value of the graphic element by the maximal allowed depth value when a depth value of the graphic element to be inserted is superior to the maximal allowed depth value,
- and means for compensating the depth difference between the depth value of the graphic element to be inserted which is superior to the maximal allowed depth value and the maximal allowed depth value in reducing the graphic element in size proportionally to the reduction of depth for the graphic element.
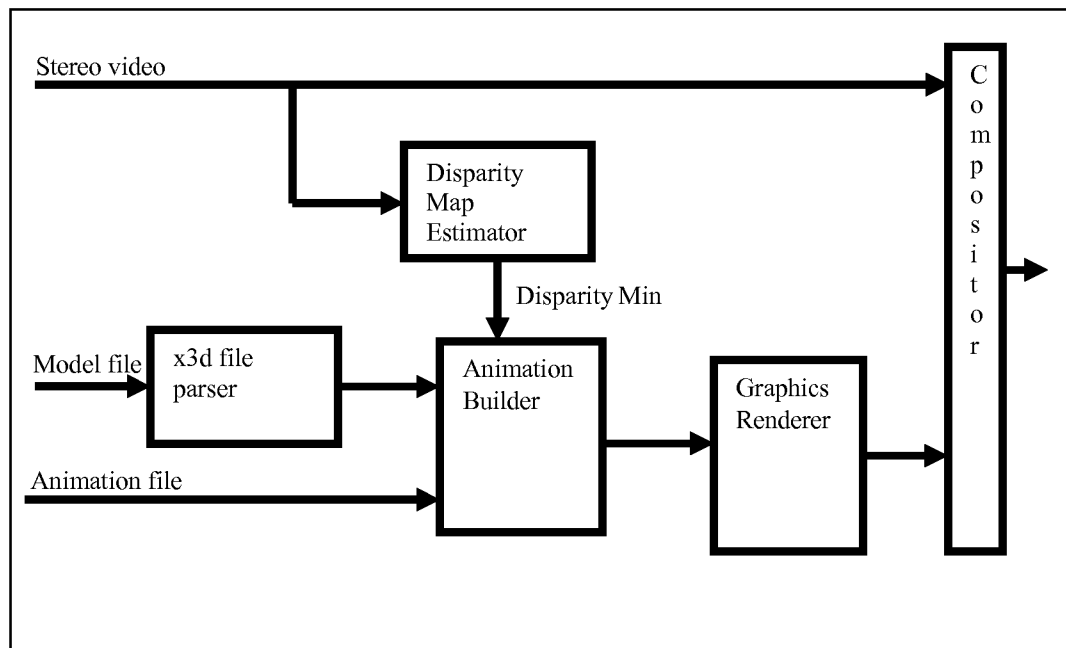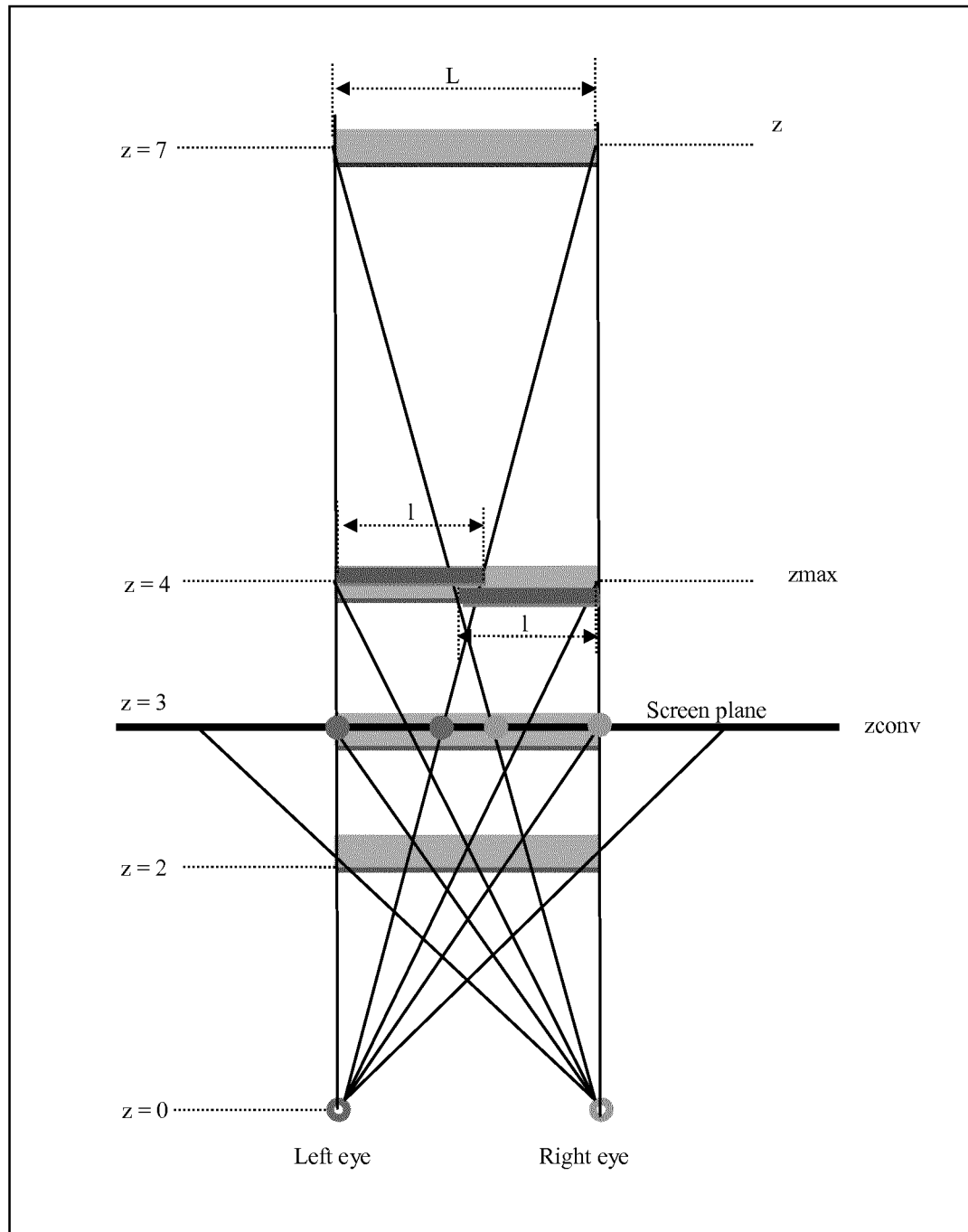
Figure 1

Figure 2

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N13/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2004/051577 A1 (VISION III IMAGING INC [US]; MARTIN MICHAEL B [US]) 17 June 2004 (2004-06-17) paragraphs [0002], [0005] - [0007], [0032]; figure 2B -----	1-3,6
Y	WO 2009/083863 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; SCALORI FRANCESCO [CH]; NEWTON PH) 9 July 2009 (2009-07-09) abstract figure 3 -----	1-3,6
Y	WO 2011/005544 A1 (DOLBY LAB LICENSING CORP [US]; WELSH RICHARD J [GB]; RALPH CHRISTIAN B) 13 January 2011 (2011-01-13) figure 5d -----	2,3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 2013	28/05/2013

| Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016 | Authorized officer Tillier, Christophe |

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Box No. II   Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III   Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

```
see additional sheet
```

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

```
2, 3(completely); 1, 6(partially)
```

Remark on Protest   ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)

FURTHER INFORMATION CONTINUED FROM   PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

    1. claims: 2, 3(completely); 1, 6(partially)

        Specify some details about the graphic elements and how to insert them

           ---

    2. claims: 4, 5(completely); 1, 6(partially)

        Specify when the method of inserting graphic elements can be used

           ---

INTERNATIONAL SEARCH REPORT

Information on patent family members

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 2004051577	A1	17-06-2004	AT	433590 T	15-06-2009
			AU	2003290739 A1	23-06-2004
			AU	2010202382 A1	01-07-2010
			CA	2507213 A1	17-06-2004
			EP	1570436 A1	07-09-2005
			JP	4766877 B2	07-09-2011
			JP	2006508467 A	09-03-2006
			KR	20050087803 A	31-08-2005
			US	2005270284 A1	08-12-2005
			US	2009174705 A1	09-07-2009
			WO	2004051577 A1	17-06-2004
WO 2009083863	A1	09-07-2009	TW	200935873 A	16-08-2009
			WO	2009083863 A1	09-07-2009
WO 2011005544	A1	13-01-2011	AR	077201 A1	10-08-2011
			AU	2010270951 A1	08-12-2011
			CA	2761974 A1	13-01-2011
			CN	102804787 A	28-11-2012
			EP	2446635 A1	02-05-2012
			JP	2012530998 A	06-12-2012
			KR	20120020131 A	07-03-2012
			TW	201119353 A	01-06-2011
			US	2012099836 A1	26-04-2012
			WO	2011005544 A1	13-01-2011