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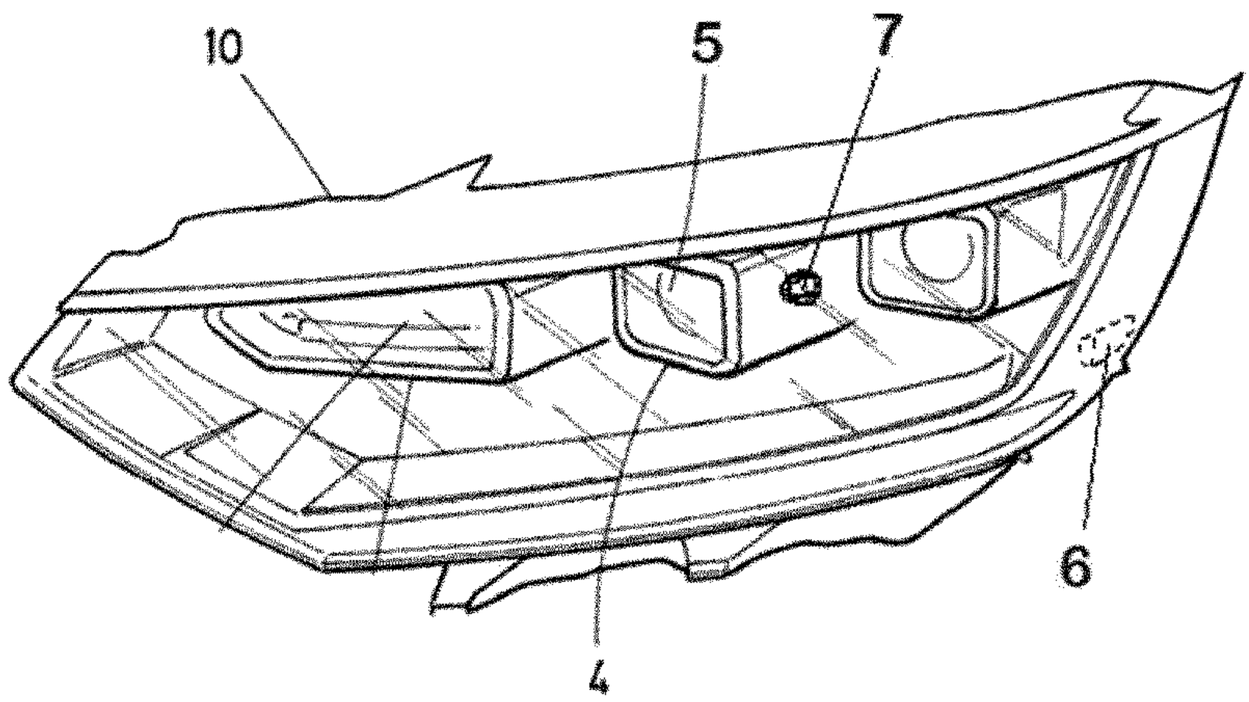
(54) Title: METHOD FOR MANAGING IMAGE DATA AND AUTOMOTIVE LIGHTING DEVICE

[Fig 5]



(57) Abstract: The invention provides a method for managing image data in an automotive lighting device (10). This method comprises the steps of providing an image pattern (1), dividing the image pattern (1) in rows or columns of pixels (2), provide, for each row pattern (2), a plurality of linear segments, compress the data of the linear segments and send the compressed data to the light module. The invention also provides an automotive lighting device (10) for performing the steps of such a method.

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Description

Title: Method for managing image data and automotive lighting device

[0001] This invention is related to the field of automotive lighting devices, and more particularly, to the management of the electronic data derived from the control of the lighting sources.

[0002] Current lighting devices comprises an increasing number of light sources which has to be controlled, to provide adaptive lighting functionalities.

[0003] This number of light sources involves a big amount of data, which has to be managed by the control unit. The CAN protocol is often used, in some of their variants (CAN-FD is one of the most used ones) to transfer data between the PCM and the light module. However, some car manufacturers decide to limit the bandwidth of the CAN protocol, and this affects the management operations, which usually requires about 5 Mbps.

[0004] Current compression methods are not very efficient for high beam patterns, and this compromises the bandwidth reduction which is requested by car manufacturers.

[0005] A solution for this problem is sought.

[0006] The invention provides a solution for these problems by means of a method for managing image data according to claim 1 and an automotive lighting device according to claim 7. Preferred embodiments of the invention are defined in dependent claims.

[0007] Unless otherwise defined, all terms (including technical and scientific terms) used herein are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealised or overly formal sense unless expressly so defined herein.

[0008] In this text, the term “comprises” and its derivations (such as “comprising”, etc.) should not be understood in an excluding sense, that is, these terms should

not be interpreted as excluding the possibility that what is described and defined may include further elements, steps, etc.

[0009] In a first inventive aspect, the invention provides a method for managing image data in an automotive lighting device, the method comprising the steps of

- providing an image pattern comprising a plurality of pixels, wherein each pixel is characterized by a number related to the luminous intensity of the pixel;
- divide the image pattern in rows or columns of pixels, thus creating a plurality of row patterns;
- provide, for each row pattern, a plurality of linear segments, each linear segment providing a linear approximation to a group of pixels;
- compress the data of the linear segments; and
- send the compressed data to the light module.

[0010] This method is aimed to manage the image data which is exchanged between a control unit and a light module. The control unit is in charge of calculating the image pattern and the compression data, and may be located in any position of the automotive vehicle, not necessarily physically inside the lighting device. The lighting module is aimed to provide a light pattern, either for lighting or signalling, and is located inside the lighting device.

[0011] The main advantage of this method is the increase in the compression rate, due to the fact that the linear segments comprises a lower amount of data compared to the original pixels replaced thereby, especially when the image pattern is referred to a high beam pattern. The pseudo-Gaussian shape of the row patterns also contributes to the compression rate being increased, since there are some portions of the row pattern which can be replaced by a linear approximation without a significant loss in data.

[0012] In some particular embodiments, the light pixels of the image pattern are grey scale pixels, and more particularly, the luminous intensity of each pixel is according to a scale from 0 to 255.

[0013] Light modules usually define the light pattern on a grey scale, where the luminous intensity is graded from 0 to 255. This is a way of quantifying the light

pattern so that it becomes able to be converted into light data, and then transmitted and managed by the control unit of the vehicle.

[0014] In some particular embodiments, each linear segment is defined by a start value, an end value and the number of pixels comprised between the start value and the end value.

[0015] This is a way of saving data: for example, a string of n values is replaced by only 3 values: the value of the luminous intensity in the first pixel, the value in the last pixel and the number of pixels between the first pixel and the last pixel. If there are regions where a linear approximation is valid for a portion of 30 or 40 pixels, the data saving is evident.

[0016] In some particular embodiments, the start value of the linear segment coincides with a first value of the group of pixels and the end value of the linear segment coincides with a last value of the group of pixels.

[0017] This is made to ensure continuity between adjacent linear segments.

[0018] In some particular embodiments, the method further comprises the step of decompressing the compressed data.

[0019] This step is convenient when the original image is to be projected by the light module.

[0020] In some particular embodiments, the compressed data is related only to a particular portion of the image pattern.

[0021] This cropping step is useful when a big portion of the image is completely dark, so that the compression stage is focused only on the portion which include representative values.

[0022] In a second inventive aspect, the invention provides a lighting device comprising

- a light module comprising a plurality of light sources; and

- a control unit to carry out the steps of a method according to the first inventive aspect.

[0023] This lighting device is able to operate with a lower bandwidth than the traditional ones.

[0024] In some particular embodiments, the light module further comprises a processor unit, the processor unit being configured to decompress the compressed data.

[0025] With a decompression stage in the proper light module, the bandwidth is narrowed until the module itself.

[0026] In some particular embodiments, the light sources are solid-state light sources, such as LEDs.

[0027] The term "solid state" refers to light emitted by solid-state electroluminescence, which uses semiconductors to convert electricity into light. Compared to incandescent lighting, solid state lighting creates visible light with reduced heat generation and less energy dissipation. The typically small mass of a solid-state electronic lighting device provides for greater resistance to shock and vibration compared to brittle glass tubes/bulbs and long, thin filament wires. They also eliminate filament evaporation, potentially increasing the life span of the illumination device. Some examples of these types of lighting comprise semiconductor light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma or gas.

[0028] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate an embodiment of the invention, which should not be interpreted as restricting the scope of the invention, but just as an example of how the invention can be carried out. The drawings comprise the following figures:

[0029] [Fig 1] shows a first image of the photometry of a high beam module which is projected by an automotive lighting device according to the invention.

[0030] [Fig 2] shows a portion of a pixel matrix representing the photometry of [Fig 1].

[0031] [Fig 3] shows a graphic representation of row patterns of a method according to the invention.

[0032] [Fig 4] shows a particular example of an error map of an image pattern which has followed a method according to the invention.

[0033] [Fig 5] shows an automotive lighting device according to the invention.

[0034] In these figures, the following reference numbers have been used:

[0035] 1 Image pattern

[0036] 11 Pixel of the image pattern

[0037] 2 Row pattern

[0038] 4 Light module

[0039] 5 LEDs

[0040] 6 Control unit

[0041] 7 Processor unit

[0042] 10 Automotive lighting device

[0043] 100 Automotive vehicle

[0044] The example embodiments are described in sufficient detail to enable those of ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternate forms and should not be construed as limited to the examples set forth herein.

[0045] Accordingly, while embodiment can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling within the scope of the appended claims should be included.

[0046] [Fig 1] shows a first image of the photometry of a high beam module which is to be projected by an automotive lighting device according to the invention.

[0047] This first image may be divided into pixels and each pixel may be characterized by its luminous intensity, in a scale from 0, which would correspond to black, to 255, which would correspond to white.

[0048] [Fig 2] shows a portion of such a pixel matrix, called image pattern 1. Each pixel 11 of this image pattern 1 is characterized by a number according to the aforementioned scale. The compression of this image pattern 1 according to commercially available software products would offer a compression rate lower than 50%, which is unacceptable by some car manufacturers.

[0049] In this image, the pixels are divided into row patterns 2. Each pattern comprises a string of data, with numbers between 0 and 255, depending on the luminous intensity of the associated pixels.

[0050] [Fig 3] shows a graphic representation of one of these row patterns. The horizontal axis represents the length of the row pattern and the vertical axis represent the luminous intensity, in the scale from 0 to 255. Further, there are linear segments 3 which try to provide an approximation to different groups of pixels.

[0051] The data of the pixels is replaced by the data of the linear segments, which involves a considerable data saving.

[0052] For example, in a group of 15 pixels, with a luminous intensity of 5 – 5.5 - 6 - 7 – 7.5 - 8 - 9 – 9.5 - 10 - 11 - 12 – 12.5 - 13 - 14 - 15, these data are replaced by the coordinates of a linear segment, which would be 5, 15, 15. With these data, the segment that would be interpreted by the light module would be 5 - 5.71 – 6.43 – 7.14 – 7.86 - 8.57 – 9.29 - 10 – 10.71 – 11.43 – 12.14 – 12.86 - 13.57 – 14.29 - 15. The maximum error would be 0.71 out of 256 (0.3%) and the medium error would be 0.33 out of 256. The data saving corresponds to sending 3 data instead of 15. The first value of the linear segment coincides with the first value of the group of pixels and the last value of the linear segment coincides with the last value of the group of pixels, to ensure continuity between adjacent linear segments.

[0053] [Fig 4] shows a particular example of an error map of an image pattern which has been discretized, linearized, compressed, decompressed and converted in an image pattern, following a method according to the invention.

[0054] As may be seen in this example map, the maximum error in the whole map is 5, and the mean error is lower than 2 (out of 256). This lossy method is completely acceptable, since it provides a light projection which fulfils the same regulations as the original one.

[0055] Once these steps of linearization are carried out the data is compressed, thus creating compressed data.

[0056] The compression rate of these data is much higher than in the event the same compression method was applied to the original. As a consequence, this compressed data may be sent to the light module compelling with restrictive conditions about the bandwidth.

[0057] [Fig 5] shows an automotive lighting device according to the invention, this lighting device comprising:

- a light module 4 comprising a plurality of LEDs 5;

- a control unit 6 to carry out the compression steps described in the previous figures, generating the compressed data; and

- a processor unit 7, the processor unit 7 being configured to decompress the compressed data, this processor unit being located in the light module 4.

[0058] This light module would achieve a good quality projection with an improved transmission bandwidth.

Claims

[Claim 1] Method for managing image data in an automotive lighting device (10), the method comprising the steps of:

- providing an image pattern (1) comprising a plurality of pixels (11), wherein each pixel is characterized by a number related to the luminous intensity of the pixel (11);

- divide the image pattern (1) in rows or columns of pixels (2), thus creating a plurality of row patterns (2);

- provide, for each row pattern (2), a plurality of linear segments, each linear segment providing a linear approximation to a group of pixels;

- compress the data of the linear segments; and

- send the compressed data to the light module.

[Claim 2] Method according to claim 1, wherein the light pixels (11) of the image pattern (1) are greyscale pixels, and more particularly, the luminous intensity of each pixel (11) is characterized by a number according to a scale from 0 to 255.

[Claim 3] Method according to any of the preceding claims, wherein each linear segment is defined by a start value, an end value and the number of pixels comprised between the start value and the end value.

[Claim 4] Method according to claim 3, wherein the start value of the linear segment coincides with a first value of the group of pixels and the end value of the linear segment coincides with a last value of the group of pixels.

[Claim 5] Method according to any of the preceding claims, further comprising the step of decompressing the compressed data.

[Claim 6] Method according to any of the preceding claims, wherein the compressed data is related only to a particular portion of the image pattern (1).

[Claim 7] Automotive lighting device (10) comprising:

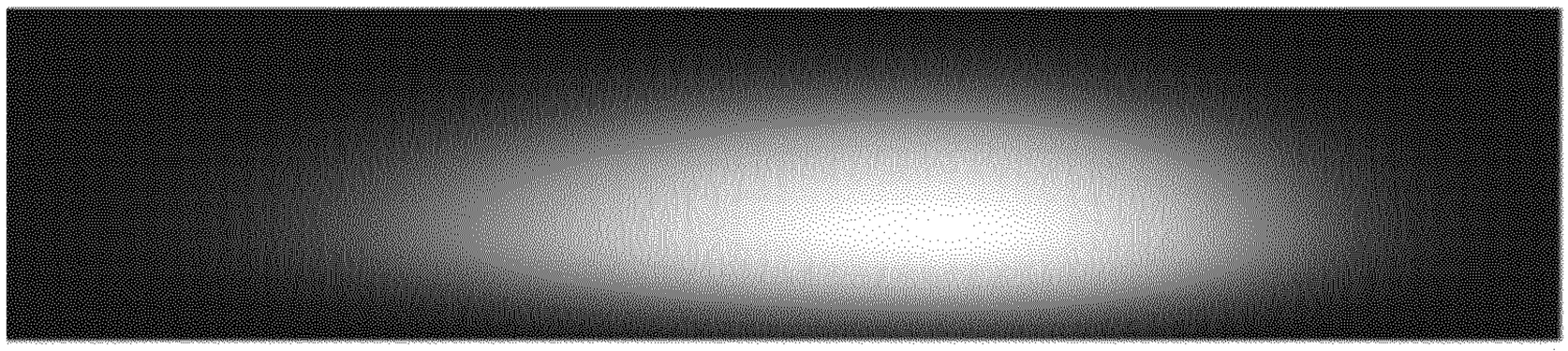
- a light module (4) comprising a plurality of light sources (5); and

- a control unit (6) to carry out the steps of a method according to any of the preceding claims.

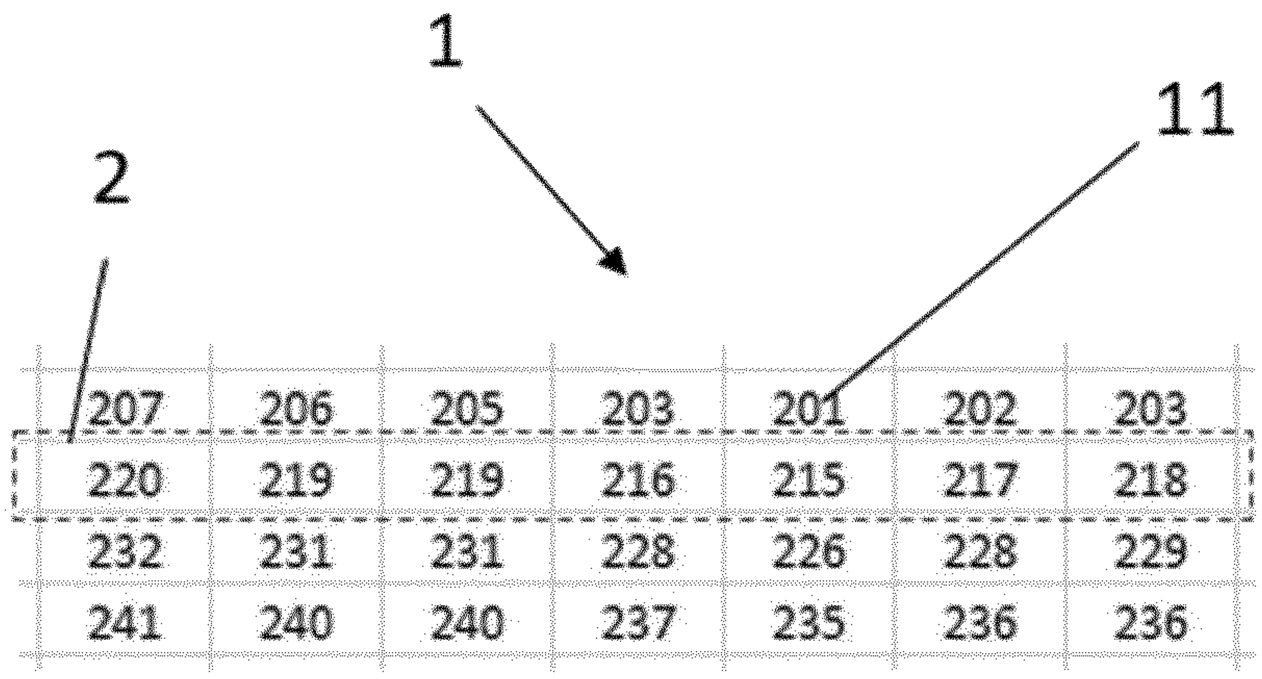
[Claim 8] Automotive lighting device (10) according to claim 7, wherein the light module (4) further comprises a processor unit (7), the processor unit (7) being configured to decompress the compressed data.

[Claim 9] Automotive lighting device (10) according to any of claims 7 or 8, wherein the light sources (5) are solid-state light sources, such as LEDs.

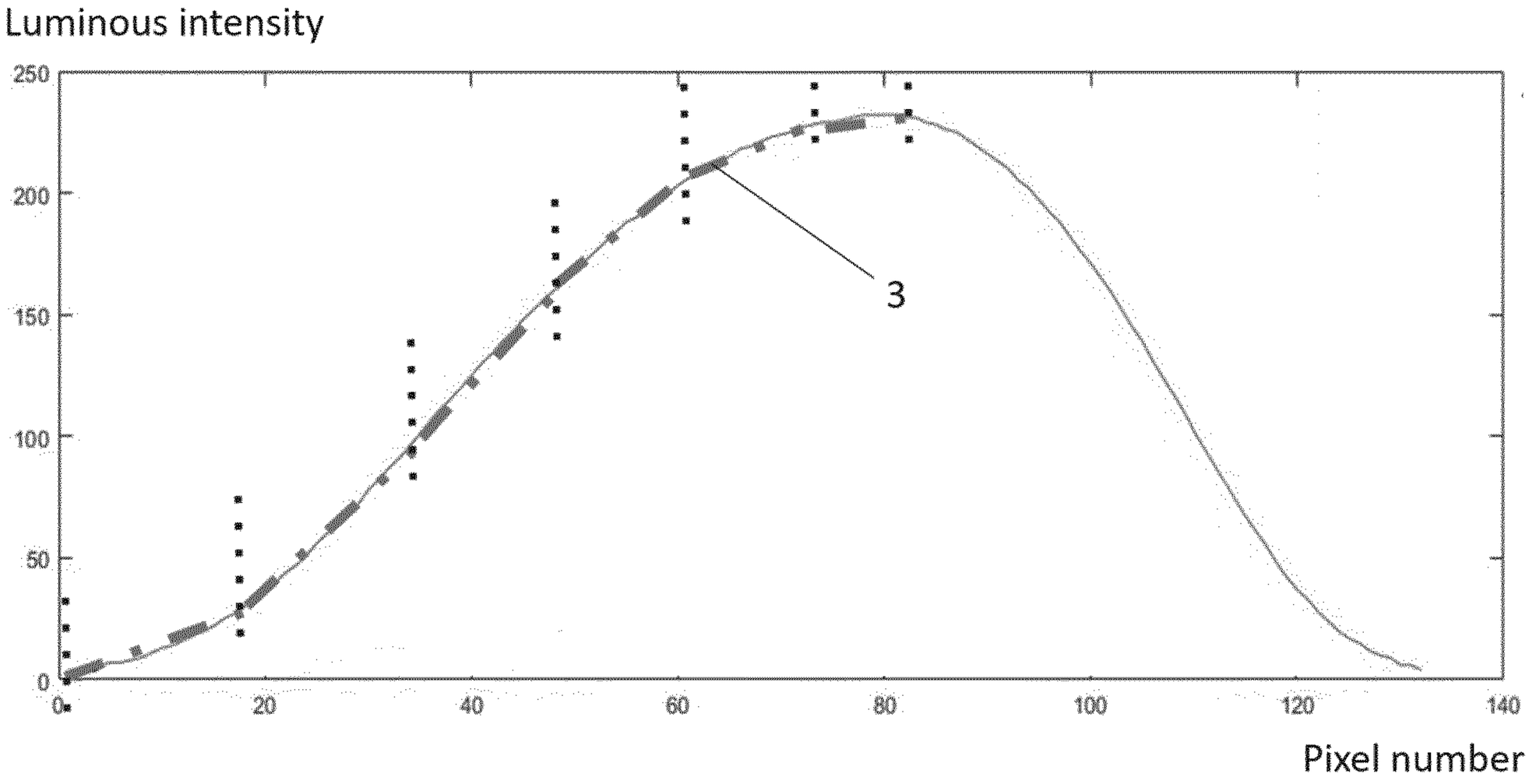
[Fig 1]



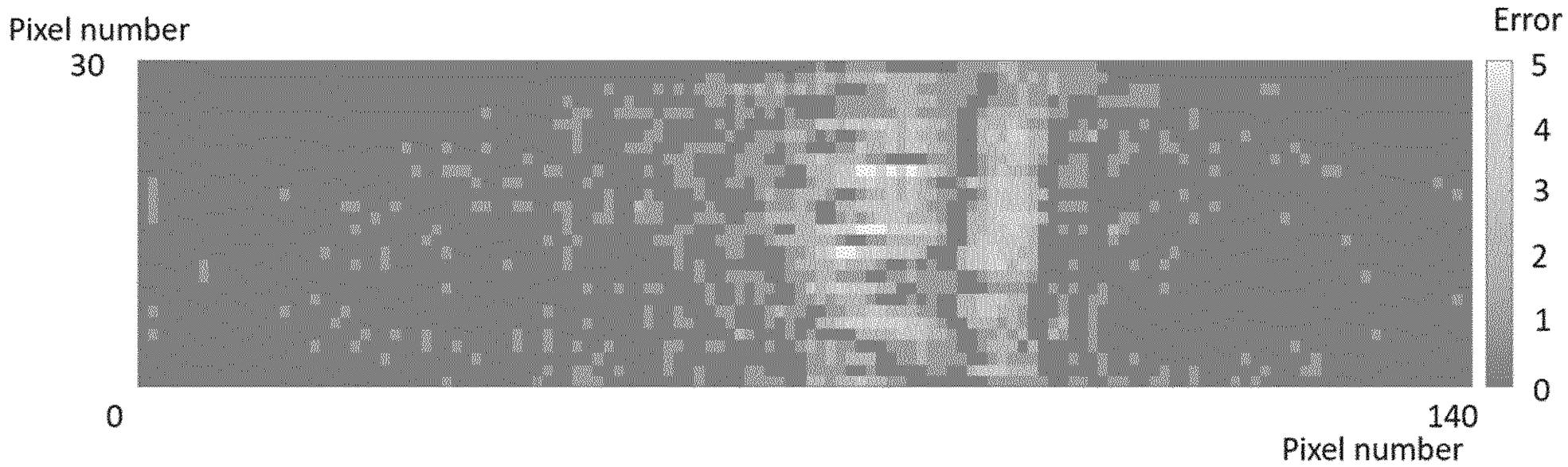
[Fig 2]


1
11
2
207 206 205 203 201 202 203
220 219 219 216 215 217 218
232 231 231 228 226 228 229
241 240 240 237 235 236 236

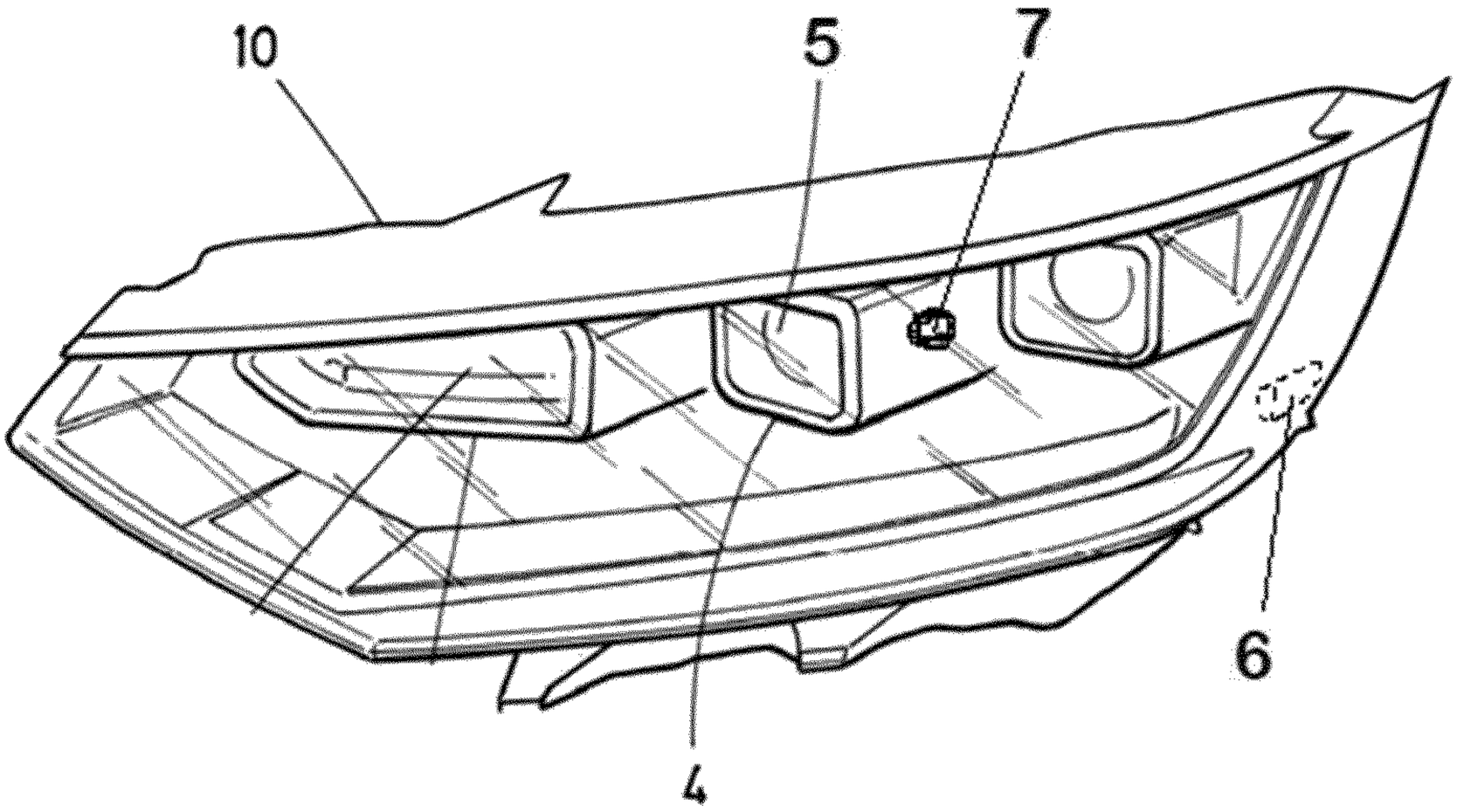
[Fig 3]


Luminous intensity
250
200
150
100
50
0
0
20
40
60
80
100
120
140
3
Pixel number

[Fig 4]



[Fig 5]



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/080087

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N19/167 H04N19/115 H04N19/593 H04N19/98 B60Q1/04
B62J6/02 F21S41/00 G01C21/36 H04N19/119
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 B60Q F21S B62M G01C B62J

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

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X	DALAI M ET AL: "l/spl infin/ norm based second generation image coding", IMAGE PROCESSING, 2004. ICIP '04. 2004 INTERNATIONAL CONFERENCE ON SINGAPORE 24-27 OCT. 2004, PISCATAWAY, NJ, USA,IEEE, vol. 5, 24 October 2004 (2004-10-24), pages 3193-3196, XP010786476, DOI: 10.1109/ICIP.2004.1421792 ISBN: 978-0-7803-8554-2 abstract section "1. Introduction" section "2.2 Sub-Optimal Approximations" section "3. Segmentation" section "4. Coding" ----- -/--	1-9

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 December 2020	15/12/2020
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 Fassnacht, Carola

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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 2016/267325 A1 (GAO D; QI Y; SUNDARESAN S; ZHONG X) 15 September 2016 (2016-09-15) abstract paragraphs [0003] - [0005], [0103] - [0107] -----	1-9
A	US 2016/073025 A1 (CILIA ANDREW [US]) 10 March 2016 (2016-03-10) abstract paragraphs [0008] - [0010] figures 4,5 claim 20 -----	1-9
A	Zoran Nikolic: "Embedded Vision in Advanced Driver Assistance Systems" In: "Embedded Vision in Advanced Driver Assistance Systems", 1 January 2014 (2014-01-01), Springer, XP055669416, ISBN: 978-3-319-09386-4 pages 45-69, DOI: 10.1007/978-3-319-09387-1_3, section "3.3.1 Front View Camera Systems", page 52-53 section "3.3.2 Rearview Camera Systems", pages 53-54 section "3.3.3 Surround View Camera Systems", pages 54-56 section "3.4.2 Imaging Sensors", pages 58-59 section "4.3.4 Embedded Processors", pages 59-61 -----	1-9
A	US 2018/118095 A1 (KUNII YASUHIKO [JP] ET AL) 3 May 2018 (2018-05-03) abstract paragraphs [0012] - [0039], [0097], [0100], [0115] figures 1-5,8,12,17,18,20,21 -----	1-9
A	US 2019/166338 A1 (GREENWOOD JEREMY J [GB]) 30 May 2019 (2019-05-30) abstract paragraphs [0005] - [0011], [0061], [0062], [0143], [0245] figures 1, 4A -----	1-9

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Information on patent family members

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