

**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:

1. claims: 1-11, 14, 16-21, 32, 35-42, 48, 50-55, 58, 67, 68

Algorithm using one or several virtual planes in order to calculate a phase hologram. The phase hologram is used for producing a security feature of a surface hologram.

1.1. claims: 3-5

Intensity and solid angle distribution of the light of the virtual light sources.

1.2. claims: 6-8

Virtual point light sources.

1.3. claims: 9-11

Periodic and/or random arrangement of the virtual light sources on a grid.

1.4. claims: 14, 16-21

Several virtual planes, several virtual models and several zones on the virtual planes, which can overlap.

1.5. claim: 32

Virtual reference light source.

1.6. claim: 35

Solid angle regions arranged about the surface normal.

1.7. claims: 36-39

Superimposition or rasterization of the elevation profiles for or in the substrate and minimum and maximum elevation values.

1.8. claims: 40-42

Usual methods for producing surface holograms.

1.9. claim: 48

Opaque substrate.

1.10. claim: 50

Volume hologram.

1.11. claims: 51-54

Combination of security elements.

1.12. claim: 67

Selection of special motives.

2. claims: 12, 13

Virtual light sources in the form of microsymbols.

3. claims: 15, 22-30, 59

Different alignment and/or curvature of the virtual hologram planes.

4. claims: 31, 56, 60-62

Tilting and/or rotation of the substrate of the real hologram leads to a sequence of several virtual models or motives for the observer in the form of a parallaxic or ortho-parallaxic movement effect.

5. claims: 33, 34

Special virtual reference fields which simulate a non-isotropic illumination of the virtual 2D or 3D model, and/or special angles with respect to the surface normal of the virtual hologram planes or special aperture angles.

6. claims: 43-47

Production of elevation profiles in a thin-film structure, such as a Fabry-Perot layer structure with semi-transparent absorber layers and/or an opaque reflection layer.

7. claim: 49

Arrangement of produced surface holograms on a window region of a product to be seen in transmitted light.

8. claim: 57

Three-dimensional barcode, the parts of which are visible in different observation directions.

9. claims: 63, 64

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

Combination of white light reconstructions with angle and color multiplexing.

10. claims: 65, 66

Generation of a true color image by superimposition of the reconstructions of virtual motives having different colors.

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 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.: **1-11, 14-30, 32-55, 58, 59, 63, 64, 67, 68**
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.:

- 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.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP2018/073904

**A. CLASSIFICATION OF SUBJECT MATTER**

**G03H 1/08**(2006.01)i; **G03H 1/02**(2006.01)i; **G03H 1/20**(2006.01)i; **G03H 1/10**(2006.01)i; **G03H 1/22**(2006.01)i;  
**G03H 1/24**(2006.01)i; **G03H 1/28**(2006.01)i; **G03H 1/26**(2006.01)i; **G03H 1/30**(2006.01)i; **G03H 1/00**(2006.01)i

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)

G03H

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.
X	EP 1484652 A1 (DAINIPPON PRINTING CO LTD [JP]) 08 December 2004 (2004-12-08)	1-11,14,16-21,32,35-42,48,50-55,58,67,68
Y	paragraphs [0001], [0002], [0045] - [0067], [0069] - [0073], [0097] - [0102]; figures 2-12, 23, 24	15,22-30,33,34, 43-47,49,59,63,64
A	ATHANASIA SYMEONIDOU ET AL. "Computer-generated holograms by multiple wavefront recording plane method with occlusion culling" <i>OPTICS EXPRESS</i> , Vol. 23, No. 17, 14 August 2015 (2015-08-14), page 22149 DOI: 10.1364/OE.23.022149 XP055521605 paragraphs 3. and 4.	14,15,18,22-30,59
A	HAO ZHANG ET AL. "Computer-generated hologram with occlusion effect using layer-based processing" <i>APPLIED OPTICS</i> , WASHINGTON, DC; US, Vol. 56, No. 13, 23 March 2017 (2017-03-23), page F138 DOI: 10.1364/AO.56.00F138 ISSN: 0003-6935, XP055393015 Sections 1. to 3.	14,15,18,22-30,59

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 <b>01 February 2019</b>	Date of mailing of the international search report <b>08 February 2019</b>
Name and mailing address of the ISA/EP <b>European Patent Office p.b. 5818, Patentlaan 2, 2280 HV Rijswijk Netherlands</b> Telephone No. (+31-70)340-2040 Facsimile No. (+31-70)340-3016	Authorized officer <b>Lutz, Christoph</b>  Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP2018/073904

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GILLES ANTONIN ET AL. "Computer generated hologram from Multiview-plus-Depth data considering specular reflections" <i>2016 IEEE INTERNATIONAL CONFERENCE ON MULTIMEDIA &amp; EXPO WORKSHOPS (ICMEW), IEEE</i> , 11 July 2016 (2016-07-11), pages 1-6 DOI: 10.1109/ICMEW.2016.7574699 XP032970836 Sections 1. to 4.	14,15,18,22-30,59
Y	DE 10236891 A1 (GIESECKE & DEVRIENT GMBH [DE]) 25 March 2004 (2004-03-25) paragraph [0005] - paragraph [0030]	15,22-30,59
Y	TOMOKI YASUDA ET AL. "Computer simulation of reconstructed image for computer-generated holograms" <i>PROCEEDINGS OF SPIE</i> , 1000 20th St. Bellingham WA 98225-6705 USA, Vol. 7233, 03 February 2009 (2009-02-03), page 72330H DOI: 10.1117/12.809774 ISSN: 0277-786X, ISBN: 978-1-5106-2099-5. XP055550144 the whole document	33,34
Y	DANIELA KARTHAUS ET AL. "Design and Simulation of Computer-generated Volume Holograms for Automotive Headlamps" <i>DGAO-PROCEEDINGS</i> , 05 August 2016 (2016-08-05), pages 1-3 XP055550095 the whole document	33,34
Y	Hiroshi Yoshikawa. "Chapter 8 COMPUTER-GENERATED HOLOGRAMS FOR WHITE LIGHT RECONSTRUCTION" In: <i>Digital Holography and Three-Dimensional Display</i> , Springer Science, pages 235-255, 01 January 2006 (2006-01-01), ISBN: 978-0-387-31340-5. XP055550208 the whole document	33,34
Y	WO 2005038136 A1 (GIESECKE & DEVRIENT GMBH [DE]; HEIM MANFRED [DE]; HOFFMUELLER WINFRIED) 28 April 2005 (2005-04-28) page 1, line 1 - page 23, line 26; figures 1-9	43-47
Y	WO 2016113220 A1 (LEONHARD KURZ STIFTUNG & CO KG [DE]; OVD KINEGRAM AG [CH]) 21 July 2016 (2016-07-21) the whole document	43-47
Y	WO 2008095706 A1 (LEONHARD KURZ STIFTUNG & CO KG [DE]; SCHILLING ANDREAS [CH]) 14 August 2008 (2008-08-14) page 1, line 1 - page 30, line 10; figures 1-5	49
Y	US 2015224809 A1 (TOMPKIN WAYNE ROBERT [CH] ET AL) 13 August 2015 (2015-08-13) the whole document	49
Y	WO 2013023052 A1 (SABIC INNOVATIVE PLASTICS IP [NL]; CHEVERTON MARK [US]; JAIN SUMEET [U]) 14 February 2013 (2013-02-14) paragraph [0001] - paragraph [0060]; figures 1, 2	63,64
Y	EP 2676802 A1 (OVD KINEGRAM AG [CH]) 25 December 2013 (2013-12-25) paragraph [0001] - paragraph [0148]; figures 1-13	63,64

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.

**PCT/EP2018/073904**

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