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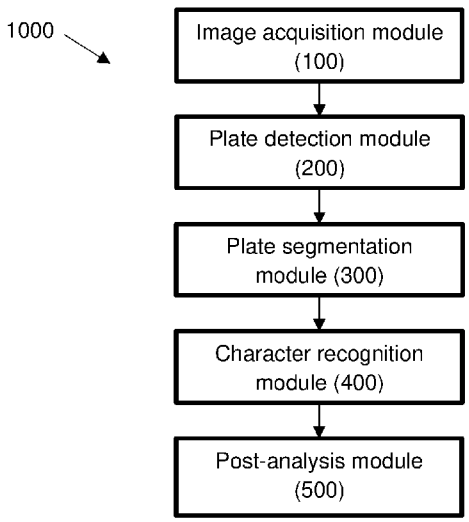

FIG. 1

(57) Abstract: The present invention relates to a system (1000) and method for licence plate detection. The system (1000) comprises an image acquisition module (100) configured to obtain an image, wherein the image includes at least one licence plate, a plate detection module (200) configured to detect at least one licence plate from within the image, and a plate segmentation module (300) configured to segment the licence plate into regions having at least one individual character per region. The system (1000) further comprises a character recognition module (400) configured to recognise the character in each region of the segmented licence plate and a post-analysis module (500) configured to determine the final text of the licence plate. The plate detection module (200) further comprises an illumination processor submodule (220) configured to perform illumination enhancement on the image and an edge recognition submodule (230) configured to detect all edges within the image.

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A SYSTEM AND METHOD FOR LICENCE PLATE DETECTION

FIELD OF INVENTION

The present invention relates to a system and method for licence plate detection. More specifically, the present invention relates to a system and method to detect licence plate in various lighting condition.

BACKGROUND OF THE INVENTION

Before a licence plate recognition system is able to recognise characters on a licence plate, location and image of the licence plate must first be established by a licence plate detection module. The use of licence plate detection in various application such as law enforcement and parking management results in lesser need for human intervention.

An example of a system and method for licence plate detection is disclosed in PCT Application Publication No. WO 2017/091060 A1 which relates to a system and method for detecting object from an image. The system and method for detecting object from image comprises an image capturing device, a detection engine, a recognition engine and a display device. The detection engine detects licence plate in the image captured by the image capturing device. The recognition engine then performs character recognition to produce an alphanumerical character of the licence plate. A text of the alphanumerical characters of the licence plate is then overlaid on the image of a vehicle to associate the vehicle with the licence plate.

Another example of a system and method for licence plate detection is disclosed in a United State Patent Application Publication No. US20150110358A1 which relates to an apparatus and a method for detecting vehicle number plate. The apparatus for detecting vehicle number plate comprises an image acquirer, a pre-processor, a number plate detector, a learner, and a post processor. The image acquirer is configured to acquire an input image. The pre-processor then performs pre-processing on the input image. The input image is then sent to the number plate detector, wherein the number plate detector determines based on optimal features, whether the input image includes a number plate. The learner determines the optimal features. The post processor is configured to calculate a

position of the number plate in the acquired input image based on the image pre-processing.

Although there are many systems and methods for licence plate detection, most of the systems do not take into account the lighting condition of the image during the image capture process. Existing systems are not suitable to be used in an environment without proper lighting or an environment where the lighting condition changes throughout the day. As a result, many lighting factors such as poor illumination, glares and shadows may affect the successful detection rate of these systems. Depending on the lighting condition, some characters on a licence plate may not be detected and recognised properly. Therefore, there is a need for a system and method that is able to detect the licence plate under various lighting conditions.

SUMMARY OF INVENTION

The present invention relates to a system (**1000**) and method for licence plate detection. The system (**1000**) comprises an image acquisition module (**100**) configured to obtain an image, wherein the image includes at least one licence plate, a plate detection module (**200**) configured to detect at least one licence plate from within the image, and a plate segmentation module (**300**) configured to segment the licence plate into regions having at least one individual character per region. The system (**1000**) further comprises a character recognition module (**400**) configured to recognise the character in each region of the segmented licence plate and a post-analysis module (**500**) configured to determine the final text of the licence plate. The plate detection module (**200**) comprises an illumination processor submodule (**220**) configured to perform illumination enhancement on the image from the image acquisition module (**100**) by computing the suitable contrast adjustment based on histogram computation, density distribution, and illumination rules. The plate detection module (**200**) further comprises an edge recognition submodule (**230**) configured to detect all edges within an image from the illumination processor submodule (**220**).

A method for licence plate detection includes the steps of obtaining the image, wherein the image includes at least one license plate by the image acquisition module (**100**), detecting the licence plate by the plate detection module (**200**),

segmenting the licence plate into regions having individual characters by the plate segmentation module (**300**), recognising characters in the character regions by the character recognition module (**400**), and determining a final text of the license plate by the post-analysis module (**500**).

The step of detecting the licence plate by the plate detection module (**200**) further comprises sub-step of converting the image into a grayscaled image by a grayscale processor submodule (**210**). Afterwards, the illumination of the image is enhanced by computing the suitable contrast adjustment based on histogram computation, density distribution, and illumination rules by the illumination processor submodule (**220**). Thereon, the edge recognition submodule (**230**) detects edges of objects within the grayscaled image. The edges detection includes the process of transforming the grayscaled image having the licence plate into a binarised image, wherein the binarised image having only black and white colours, and computing the edges of the objects in the binarised image based on a specified threshold value of white density. Subsequently, a dilation processor submodule (**240**) performs dynamic dilation on the edges of the objects in the binarised image by computing horizontal and vertical pixel densities of binary large objects, BLOBs to group similar shaped BLOBs together. Thereafter, a filtration submodule (**250**) filters the edges of the objects within the dilated binarised image. An aggregation submodule (**260**) then aggregates similar BLOBs in the binarised image by computing features of the BLOBs such as compactness and intensity of the BLOBs, extracting the final BLOBs based on similarity in features and connecting similar BLOBs as one.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 illustrates a block diagram of a system (**1000**) for licence plate detection according to an embodiment of the present invention.

FIG. 2 illustrates a block diagram of a plate detection module (**200**) of the system (**1000**) in **FIG. 1**

FIG. 3 illustrates a flowchart of a method for licence plate detection according to an embodiment of the present invention.

FIG. 4 illustrates an image of a vehicle before and after the method as shown in **FIG. 3**.

FIG. 5 illustrates a flowchart of sub-steps for detecting a licence plate by using an edge-based technique of the method of **FIG. 3**.

FIG. 6 illustrates a flowchart of sub-steps for performing illumination enhancement of an image of the sub-steps of **FIG. 5**.

FIG. 7 illustrates a flowchart of sub-steps for performing adaptive edge recognition of the sub-steps of **FIG. 5**.

FIG. 8 illustrates an equalised and unequalised images of a licence plate undergoing Sobel edge detection and image selection based on a white density rule.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well known functions or constructions are not described in detail since they would obscure the description with unnecessary detail.

Initial reference is made to **FIG. 1** which illustrates a block diagram of a system (**1000**) for licence plate detection according to an embodiment of the present invention. The system (**1000**) comprises an image acquisition module (**100**), a plate detection module (**200**), and a plate segmentation module (**300**). The system (**1000**) further comprises a character recognition module (**400**) and a post-analysis module (**500**). The system (**1000**) analyses a candidate image having a licence plate and detects characters on the licence plate.

The image acquisition module (**100**) is connected to the plate detection module (**200**). The image acquisition module (**100**) is configured to obtain an image, wherein the image includes at least one licence plate. The image acquisition module

(**100**) obtains at least one image from either an image capturing device (not shown) such as surveillance camera or from an image or video in a storage medium. The image acquisition module (**100**) sends the image to the plate detection module (**200**) for further processing.

The plate detection module (**200**) is connected to the image acquisition module (**100**) and the plate segmentation module (**300**). The plate detection module (**200**) is configured to detect at least one licence plate in the image by using an edge-based technique to detect potential characters. The edge-based technique is described as a technique of grayscaling and binarising the image and detecting edge based on a stark change in brightness. The term grayscaling refers to the process of turning a coloured image into an image having only shades of grey, white, and black, while the term binarising refers to the process of turning a grayscaled image into an absolute black and white image. The plate detection module (**200**) sends the image to the plate segmentation module (**300**) to segment individual characters into one region each.

The plate segmentation module (**300**) is configured to segment the licence plate within the image into regions, wherein each region comprises at least one individual character. The plate segmentation module (**300**) is connected to the plate detection module (**200**) and the character recognition module (**400**). The plate segmentation module (**300**) segments the licence plate of the image by dividing the licence plate into a plurality of regions, wherein each section contains at least one character. The plate segmentation module (**300**) sends the image to the character recognition module (**400**) to recognise the characters contained within the licence plate.

The character recognition module (**400**) is connected to the plate segmentation module (**300**) and the post-analysis module (**500**). The character recognition module (**400**) is configured to recognise the individual character in each region of the licence plate which has been segmented by utilising machine learning and image processing. The character recognition module (**400**) sends the image with recognised characters to the post-analysis module (**500**) to determine final text of the licence plate.

The post-analysis module (**500**) is configured to determine the final text of the licence plate. The post-analysis module (**500**) is connected to the character recognition module (**400**). The post-analysis module (**500**) utilises the recognised characters to produce the content of the licence plate in plain alphanumerical text.

Reference is now made to **FIG. 2** which illustrates a block diagram of the plate detection module (**200**) of the system (**1000**). The plate detection module (**200**) comprises a grayscale processor submodule (**210**), an illumination processor submodule (**220**), and an edge recognition submodule (**230**). The plate detection module (**200**) further comprises a dilation processor submodule (**240**), a filtration submodule (**250**), and an aggregation submodule (**260**).

The grayscale processor submodule (**210**) is connected to the image acquisition module (**100**) and the illumination processor submodule (**220**). The grayscale processor submodule (**210**) is configured to perform grayscale conversion. The grayscale processor submodule (**210**) receives the image from the image acquisition module (**100**) and performs grayscale conversion by converting the image from a coloured image utilising colour spaces such as red-green-blue, RGB, cyan-magenta-yellow-black, CMYK, or hue-saturation-brightness, HSV, into a grayscaled image, composed of only black, white, and shades of grey. The grayscale processor submodule (**210**) sends the grayscaled image to the illumination processor submodule (**220**) to enhance illumination of the grayscaled image.

The illumination processor submodule (**220**) is connected to the grayscale processor submodule (**210**) and the edge recognition submodule (**230**). The illumination processor submodule (**220**) is configured to perform illumination enhancement on the grayscaled image by computing the suitable contrast adjustment based on histogram computation, density distribution, and illumination rules. The illumination processor submodule (**220**) sends the grayscaled image to the edge recognition module (**230**) to recognise the edges contained in the grayscaled image.

The edge recognition submodule (**230**) is connected to the illumination processor submodule (**220**) and the dilation processor submodule (**240**). The edge recognition submodule (**230**) is configured to detect all edges within the grayscaled

image by transforming the grayscaled image which has undergone illumination enhancement into a binarised image, wherein the binarised image comprises only black and white colours, and computing the edge of the objects in the grayscaled image based on a specified threshold value of white density. Groups of adjacent edges are known as binary large objects, BLOBs, which potentially represents characters. The BLOBs are characterised by areas where the brightness values of adjacent groups of pixels differ greatly. The BLOBs are comprised within the binarised image. The edge recognition submodule (**230**) sends the binarised image to the dilation processor submodule (**240**) for dynamic dilation process.

The dilation processor submodule (**240**) is connected to the edge recognition submodule (**230**) and the filtration submodule (**250**). The dilation processor submodule (**240**) is configured to perform dynamic dilation. The dynamic dilation is a process of computing horizontal and vertical pixel densities of the BLOBs to group similar shaped BLOBs together. The dilation processor submodule (**240**) sends a dilated binarised image to the filtration submodule (**250**) for a filtration process.

The filtration submodule (**250**) is connected to the dilation processor submodule (**240**) and the aggregation submodule (**260**). The filtration submodule (**250**) is configured to perform a group-based filtration. The group based filtration is done on the dilated binarised image based on compactness, ratio, and size of the grouped BLOBs. The group based filtration is applied to remove noise from the binarised image. The filtration submodule (**250**) sends a filtered binarised image to the aggregation submodule (**260**).

The aggregation submodule (**260**) is connected to the filtration submodule (**250**) and the plate segmentation module (**300**). The aggregation submodule (**260**) is configured to perform BLOBs aggregation. The BLOBs aggregation process is done on the filtered binarised image by computing features of the BLOBs such as compactness and intensity of the BLOBs. The final BLOBs are extracted based on similarity in features and similar BLOBs are connected as one. The aggregation submodule (**260**) sends the binarised image which has the BLOBs aggregated to the plate segmentation module (**300**) to segment individual characters into one region each.

FIG. 3 illustrates a flowchart of a method for licence plate detection according to an embodiment of the present invention. Initially, the image acquisition module (**100**) obtains an image, wherein the image includes at least one licence plate, as in step **2100**. The image acquisition module (**100**) acquires the image from either an image capturing device such as surveillance camera or from an image or a video in a storage medium. An example of the image is illustrated in **FIG. 4a**.

The image is then transferred to a plate detection module (**200**). The plate detection module (**200**) detects at least one licence plate by using an edge-based technique as in step **2200**. The edge-based technique is described as a technique of grayscaling and binarising the image and detecting edge based on a stark change in brightness. The term grayscaling refers to the process of turning a coloured image into an image having only shades of grey, white, and black, while the term binarising refers to the process of turning a grayscaled image into an absolute black and white image. The sub-steps for detecting the licence plate by the plate detection module (**200**) are further explained in relation to **FIG. 5**.

Thereafter, the plate segmentation module (**300**) receives the image from the plate detection module (**200**). The plate segmentation module (**300**) segments the licence plate into regions having at least one individual character per region as in step **2300**. The plate segmentation module (**300**) segments the licence plate by dividing the licence plate into a plurality of regions, wherein each region contains at least one character.

Afterwards, the image which has a segmented licence plate is transferred to the character recognition module (**400**). The character recognition module (**400**) recognises the character in each regions of the segmented licence plate as in step **2400**. The character recognition module (**400**) recognises the character by utilising machine learning and image processing.

Finally, the character-recognised image is sent to the post-analysis module (**500**). The post-analysis module (**500**) determines the final text of the licence plate as in step **2500**. The post-analysis module (**500**) utilises the recognised characters from the character recognition module (**400**) to produce the content of the licence plate in plain alphanumerical text. The image with an associated licence plate text is then

sent to a storage unit or a display, where the associated licence plate text is preferably overlaid on the image as shown in **FIG. 4b**.

The reference is now made to **FIG. 5** which illustrates a flowchart of sub-steps for detecting a licence plate by using an edge-based technique as in step **2200** of the method of **FIG. 3**. Initially, the grayscale processor submodule (**210**) receives the image from the image acquisition module (**100**) and performs grayscale conversion as in step **2210**. The grayscale processor submodule (**210**) converts the image from the image acquisition module (**100**) from a coloured image into a grayscaled image.

Next, the illumination processor submodule (**220**) receives the grayscaled image from the grayscale processor submodule (**210**). The illumination processor submodule (**220**) performs illumination enhancement on the grayscaled image as in step **2220**. The illumination processor submodule (**220**) enhances the illumination of the grayscaled image by computing the suitable contrast adjustment based on histogram computation, density distribution, and illumination rule. The sub-steps for enhancing the illumination of the grayscaled image by the illumination processor submodule (**220**) are further explained in relation to **FIG. 6**.

Thereon, the edge recognition submodule (**230**) receives an illumination-enhanced grayscaled image from the illumination processor submodule (**220**). The edge recognition submodule (**230**) detect edges as in step **2230**. The edges detection is done by transforming the illumination-enhanced grayscaled image into a binarised image, having only black and white colours, and computing the edges of the objects in the binarised image based on a specified threshold value of white density. Groups of adjacent edges are known as binary large objects, BLOBs, which potentially represents characters. The BLOBs are characterised by areas where the brightness values of adjacent groups of pixels differ greatly. The BLOBs are comprised within the binarised image. The sub-steps for detecting edges by the edge recognition module submodule (**230**) are further explained in relation to **FIG. 7**.

Thereafter, the dilation processor submodule (**240**) receives an edge-recognised binarised image from the edge recognition submodule (**240**). The dilation processor submodule (**240**) performs dynamic dilation on the edges of objects in the edge-recognised binarised image as in step **2240**. The dynamic dilation is a process

of computing horizontal and vertical pixel densities of the BLOBs to group similar shaped BLOBs together.

Subsequently, the filtration submodule (**250**) receives a dilated binarised image from the dilation processor submodule (**240**). The filtration submodule (**250**) filters the edges of the objects within the dilated binarised image as in step **2250**. The filtration is done on the dilated binarised image based on compactness, ratio, and size of the grouped BLOBs. The filtration is applied to remove noise from the dilated binarised image.

Afterwards, the aggregation submodule (**260**) receives the binarised image which has been filtered. The aggregation submodule (**260**) performs similar BLOB aggregation as in step **2260**. The BLOB aggregation is done by computing features of the BLOBs such as compactness and intensity of the BLOBs. The final BLOBs are extracted based on similarity in features and similar BLOBs are connected as one.

FIG. 6 illustrates a flowchart of the sub-steps for performing illumination enhancement of the grayscaled image as in step **2220** of the method of **FIG. 5**. Initially, a histogram of the grayscaled image is computed by the illumination processor submodule (**220**) as in step **2221**. The range of the histogram is split into two, namely a low range and a high range. Thereafter, the illumination processor submodule (**220**) computes density distribution of the low range of the histogram as in step **2222**.

The illumination processor submodule (**220**) then implements a illumination rule to determine if the grayscaled image is over-dark as in step **2223**. If the white density value is more than 30% of the whole distribution, the grayscaled image is considered over-dark. On the other hand, if the white density value is less than 30%, the grayscaled image is considered not over-dark. Next, the illumination processor submodule (**220**) determines whether the grayscaled image is over-dark based on the illumination rule as in decision **2224**. If the grayscaled image is not over-dark, the grayscaled image is sent to the edge recognition submodule (**230**) as in step **2225**.

On the other hand, if the grayscaled image is found as over-dark by the illumination processor submodule (**220**), the illumination processor submodule (**220**)

triggers a flag for the grayscaled image as in step **2226**. Subsequently, the illumination processor submodule (**220**) computes several histograms from different parts of the grayscaled image and redistributes lightness value of the grayscaled image within an amplification limit as in step **2227**.

Thereafter, a flagged grayscaled image is sent to the edge recognition submodule (**230**) as in step **2228** to detect edges as in step **2230** of the method of **FIG. 5**.

The reference is now made to **FIG. 7** which illustrates a flowchart of sub-steps for detecting edges as in step **2230** of the method of **FIG. 5**. Initially, the edge recognition submodule (**230**) sets a threshold value to the grayscaled image received from the illumination processor submodule (**220**) as in step **2231**. Every pixel in the grayscaled image is represented by an intensity value on a scale of 0 to 255, where 0 is pure black and 255 is pure white and anything in between is a shade of grey. The threshold value is an intensity value in the process of binarising the grayscaled image, whereby any pixel with the intensity value lower than the threshold value is considered as black and any pixel with the intensity value above the threshold value is considered white, producing a binarised, black and white only image. For example, if the threshold value is set to be 80, every pixel with the intensity value less than 80 is turned into a black pixel. On the other hand, every pixel with the intensity value more than 80 is turned into a white pixel.

The edge recognition submodule (**230**) then produces two similar grayscaled image as in step **2232**. Thereafter, the histogram of either of the two grayscaled images is equalised by the edge recognition submodule (**230**) as in step **2233**. **FIG. 8a** illustrates an equalised grayscaled image while **FIG. 8b** illustrates an unequalised grayscaled image.

Afterwards, both equalised and unequalised grayscaled images are examined for an over-darkness flag from the illumination submodule (**220**) as in decision **2234**. If the grayscaled image is flagged for over-darkness, the threshold value of the flagged grayscaled image is then reduced by the edge recognition submodule (**230**) as in step **2235a**. Afterwards, the edge recognition submodule (**230**) performs binarisation based on the threshold value as in step **2235b**. Thereafter, the edge

recognition submodule (**230**) performs Sobel edge detection as in step **2236**. The Sobel edge detection is described as an operation of emphasising the visible edges within an image.

On the other hand, if the grayscaled image is not flagged for over-darkness, the edge recognition submodule (**230**) directly performs binarisation based on the threshold value as in step **2235b** without reducing the threshold value of the grayscaled image. **FIG. 8c** and **8d** illustrate two binarised images originating from equalised and unequalised grayscaled images respectively, having undergone the Sobel edge detection.

Subsequently, both binarised images from equalised and unequalised grayscaled images are compared based on a set of white density rules as in step **2237**. The white density rules comprise three conditions. The first condition is that the white density value of the binarised image from the unequalised grayscaled image is less than 5 %. The second condition is that when the white density value of the binarised image from the equalised grayscaled image is bigger the 10 %, the white density value difference between both binarised images from the equalised and unequalised grayscaled images is less than 5 %. The third condition is that when the white density value of the binarised image from the equalised grayscaled image is less than 10 %, the white density value difference between both binarised images from the equalised and unequalised grayscaled images is less than 2 %. If any single one of the condition is fulfilled, the binarised image from the equalised grayscaled image is selected. In another scenario, the binarised image from the unequalised grayscaled image is selected.

FIG. 8e illustrates the selected image based on the white density rule. After the edge recognition submodule (**230**) implements the white density rule, the binarised image from the equalised image is selected.

Afterwards, the selected binarised image based on the white density rule undergoes threshold tuning by the edge recognition submodule (**230**) as in step **2238**. The threshold tuning is done by examining the final white density of the selected binarised image. The amount of threshold tuning done on the selected binarised image corresponds to pre-set ranges of white density. For example, if the

final white density is higher than 30%, the edge recognition submodule (**230**) increases the threshold value by 15, however, if the final white density is lower than 10%, the edge recognition submodule (**230**) reduces the threshold value by 15.

The edge recognition submodule (**230**) then nominates the tuned binarised image to be sent to the dilation processor submodule (**240**) as in step **2239** to perform dynamic dilation on the edges of the objects as in step **2240** of the method of **FIG. 5**.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specifications are words of description rather than limitation and various changes may be made without departing from the scope of the invention.

CLAIMS

1. A system (**1000**) for licence plate detection comprising:
   a) an image acquisition module (**100**) configured to obtain an image, wherein the image includes at least one licence plate;
   b) a plate detection module (**200**) configured to detect at least one licence plate from within the image;
   c) a plate segmentation module (**300**) configured to segment the licence plate into regions having at least one individual character per region;
   d) a character recognition module (**400**) to recognise the character in each region of the segmented licence plate; and
   e) a post-analysis module (**500**) configured to determine the final text of the licence plate,

   characterised in that the plate detection module (**200**) further comprising:
      i. an illumination processor submodule (**220**) configured to perform illumination enhancement on the image from the image acquisition module (**100**) by computing the suitable contrast adjustment based on histogram computation, density distribution, and illumination rules; and
      ii. an edge recognition submodule (**230**) configured to detect all edges within the image from the illumination processor submodule (**220**).

2. The system (**1000**) as claimed in claim **1**, wherein the plate detection module (**200**) further comprising:
   a) a grayscale processor submodule (**210**) configured to perform grayscale conversion on the image;
   b) a dilation processor submodule (**240**) configured to perform dynamic dilation on a binarised image by computing horizontal and vertical pixel densities of binary large objects, BLOBs to group similar shaped BLOBs together;
   c) a filtration submodule (**250**) configured to perform group-based filtration on a dilated binarised image based on compactness, ratio, and size of the grouped BLOBs; and
   d) an aggregation submodule (**260**) configured to perform BLOBs aggregation on a filtered binarised image by computing features of the

BLOBs such as compactness and intensity of the BLOBs, extracting the final BLOBs based on similarity in features and connecting similar BLOBs as one.

3. A method for licence plate detection including the steps of:

a) obtaining an image, wherein the image includes at least one licence plate by an image acquisition module (**100**);

b) detecting at least one licence plate from within the image by a plate detection module (**200**);

c) segmenting the licence plate into regions having at least one individual character per region by a plate segmentation module (**300**);

d) recognising the characters in each region of the segmented licence plate by a character recognition module (**400**); and

e) determining a final text of the license plate by a post-analysis module (**500**),

characterised in that the step of detecting the licence plate by the plate detection module (**200**) includes the sub-steps of:

i. converting the image into a grayscaled image by a grayscale processor submodule (**210**);

ii. enhancing an illumination of the grayscaled image by computing a suitable contrast adjustment based on histogram computation, density distribution, and illumination rule by an illumination processor submodule (**220**);

iii. detecting edges by an edge recognition submodule (**230**);

iv. performing dynamic dilation on the edges of the objects in a binarised image by computing horizontal and vertical pixel densities of binary large objects, BLOBs to group similar shaped BLOBs together by a dilation processor submodule (**240**);

v. filtering the edges within the dilated binarised image based on the compactness, ratio, and size of the grouped BLOBs by a filtration submodule (**250**); and

vi. aggregating similar BLOBs in the binarised image by computing features of the BLOBs such as compactness and intensity of the BLOBs, extracting the final BLOBs based on

similarity in features and connecting similar BLOBs as one by an aggregation submodule (**260**).

4. The method as claimed in claim **3**, wherein enhancing the illumination of the grayscaled image by computing a suitable contrast adjustment based on histogram computation, density distribution, and illumination rule by the illumination processor submodule (**220**) includes the steps of:
    a) computing a histogram of the grayscaled image by splitting the histogram into two ranges, namely a low range and a high range;
    b) computing density distribution of the low range of the histogram;
    c) implementing a illumination rule to determine if the grayscaled image is over-dark;
    d) determining whether the grayscaled image is over-dark based on the illumination rule;
    e) triggering a flag for the grayscaled image if the grayscaled image is found as over-dark;
    f) computing several histograms from different parts of the grayscaled image and redistributing lightness value of the grayscaled image within an amplification limit; and
    g) sending a flagged grayscaled image to the edge recognition submodule (**230**).

5. The method as claimed in claim **4**, wherein if the grayscaled image is not over-dark, the method further includes the steps of sending the grayscaled image to the edge recognition submodule (**230**).

6. The method as claimed in claim **3**, wherein detecting edges by the edge recognition submodule (**230**) includes the steps of:
    a) setting a threshold value to the grayscaled image received from the illumination processor submodule (**220**);
    b) producing two similar grayscaled images;
    c) equalising the histogram of either of the two grayscaled images;
    d) binarising the grayscaled images based on the threshold value to produce the binarised images;

e) performing Sobel edge detection on the binarised images to emphasise the visible edges within the binarised images;

f) implementing white density rule on both binarised images originating from equalised and unequalised grayscaled images;

g) tuning the threshold of the selected binarised image based on the white density rule; and

h) nominating the tuned binarised image to be sent to the dilation processor submodule (**240**).

7. The method as claimed in claim **6**, wherein detecting edges by the edge recognition submodule (**230**) includes the step of reducing the threshold value of the grayscaled images prior to binarising the grayscaled images based on the threshold value to produce the binarised images if the grayscaled images are flagged for over darkness.

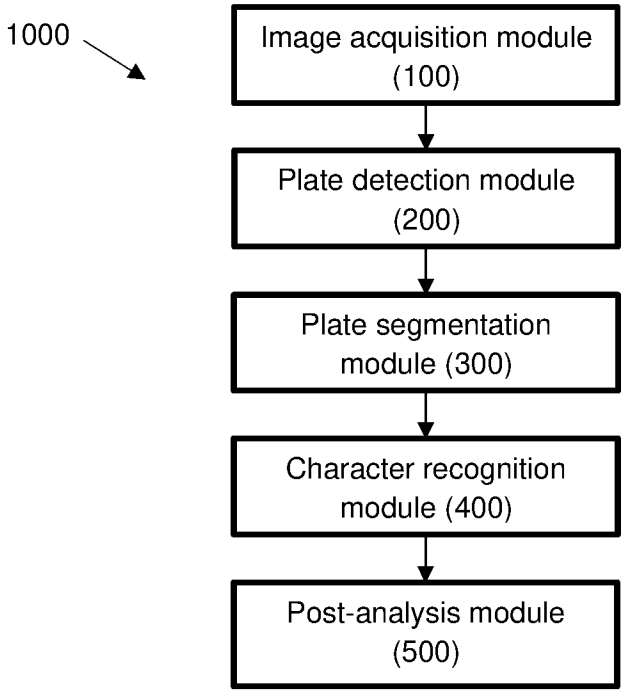
1000
Image acquisition module (100)
Plate detection module (200)
Plate segmentation module (300)
Character recognition module (400)
Post-analysis module (500)

FIG. 1

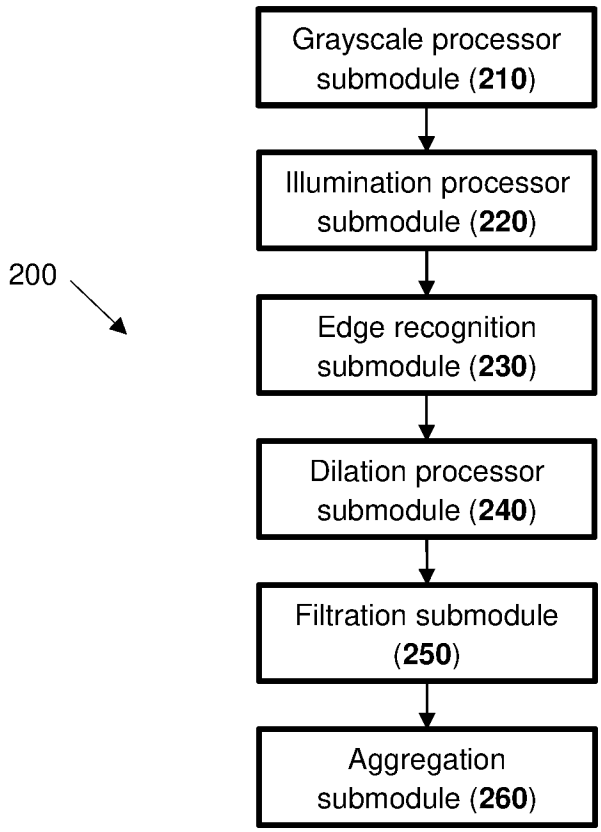
200
Grayscale processor submodule (210)
Illumination processor submodule (220)
Edge recognition submodule (230)
Dilation processor submodule (240)
Filtration submodule (250)
Aggregation submodule (260)

FIG. 2

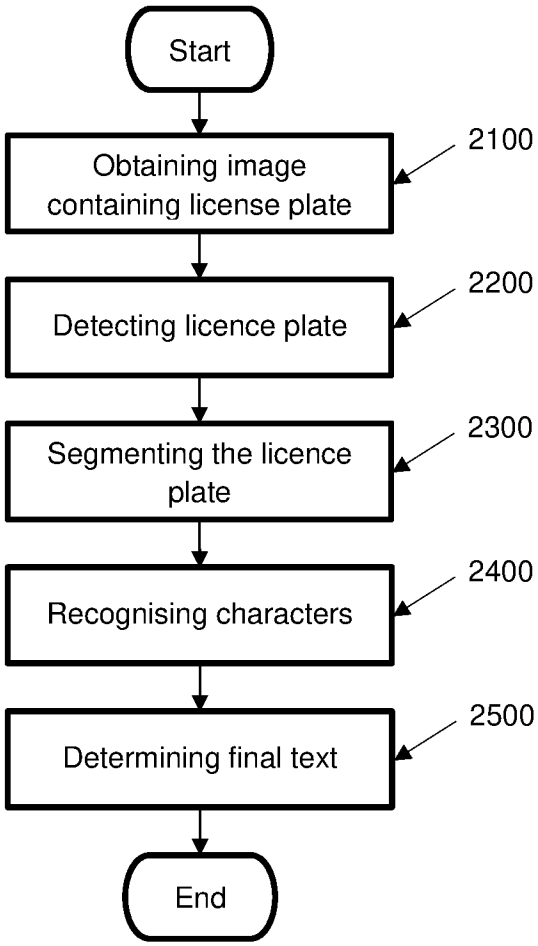
Start
Obtaining image containing license plate
2100
Detecting licence plate
2200
Segmenting the licence plate
2300
Recognising characters
2400
Determining final text
2500
End

FIG. 3

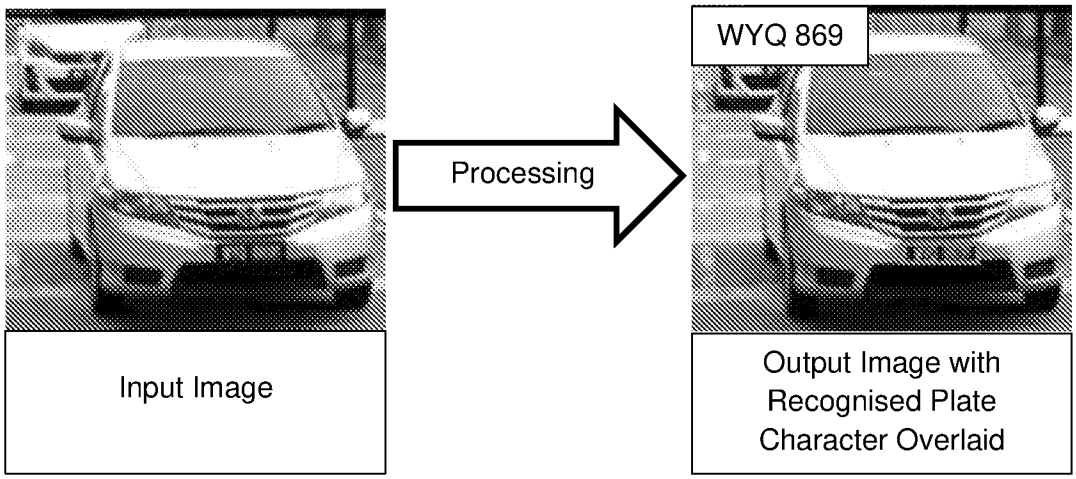
WYQ 869
Processing
Input Image
Output Image with Recognised Plate Character Overlaid
(4a)
(4b)

FIG. 4

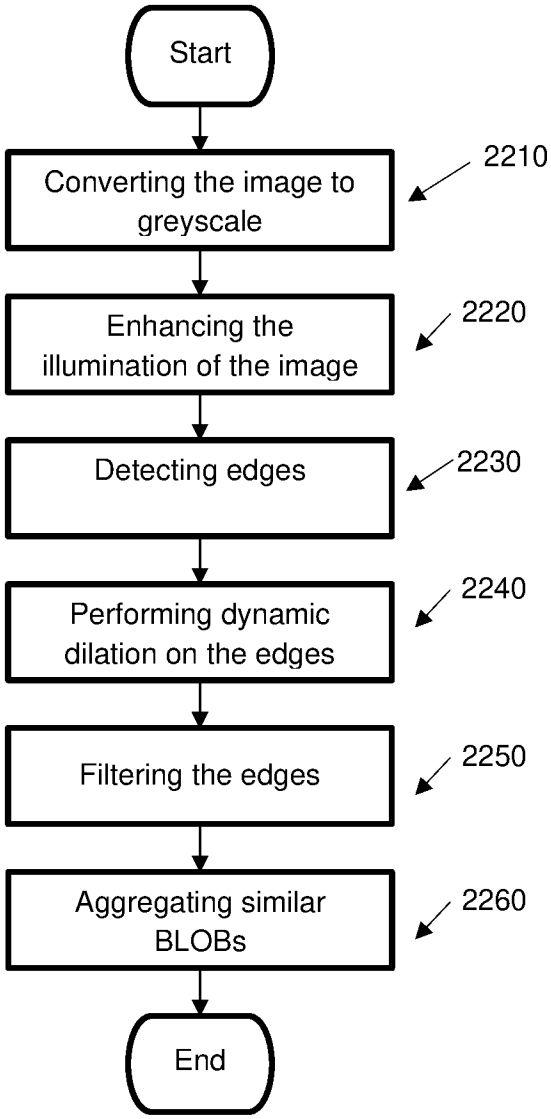
Start
Converting the image to greyscale
2210
Enhancing the illumination of the image
2220
Detecting edges
2230
Performing dynamic dilation on the edges
2240
Filtering the edges
2250
Aggregating similar BLOBs
2260
End

FIG. 5

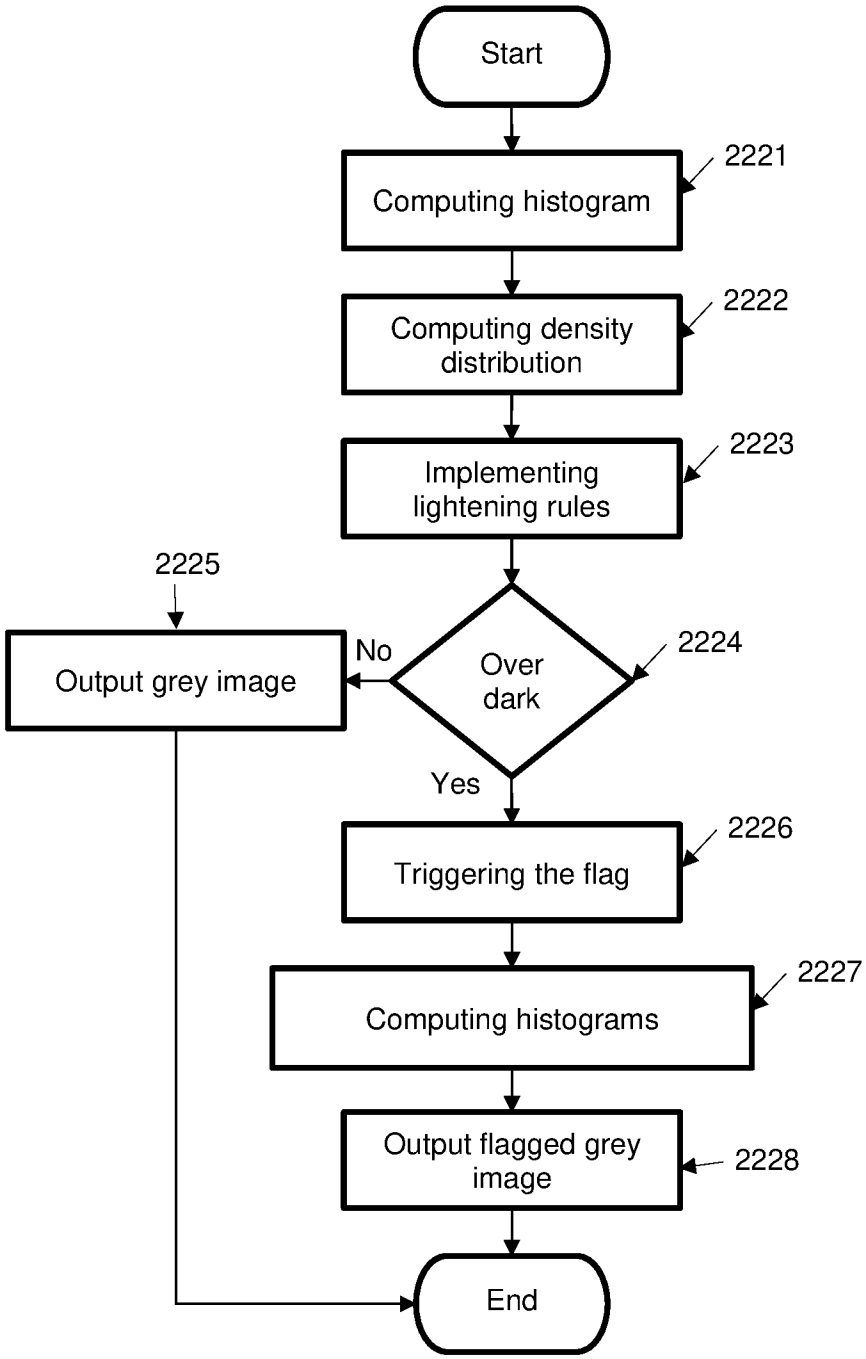
Start
Computing histogram
2221
Computing density distribution
2222
Implementing lightening rules
2223
2225
Output grey image
No
Over dark
2224
Yes
Triggering the flag
2226
Computing histograms
2227
Output flagged grey image
2228
End

FIG. 6

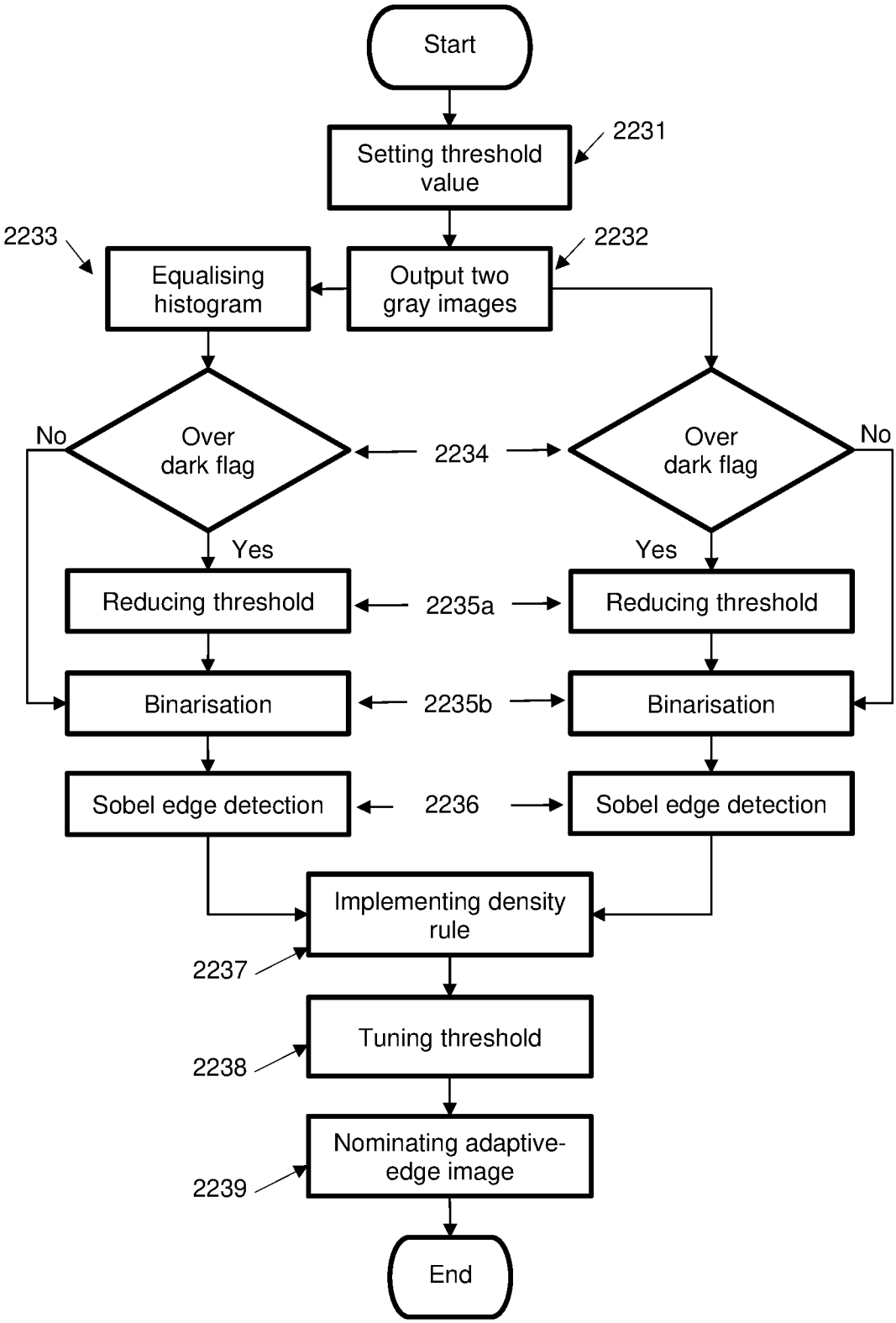
Start
Setting threshold value
2231
2233
Equalising histogram
Output two gray images
2232
No
Over dark flag
2234
Over dark flag
No
Yes
Yes
Reducing threshold
2235a
Reducing threshold
Binarisation
2235b
Binarisation
Sobel edge detection
2236
Sobel edge detection
Implementing density rule
2237
Tuning threshold
2238
Nominating adaptive-edge image
2239
End

FIG. 7

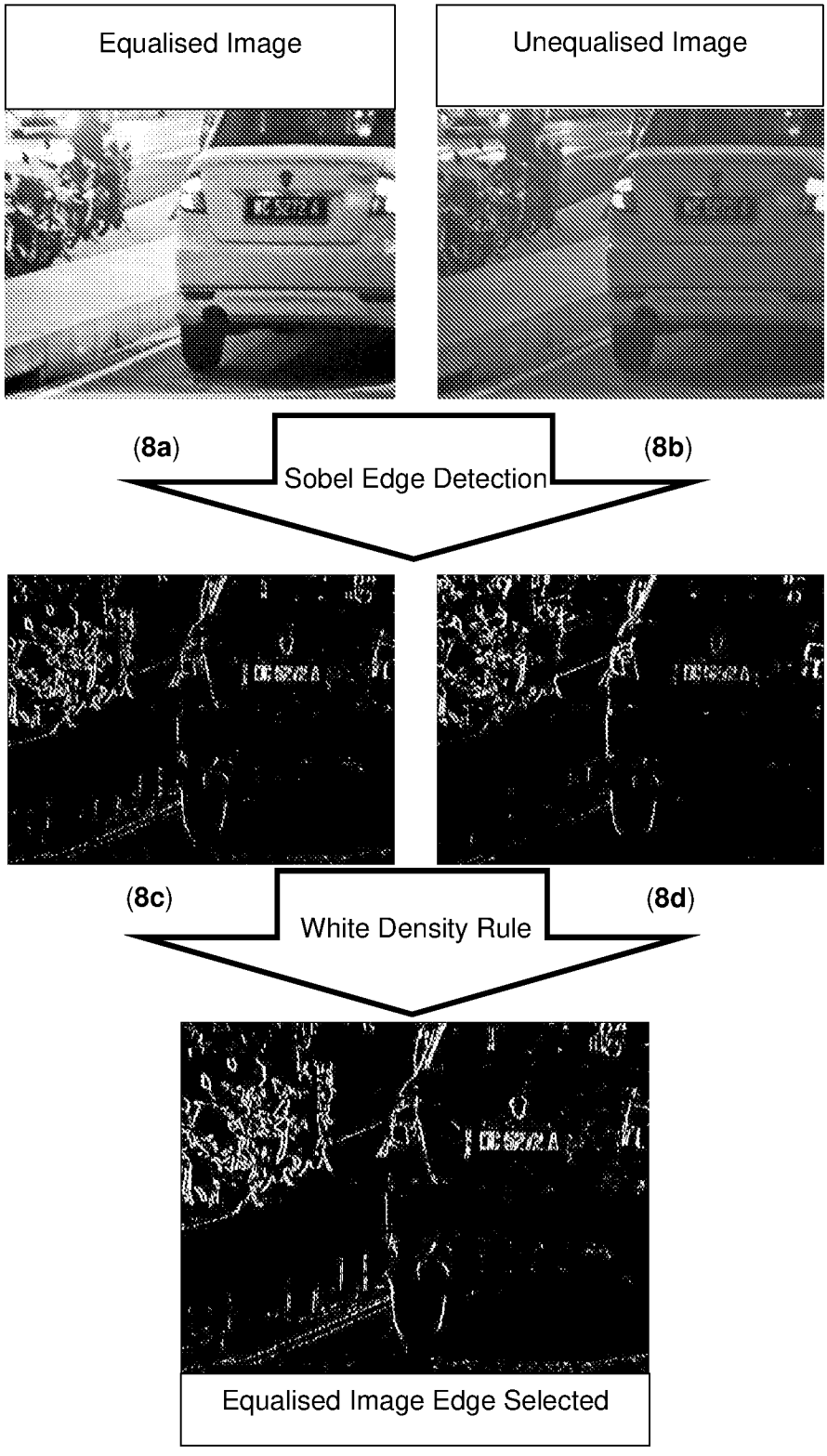
Equalised Image
Unequalised Image
(8a)
Sobel Edge Detection
(8b)
(8c)
White Density Rule
(8d)
Equalised Image Edge Selected
(8e)

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2019/050123

A. CLASSIFICATION OF SUBJECT MATTER

G06K 9/32(2006.01)i, G06K 9/46(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)
G06K 9/32; G06K 9/00; G06K 9/46

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: license plate, image, recognize, illumination, contrast

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	HOOI SIN NG et al. Detection and Recognition of Malaysian Special License Plate Based On SIFT Features. Computer Vision and Pattern Recognition [online], April 2015 [retrieved on 2020-04-07]. Retrieved from <arXiv.org, https://arxiv.org/abs/1504.06921>page 4 and figures 1-5	1-7
Y	US 2013-0129151 A1 (JOSE ANTONIO RODRIGUEZ SERRANO et al.) 23 May 2013 paragraphs [0043]-[0044] and figure 4	1-7
A	WO 2014-193220 A2 (MIMOS BERHAD) 04 December 2014 claims 1-4 and figures 4-10	1-7
A	CN 106650553 A (BYD COMPANY LIMITED) 10 May 2017 claims 1-6 and figures 1-9	1-7
A	US 2012-0269398 A1 (ZHIGANG FAN et al.) 25 October 2012 claims 1-7 and figures 1-8	1-7

☐ 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
"D" document cited by the applicant in the international application
"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
24 April 2020 (24.04.2020)	**24 April 2020 (24.04.2020)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2019/050123

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP 2595092 A3	03/09/2014
		EP 2595092 B1	02/03/2016
		EP 2897082 A1	22/07/2015
		EP 2897082 B1	31/07/2019
		US 2013-0129152 A1	23/05/2013
		US 8582819 B2	12/11/2013
		US 8588470 B2	19/11/2013
WO 2014-193220 A2	04/12/2014	WO 2014-193220 A3	23/04/2015
CN 106650553 A	10/05/2017	None	
US 2012-0269398 A1	25/10/2012	US 8792682 B2	29/07/2014