(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 January 2022 (27.01.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/019747 A1

(51) International Patent Classification:
G06K 9/32 (2006.01) *G06N 3/08* (2006.01)

(21) International Application Number:
PCT/MY2020/050188

(22) International Filing Date:
02 December 2020 (02.12.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PI 2020003846 24 July 2020 (24.07.2020) MY

(71) Applicant: **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, Kuala Lumpur, 57000 (MY).

(72) Inventors: **MOKAYED, Hamam**; MIMOS Berhad, Technology Park Malaysia, Kuala Lumpur, 57000 (MY). **HON, Hock Woon**; MIMOS Berhad, Technology Park Malaysia, Kuala Lumpur, 57000 (MY). **HASAN, Hasmarina**; MIMOS Berhad, Technology Park Malaysia, Kuala Lumpur, 57000 (MY). **YUEN, Shang Li**; MIMOS Berhad, Technology Park Malaysia, Kuala Lumpur, 57000 (MY).

(74) Agent: **AWANG, Muhammad Irfan Mustaqim**; Patentsworth International Sdn Bhd, A-SG-11A, Sunway GEO Avenue, Jalan Lagoon Selatan, Sunway South Quay, Sunway City, Subang Jaya, 47500 (MY).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

WO 2022/019747 A1

(54) Title: SYSTEM AND METHOD FOR IDENTIFICATION OF TEXT REGION IN VIDEO

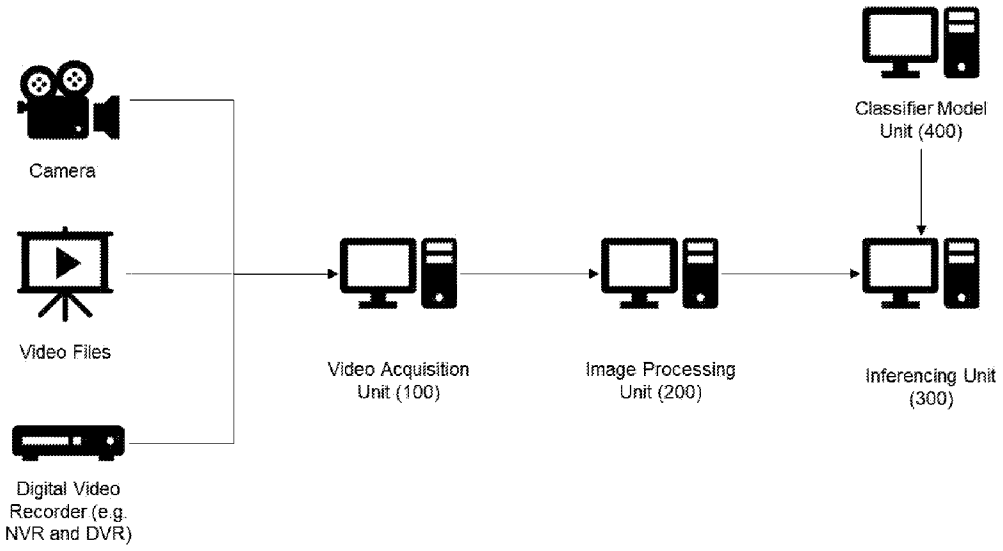

FIGURE 1

(57) Abstract: The present invention discloses a system and a method for identifying a text region in a video captured by a moving or still camera. The system comprises a video acquisition unit to obtain images recorded in an input video, an image processing unit comprising a seed point extraction unit and a text box determination unit to identify seed points of the images and locate potential text regions therefrom, and an inferencing unit comprising a classification module to characterize and verify the potential text regions. The seed point extraction unit comprises a statistical moment analysis module, a K-means clustering module, a N x N kernel for convolution module and a linearity evaluation module.

[Continued on next page]

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, 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, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

SYSTEM AND METHOD FOR IDENTIFICATION OF TEXT REGION IN VIDEO

FIELD OF THE INVENTION

The present invention generally relates to the field of digital imaging. More particularly, the present invention relates to a system and a method for identifying a text region in a video captured using a camera.

BACKGROUND OF THE INVENTION

Text detection is important for any text recognition system where it deals with detecting presence of text in input images. It is one of the most challenging and commonly dealt in the field of artificial intelligence, augmented reality, and other innovations. The text may appear on any part of the input images and the regions that contain is referred to as text regions. The use of texts is extensive, and they can be found in many places, for example, car license plates, signboards, or billboards. These texts may be located or can be found at various positions which are difficult to access for scanning and information extraction.

For obtaining the input images, cameras on a moving platform such as unmanned aerial vehicle (UAV) and unmanned ground vehicle (UGV) may be employed. The cameras on the moving platform receive a good traction from video acquisition industry as this way of video acquisition leaves the cameras always in an active mode for reaching to many places. For instance, considers a car park management that requires recognition or identification of all vehicles' license plates. Typically, a stationary, static or non-moving camera will be placed at entry and exit points of the car park in order to enable scanning of those license plates. This approach however is simply not feasible and practical for mass scanning as the stationary camera would only be able to scan one license plate at a time. The moving cameras provides a solution for mass scanning and information extraction. The moving cameras may be deployed to the car park for actively scanning all the parked vehicles.

The videos or images produced by the moving cameras however exhibits several unfavorable properties as compared to the static cameras. These properties include noises in terms of contrast, brightness, motion blur, perspective distortions and object quality in terms of level of details. Also, as the camera is moving in

relative with the scene, it causes changes in height, distance, and angle which are directly affecting the view of the camera. The combination of these effects gives rise to low quality resultant video or image sequences. Besides that, due to the variability in imaging conditions, for example, lighting, specular reflections, commotion, obscure, and nearness of blocks over the content, and in the changeability of the content itself, for example, its scale, introduction, textual style, and style, the text detection remains a challenging problem.

In addition to the problems, as most of the time text detection is an uncooperative in nature and text can appear anywhere in the camera view, quite clearly, a new approach must be developed to detect the actual text regions of the texts before subsequence processes can be executed for recognition and other purposes.

By way of background, United States Patent 6,704,449 B1 discloses a method for extracting text from images whereby the intensity of each color plane of the image is identified. According to the '449 patent, the color plane with the highest intensity is converted into a black and white image, and character recognition is performed on the black and white image to determine the text of the image. The method of the '449 patent can be used for textual word searches for images with the capability to perform text searches for images. This method suggested by the '449 patent makes some global assumptions about background content that might work for displayed images such as those downloaded from web pages, but would have limited usefulness for videos and images that may have complex color backgrounds.

It would, therefore, be advantageous to provide a solution that would overcome the deficiencies and shortcomings of prior art by way of providing a system and a method for identifying the actual text regions in the videos captured using the moving cameras prior to text recognition or any other processes. Although there are systems and methods for the same in the prior art, for many practical purposes, there is still considerable room for improvement.

SUMMARY OF THE INVENTION

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is

not an extensive overview of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

Accordingly, the present invention provides a system for identifying a text region in a video.

The system of the present invention comprises a video acquisition unit configured for receiving an input video from one or more cameras, wherein the video acquisition unit analyzes the input video to obtain images recorded thereof; The system further comprises an image processing unit configured for receiving the images transmitted from the video acquisition unit. The image processing unit comprises a seed point extraction unit configured for processing each pixel in the images to generate a phase congruency map having candidate pixels. The seed point extraction unit comprises a statistical moment analysis module configured to process the phase congruency map thereof to extract max moments of corner points associated with potential text regions; a K-means clustering module configured to cluster the max moments extracted thereof; a N x N kernel for convolution module configured to determine neighboring points in pair for each of the candidate pixels and distance values therebetween using the phase congruency map; and a linearity evaluation module configured to determine seed points of the potential text regions from the images by way of subjecting the distance values computed thereof to linearity checking. The image processing unit further comprises a text box determination unit comprising an edge detection module configured for generating edged images by way of processing the images using an edge detection model. The text box determination unit superimposes the seed points on the edged images to analyze edge data resulting therefrom. The text box determination unit determines a bounding box of the potential text regions based on the edge data thereof. The system further comprises an inferencing unit comprising a classification module configured for characterizing the potential text regions thereof against noises using a trained classifier model to determine a presence of text in the potential text regions, wherein the trained classifier model is selected from a group comprising a machine learning model, a Hidden Markov model, a support vector machine model, and a deep learning model.

Preferably, the one or more cameras include a moving camera and a still camera.

Preferably, the seed point extraction unit determines, for each candidate pixel of the images, a local amplitude and phase and adopts the same for computing the phase congruency map.

Preferably, the statistical moment analysis module utilizes intensity information of the phase congruency map which represents phase and magnitude information per pixel to determine the corner points thereof.

Preferably, the edge detection model is selected from a group comprising a Laplacian filter, Gaussian filter, a Canny filter, an Otsu filter and a Sober filter.

Preferably, the text box determination unit assigns the edge data comprising nominated edges to edge groups based on geometric features which includes width, height, compactness, distance and slope, and removes any of the edge groups that has the nominated edges below a threshold.

Preferably, the potential text regions having the bounding box drawn thereof are an aggregation of the edge groups thereof.

Preferably, the system comprises a classifier model unit configured for preparing the trained classifier model and providing the same to the inferencing unit.

In accordance with another aspect of the present invention, there is provided a method of identifying a text region in a video.

The method of the present invention comprises the steps of receiving and analyzing an input video from one or more cameras to obtain images recorded thereof; processing each pixel in the images to generate a phase congruency map having candidate pixels; processing the phase congruency map thereof to extract max moments of corner points associated with potential text regions; clustering the max moments extracted thereof; determining neighboring points in pair for each of the candidate pixels and distance values therebetween using the phase congruency map; determining seed points of the potential text regions from the images by way of subjecting the distance values computed thereof to linearity checking; generating edged images by way of processing the images using an edge detection model; superimposing the seed points on the edged images to analyze edge data resulting

therefrom; determining a bounding box of the potential text regions based on the edge data thereof; and characterizing the potential text regions thereof against noises using a trained classifier model to determine a presence of text in the potential text regions, wherein the trained classifier model is selected from a group comprising a machine learning model, a Hidden Markov model, a support vector machine model, and a deep learning model.

Further advantages of the present invention include that the system and the method enhance tourist decision-making, reduce users' efforts and preserve their privacy, increase recommendation performance, and improve user satisfaction.

The foregoing and other objects, features, aspects and advantages of the present invention will become better understood from a careful reading of a detailed description provided herein below with appropriate reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Figure 1 is a schematic diagram of a system for identifying a text region in a video according to one embodiment of the present invention;

Figure 2 is a schematic diagram of an image processing unit employed in the system of Figure 1 according to one embodiment of the present invention;

Figure 3 is a schematic diagram of an inferencing unit employed in the system of Figure 1 according to one embodiment of the present invention;

Figure 4 is a flow diagram of a method for identifying a text region in a video according to one embodiment of the present invention;

Figures 5A, 5B, 5C 5D, 5E and 5F, respectively, show a phase congruency map with candidate pixels, a first K-means processed image, a second K-means

processed image, a N x N kernel for convolution, a first plot of distance values and a second plot of distance values for linearity checking which are related to the seed point extraction unit according to one embodiment of the present invention;

Figures 6A, 6B, 6C and 6D, respectively, show a processed image with extracted seed points, an edged image, a superimposed image and a filtered image which are related to the text box determination unit according to one embodiment of the present invention;

Figure 7 is a flow diagram of a classifier model employed in a classification module of an inferencing unit according to one embodiment of the present invention; and

Figures 8A and 8B, respectively, show a raw input image and a final processed image of a scene that is subjected to the system and method according to one embodiment of the present invention.

It is noted that the drawings may not be to scale. The drawings are intended to depict only typical aspects of the invention, and therefore should not be considered as limiting the scope of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention discloses a system and a method for identifying a text region in a video captured using one or more cameras prior to text recognition or any other processes.

The term “text region” as used herein refers to a region in an image that comprises text. Likewise, the term “potential text region” as used herein refers to a candidate text region in an input image that potentially contains text.

The one or more cameras essentially refer to an image capture device or multiple image capture devices and equivalents thereof known to those skilled in the art. The term “camera” may include moving, stationary, static, and still image cameras and video cameras. A camera may be analog or digital. In some embodiments, the camera may capture high-definition video. In some embodiments, the camera may be configured to stream image data (e.g. video data

or files) to a computing device and/or remote computing device via a wired or wireless communication pathway. The computing device may be a camera or other memory storing the video data or files, a digital video recorder (DVR), a network video recorder (NVR) and the like.

According to one preferred embodiment of the present invention, the system comprises a video acquisition unit **100**, an image processing unit **200**, an inferencing unit **300** and a classifier model unit **400**. An interconnection and interrelationship between the video acquisition unit **100**, the image processing unit **200**, the inferencing unit **300** and the classifier model unit **400** are schematically shown in Figure 1.

The video acquisition unit **100** is preferably connected to the camera or to any computing device associated with the camera thereof. The video acquisition unit **100** is configured for receiving an input video streamed from the camera or the associated computing device. Upon receiving, the video acquisition unit **100** analyzes the input video thereof to obtain one or more images recorded thereof. It is preferred that the video acquisition unit **100** performs a conversion process onto the input video to generate images with an equivalent or appropriate resolution.

Once the images are completely extracted from the input video, the video acquisition unit **100** transmits those images to the image processing unit **200** for further processing. The image processing unit **200** preferably comprises a seed point extraction unit **201** and a text box determination unit **202** as shown in Figure 2.

The seed point extraction unit **201** is configured for processing each pixel in the images thereof to generate a phase congruency map having candidate pixels. It is also configured to determine, for each candidate pixel of the images, a local amplitude and phase and adopts the same for computing the phase congruency map.

The seed point extraction unit **201** preferably comprises a statistical moment analysis module **201a**, a K-means clustering module **201b**, a N x N kernel for convolution module **201c**, and a linearity evaluation module **201d**.

The statistical moment analysis module **201a** is configured to process the phase congruency map thereof to extract max moments of corner points associated with potential text regions. In one embodiment, the statistical moment analysis module **201a** utilizes intensity information of the phase congruency map which represents phase and magnitude information per pixel to determine the corner points thereof. In an alternative embodiment, the seed point extraction unit **201** may utilize any corner or edge detection models.

The K-means clustering module **201b** is configured to cluster the max moments extracted from the phase congruency map thereof. In one embodiment, the K number can be any integer that is equal to or greater than 2.

The N x N kernel for convolution module **201c** is configured to determine neighboring points in pair for each of the candidate pixels of the phase congruency map. It is further configured to compute distance values between the detected neighboring points using the phase congruency map thereof. In one embodiment of the N x N kernel for convolution module **201c**, the N can be any odd integer, for examples 3, 5 and 7.

The linearity evaluation module **201d** is configured to determine, shortlist and finalize seed points of the potential text regions from the images. In one embodiment, the seed points can be obtained by way of subjecting the distance values computed thereof to linearity checking. The linearity checking involves a linearity evaluation to check all connected points are linear in any gradient value.

Once the seed points have been determined, the text box determination unit **202** will employ those seed points for a subsequent process. The text box determination unit preferably comprises an edge detection module **202a**. It is configured for generating edged images by way of processing the images using an edge detection model. According to one embodiment, the edge detection model is selected from a group comprising a Laplacian filter, Gaussian filter, a Canny filter, an Otsu filter, and a Sober filter.

The text box determination unit **202** preferably superimposes the seed points on the edged images generated thereof. Edge data resulting therefrom which may include nominated edges will be subject to an analysis by the text box determination unit **202**. Accordingly, the text box determination unit **202** assigns the

edge data with the nominated edges to one or more edge groups based on geometric features. The geometric features may include width, height, compactness, distance, and slope or gradient. The text box determination unit **202** removes any of the edge groups that has the nominated edges below a predefined threshold. The edge groups which remains and were not removed by the text box determination unit **202** shall be considered in the following course.

At the next course, the text box determination unit **202** determines and draws a bounding box of the potential text regions based on the edge data thereof. It is preferred that the potential text regions having the bounding box drawn thereof are an aggregation of the remaining, non-removed edge groups thereof.

The inferencing unit **300** preferably comprises a classification module **301** as shown in Figure 3. It is configured for characterizing the potential text regions identified thereof against noises using a trained classifier model to determine a presence of text in the potential text regions. By performing this content classification, i.e. the determination of presence of text thereof, the inferencing unit **300** would be able to differentiate and hence, verify the said text regions in respect of text properties and non-text properties. In one embodiment, the inferencing unit **300** may be an online or offline inferencing unit.

The potential text regions employed at the inferencing unit **300** are preferably those that have been processed by the text box determination unit **202** and that have been drawn with the bounding box. In one embodiment, the trained classifier model is selected from a group comprising a machine learning model, a Hidden Markov model, a support vector machine model, and a deep learning model.

The classifier model unit **400** connected to the inferencing unit **300** is preferably configured for preparing the trained classifier model including training of classifier models using a set of training data to reflect salient attributes and behaviors of the phenomena being modeled. The trainings may include a parallel training of multiple classifier models or a sequential training of multiple classifier models. The training data includes historical training data associated with the identification of text regions in videos or images. The classifier model unit **400** is further configured to provide the trained classifier model to the inferencing unit **300**.

As with the method of the present invention, Figure 4 provides a summarized flow diagram depicting the steps involved, as explained in the preceding paragraphs in connection with the system thereof. For purposes of clarity in explanation and understanding, the method of the present invention will be described in the following section.

The method of the present invention preferably comprises the following steps:

S500 - receiving and analyzing an input video from one or more cameras to obtain images recorded thereof;

S501 - processing each pixel in the images to generate a phase congruency map having candidate pixels;

S502 - processing the phase congruency map thereof to extract max moments of corner points associated with potential text regions;

S503 - clustering the max moments extracted thereof;

S504 - determining neighboring points in pair for each of the candidate pixels and distance values therebetween using the phase congruency map;

S505 - determining seed points of the potential text regions from the images by way of subjecting the distance values computed thereof to a linearity checking;

S506 - generating edged images by way of processing the images using an edge detection model;

S507 - superimposing the seed points on the edged images to analyze edge data resulting therefrom;

S508 - determining a bounding box of the potential text regions based on the edge data thereof; and

S509 - characterizing the potential text regions thereof against noises using a trained classifier model to determine a presence of text in the potential text regions,

The present invention will now be specifically described by the following examples, but it should be understood that the invention is not limited in any way to these examples.

Example 1

Determination of Seed Points

The determination of seed points is referred to the seed point extraction unit **201**. For each pixel in an image, the seed point extraction unit **201** determines magnitudes of a local amplitude, A_{no} and phase, $\emptyset_{no}$ as defined in Equations 1 and 2, respectively.

$$A_{no} = \sqrt{e_{no}(x,y)^2 + O_{no}(x,y)^2} \quad (1)$$

$$\emptyset_{no} = atan2\big(e_{no}(x,y), O_{no}(xy)\big) \quad (2)$$

By using the above equations, the seed point extraction unit **201** estimates a phase congruency for preparing a phase congruency map as defined in Equation 3 which is cosine minus magnitude of the sine of the phase deviation.

$$PC_2(x) = \frac{\sum_n W(x)[A_n(x)(\cos(\emptyset_n(x) - \bar{\emptyset}(x)) - \left|\sin\big(\emptyset(x) - \bar{\emptyset}(x)\big)\right|) - T]}{\sum_n A_n(x) + \epsilon} \quad (3)$$

Figure 5A illustrates an exemplary phase congruency map of the present invention.

Further, the seed point extraction unit **201** utilizes information of phase congruency's variation with orientation for use in the statistical moment analysis module **201a** as defined in Equation 4 to calculate moment information including max moments.

$$a = \sum(PC(\theta)\cos(\theta))^2$$
$$b = 2\sum(PC(\theta)\cos(\theta))(PC(\theta)\sin(\theta)) \quad (4)$$

$$c = \sum(PC(\theta)\sin(\theta))^2$$

$$\phi = \frac{1}{2}atan2\left(\frac{b}{\sqrt{b^2+(a-c)^2}}, \frac{a-c}{\sqrt{b^2+(a-c)^2}}\right) \quad (5)$$

$$M = \frac{1}{2}\left(c + a + \sqrt{b^2 + (a-c)^2}\right) \quad (6)$$

$$m = \frac{1}{2}\left(c + a - \sqrt{b^2 + (a-c)^2}\right) \quad (7)$$

The statistical moment analysis module **201a** extracts the max moments of the detected points from the phase congruency map thereof (for corner points detection).

At the K-means clustering module **201b**, the pixels which represent a text cluster are classified using a K-means clustering model. In this regard, the K-means clustering model is set to value X. The value X can range from 2 to 5. Figures 5B and 5C illustrates an exemplary first K-means processed image and an exemplary second K-means processed image associated thereof.

Next, the K-means pixels are convoluted using 3 x 3 convolution by the N x N kernel for convolution module **201c** using information or values retrieved from the phase congruency map thereof, as follows:

0.234382	0.483961	0.670638
0.196997	0.438693	0.667947
0.131925	0.312482	0.449373

Based on the convolution, the N x N kernel for convolution module **201c** finds the closest neighboring points in pair (there will be eight points which form four start and end points to form a vector) and their distance values from each other. The N x N kernel for convolution module **201c** calculates the distances values based on the closest neighboring points thereof. Figure 5D illustrates an exemplary convolution thereof.

The linearity evaluation module **201d** checks the linearity of the distance values in order to find seed points. It formulates a line and links the four vectors into a plot. The linearity checking is as follows:

$$slope = (sum_{xy} - sum_x * y_{mean})/(sum_{xx} - sum_x * x_{mean}) \quad (8)$$

where $sum_x = \sum_{i=0}^{i=3} xDist_i$

$$sum_y = \sum_{i=0}^{i=3} yDist_i$$

$$sum_{xy} = \sum_{i=0}^{i=3} xDist_i * yDist_i$$

$$sum_{xx} = \sum_{i=0}^{i=3} xDist_i * xDist_i$$

If (diff < β) -> nominated seed points (9)

where

$$diff = \sum_{i=0}^{i=3} abs(yDist_i - (slope * xDist_i + (y_{mean} - slope * x_{mean}))$$

Figures 5E and 5F provides an exemplary first plot of distance values and an exemplary second plot of distance values for the linearity checking.

Eight neighboring points of each candidate pixel in the image will be used for detecting false candidates based on new clustering. The N x N kernel for convolution module **201c** finds the minimum of its eight neighbors and then finds the element which is closest to it from other elements. This results in cluster-1 containing a pair of elements with close proximity. For the second iteration, it chooses the minimum from the list of the remaining elements (excluding those in cluster-1). This process results in four clusters containing pairs of elements for 8 neighbors of each candidate pixel. For each of the four clusters, the N x N kernel for convolution module **201c** computes absolute differences, which outputs four distance values for the respective clusters. It is expected that if the candidate pixel happens to be a text pixel, the distances values must share nearly the same values and hence will satisfy the linearity property. Otherwise, the distance values satisfy

the non-linearity property as illustrated in Figures 5E and 5F, where it can be seen that the line in Figure 5F behaves linearity for candidate text pixels and the line in Figure 5E behaves non-linearly property for false candidate pixels.

Example 2
Determination of Text Box

The text box determination unit **202** applies an edge detection model or algorithm onto a raw input frame, i.e. the images transmitted from the video acquisition unit **100** thereof to produce edged images.

The seed points in Example 1 are superimposed on or intersected with the edged images to obtain edge data which includes the nominated edges. The edges with overlapped seed points will be kept. The nominated edges (and neighboring edges) are grouped together to edge groups according to the geometric features such as width, height, compactness and distance.

The edge detection module **202a** filters out the edge group(s) which has lower number of members according to the predefined threshold of number of edges. The isolated edge groups will be isolated. The edge detection module **202a** aggregates the group elements to obtain the nominated text regions. Finally, a bounding box is provided and drawn based on the region of the edge groups.

Figures 6A, 6B, 6C and 6D, respectively, illustrate an exemplary processed image with extracted seed points obtained from the seed point extraction unit **201**, an exemplary edged image, an exemplary superimposed image and an exemplary filtered image.

Example 3
Content Classification

The inferencing unit **300** applies a trained classifier model to the potential text regions as identified by the text box determination unit **202**. The trained classifier model subjects the potential text regions thereof through the flow diagram of the trained classifier model as shown in Figure 7. During the process, the classification module **301** of the inferencing unit **300** differentiates and verifies the

text regions in respect of text properties and non-text properties to identify text object and non-text object.

With respect to the preparation of the trained classifier model, the classifier model unit **400** is employed. The classifier model unit **400** creates a trained classifier model with two classes that are capable of differentiating text properties from non-text properties, for instance text object and non-text object. The classifier model is trained with training data such as sample images of the said two classes.

Once trained, the classifier model unit **400** will apply the trained classifier model to the classification module **301** of the inferencing unit **300**.

Figure 8A shows an exemplary raw input image of a scene. Figure 8B shows an exemplary processed image of the same scene with a plurality of bounding boxes drawn at the potential text regions detected thereof using the system and the method demonstrated by the present invention.

Although an overview of the inventive subject matter has been described with reference to specific example embodiments, various modifications and changes may be made to these embodiments without departing from the broader scope of embodiments of the present disclosure. Such embodiments of the inventive subject matter may be referred to herein, individually or collectively, by the term “invention” merely for convenience and without intending to voluntarily limit the scope of this application to any single disclosure or inventive concept if more than one is, in fact, disclosed.

The embodiments illustrated herein are described in sufficient detail to enable those skilled in the art to practice the teachings disclosed. Other embodiments may be used and derived therefrom, such that structural and logical substitutions and changes may be made without departing from the scope of this disclosure. The Detailed Description, therefore, is not to be taken in a limiting sense, and the scope of various embodiments is defined only by the appended claims, along with the full range of equivalents to which such claims are entitled.

As used herein, the term “or” may be construed in either an inclusive or exclusive sense. Moreover, plural instances may be provided for resources, operations, or structures described herein as a single instance. Additionally,

boundaries between various resources, operations, modules, engines, and data stores are somewhat arbitrary, and particular operations are illustrated in a context of specific illustrative configurations. Other allocations of functionality are envisioned and may fall within a scope of various embodiments of the present disclosure. In general, structures and functionality presented as separate resources in the example configurations may be implemented as a combined structure or resource. Similarly, structures and functionality presented as a single resource may be implemented as separate resources. These and other variations, modifications, additions, and improvements fall within a scope of embodiments of the present disclosure as represented by the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

The foregoing description, for the purpose of explanation, has been described with reference to specific example embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the possible example embodiments to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The example embodiments were chosen and described in order to best explain the principles involved and their practical applications, to thereby enable others skilled in the art to best utilize the various example embodiments with various modifications as are suited to the particular use contemplated.

It will also be understood that, although the terms “first,” “second,” and so forth may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first contact could be termed a second contact, and, similarly, a second contact could be termed a first contact, without departing from the scope of the present example embodiments. The first contact and the second contact are both contacts, but they are not the same contact.

The terminology used in the description of the example embodiments herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used in the description of the example embodiments and the appended examples, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term “and/or” as used herein refers to and encompasses any and all possible combinations of one or more of the associated

listed items. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

As used herein, the term “if” may be construed to mean “when” or “upon” or “in response to determining” or “in response to detecting,” depending on the context. Similarly, the phrase “if it is determined” or “if [a stated condition or event] is detected” may be construed to mean “upon determining” or “in response to determining” or “upon detecting [the stated condition or event]” or “in response to detecting [the stated condition or event],” depending on the context.

CLAIMS

1. A system for identifying a text region in a video, **characterized in that**, the system comprising:

a video acquisition unit (100) configured for receiving an input video from one or more cameras, wherein the video acquisition unit (100) analyzes the input video to obtain images recorded thereof;

an image processing unit (200) configured for receiving the images transmitted from the video acquisition unit (100), comprising:

a seed point extraction unit (201) configured for processing each pixel in the images to generate a phase congruency map having candidate pixels, comprising:

a statistical moment analysis module (201a) configured to process the phase congruency map thereof to extract max moments of corner points associated with potential text regions;

a K-means clustering module (201b) configured to cluster the max moments extracted thereof;

a N x N kernel for convolution module (201c) configured to determine neighboring points in pair for each of the candidate pixels and distance values therebetween using the phase congruency map; and

a linearity evaluation module (201d) configured to determine seed points of the potential text regions from the images by way of subjecting the distance values computed thereof to linearity checking; and

a text box determination unit (202) comprising an edge detection module (202a) configured for generating edged images by way of processing the images using an edge detection model, wherein the text box determination unit (202) superimposes the seed points on the edged images to analyze edge data resulting therefrom, wherein the text box determination unit (202) determines a bounding box of the potential text regions based on the edge data thereof; and

an inferencing unit (300) comprising a classification module (301) configured for characterizing the potential text regions thereof against noises using a trained classifier model to determine a presence of text in the potential text regions.

2. The system according to Claim 1, wherein the one or more cameras include a moving camera and a still camera.

3. The system according to Claim 1, wherein the seed point extraction unit (201) determines, for each candidate pixel of the images, a local amplitude and phase and adopts the same for computing the phase congruency map.

4. The system according to Claim 1, wherein the statistical moment analysis module (201a) utilizes intensity information of the phase congruency map which represents phase and magnitude information per pixel to determine the corner points thereof.

5. The system according to Claim 1, wherein the trained classifier model is selected from a group comprising a machine learning model, a Hidden Markov model, a support vector machine model, and a deep learning model.

6. The system according to Claim 1, wherein the edge detection model is selected from a group comprising a Laplacian filter, Gaussian filter, a Canny filter, an Otsu filter and a Sober filter.

7. The system according to Claim 1, wherein the text box determination unit (202) assigns the edge data comprising nominated edges to edge groups based on geometric features which includes width, height, compactness, distance and slope, and removes any of the edge groups that has the nominated edges below a threshold.

8. The system according to Claim 6, wherein the potential text regions having the bounding box drawn thereof are an aggregation of the edge groups thereof.

9. The system according to Claim 1 further comprises a classifier model unit (400) configured for preparing the trained classifier model and providing the same to the inferencing unit (300).

10. A method of identifying a text region in a video, **characterized in that**, the method comprising the steps of:

receiving and analyzing an input video from one or more cameras to obtain images recorded thereof (S500);

processing each pixel in the images to generate a phase congruency map having candidate pixels (S501);

processing the phase congruency map thereof to extract max moments of corner points associated with potential text regions (S502);

clustering the max moments extracted thereof (S503);

determining neighboring points in pair for each of the candidate pixels and distance values therebetween using the phase congruency map (S504);

determining seed points of the potential text regions from the images by way of subjecting the distance values computed thereof to linearity checking (S505);

generating edged images by way of processing the images using an edge detection model (S506);

superimposing the seed points on the edged images to analyze edge data resulting therefrom (S507);

determining a bounding box of the potential text regions based on the edge data thereof (S508); and

characterizing the potential text regions thereof against noises using a trained classifier model to determine a presence of text in the potential text regions (S509),

wherein the trained classifier model is selected from a group comprising a machine learning model, a Hidden Markov model, a support vector machine model, and a deep learning model.

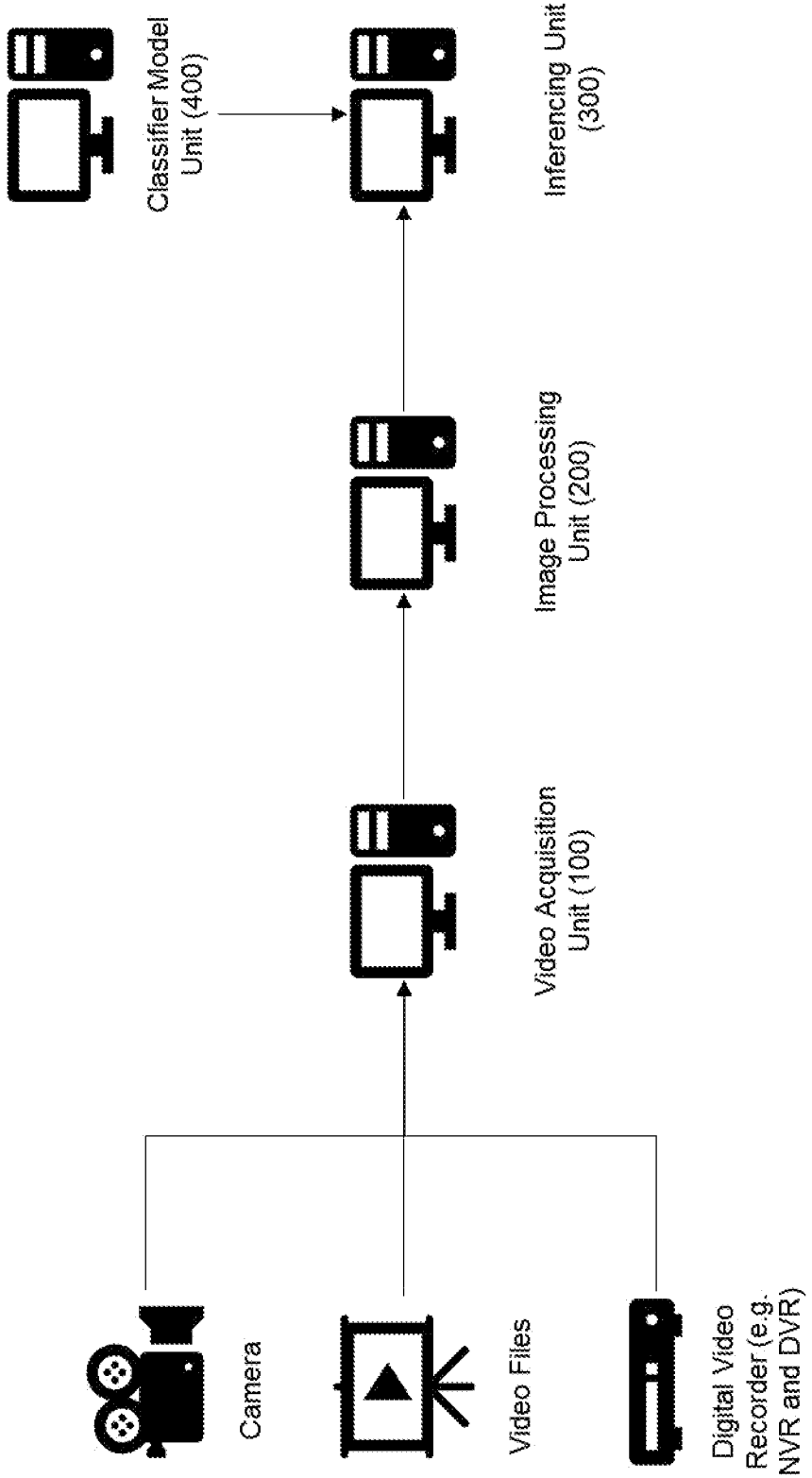
Classifier Model Unit (400)
Inferencing Unit (300)
Image Processing Unit (200)
Video Acquisition Unit (100)
Camera
Video Files
Digital Video Recorder (e.g. NVR and DVR)

FIGURE 1

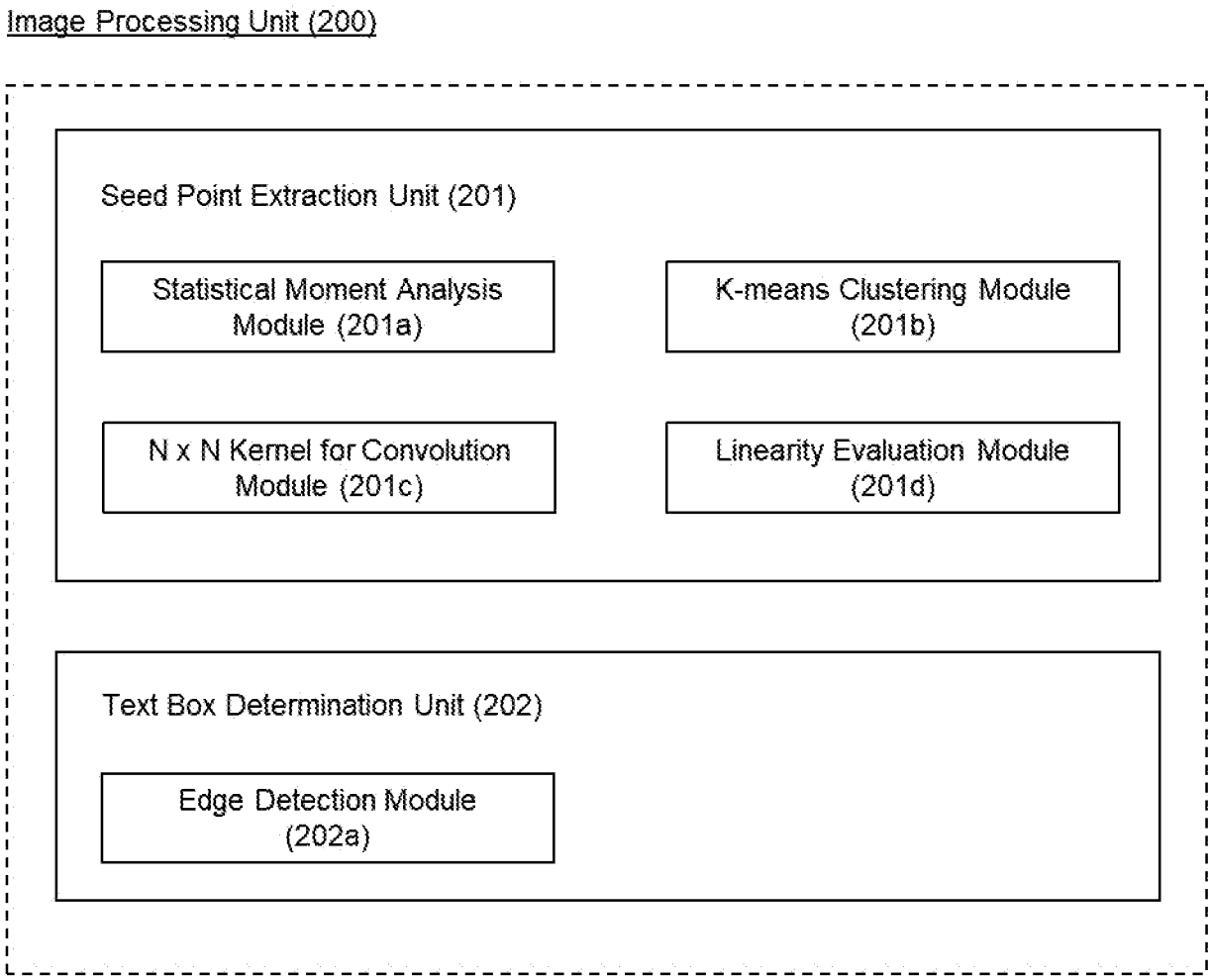

FIGURE 2

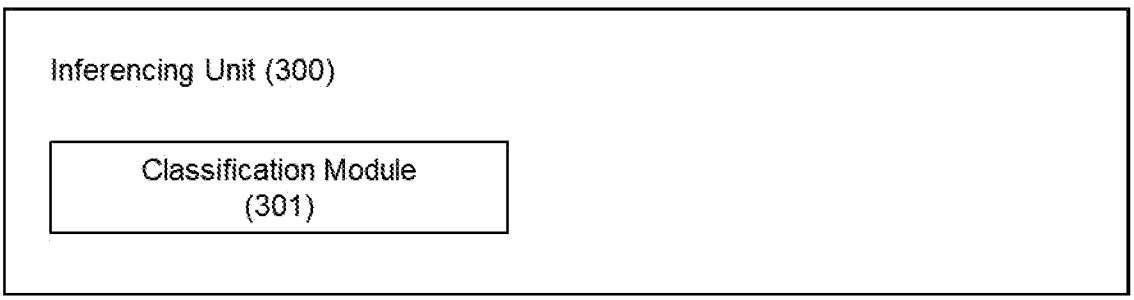

FIGURE 3

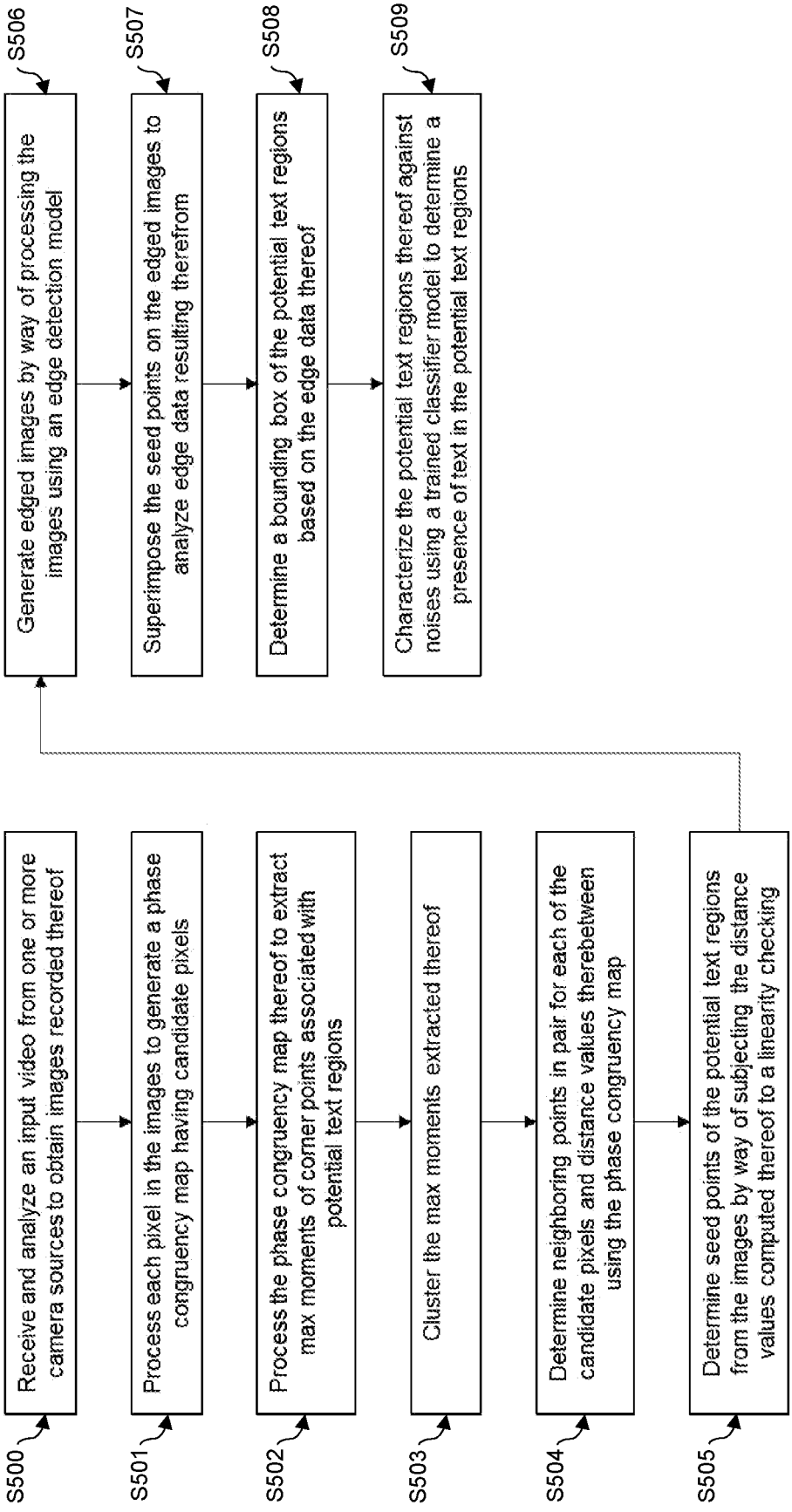
S500
Receive and analyze an input video from one or more camera sources to obtain images recorded thereof
S501
Process each pixel in the images to generate a phase congruency map having candidate pixels
S502
Process the phase congruency map thereof to extract max moments of corner points associated with potential text regions
S503
Cluster the max moments extracted thereof
S504
Determine neighboring points in pair for each of the candidate pixels and distance values therebetween using the phase congruency map
S505
Determine seed points of the potential text regions from the images by way of subjecting the distance values computed thereof to a linearity checking
S506
Generate edged images by way of processing the images using an edge detection model
S507
Superimpose the seed points on the edged images to analyze edge data resulting therefrom
S508
Determine a bounding box of the potential text regions based on the edge data thereof
S509
Characterize the potential text regions thereof against noises using a trained classifier model to determine a presence of text in the potential text regions

FIGURE 4

FIGURE 5A

FIGURE 5B

FIGURE 5C

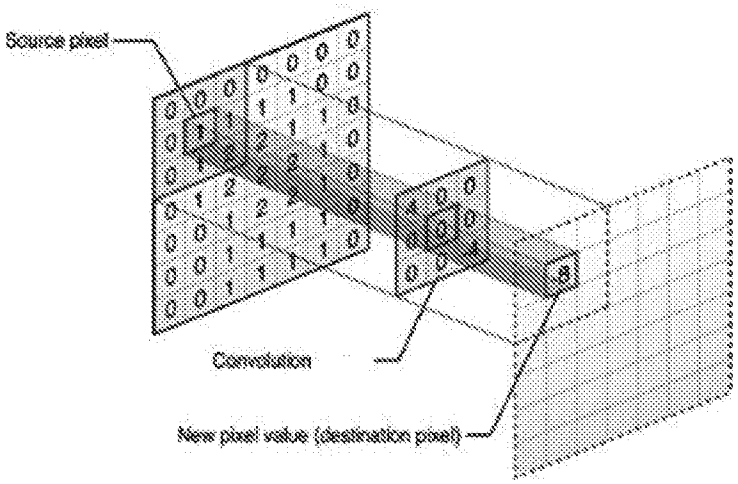

FIGURE 5D

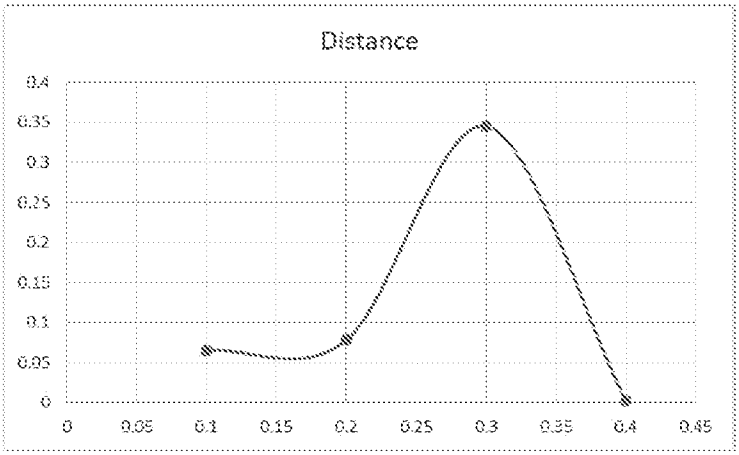

FIGURE 5E

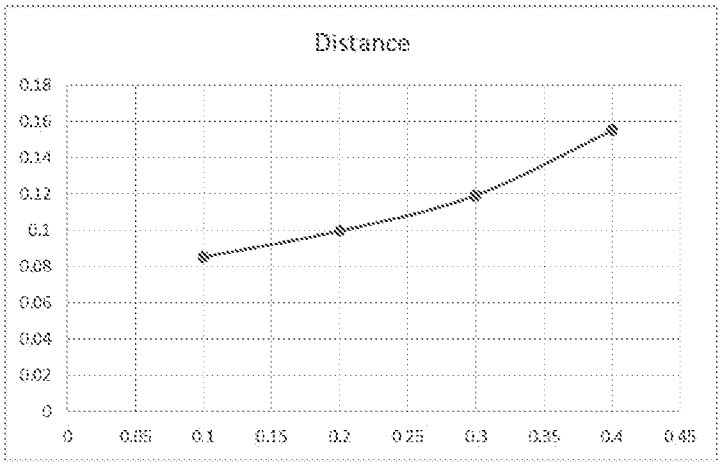

FIGURE 5F

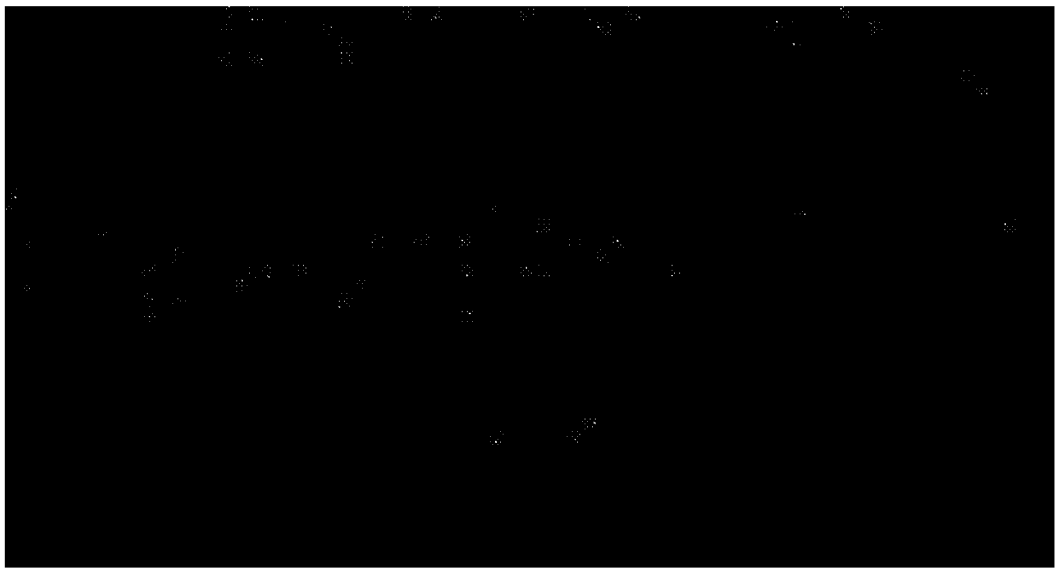

FIGURE 6A

FIGURE 6B

FIGURE 6C

FIGURE 6D

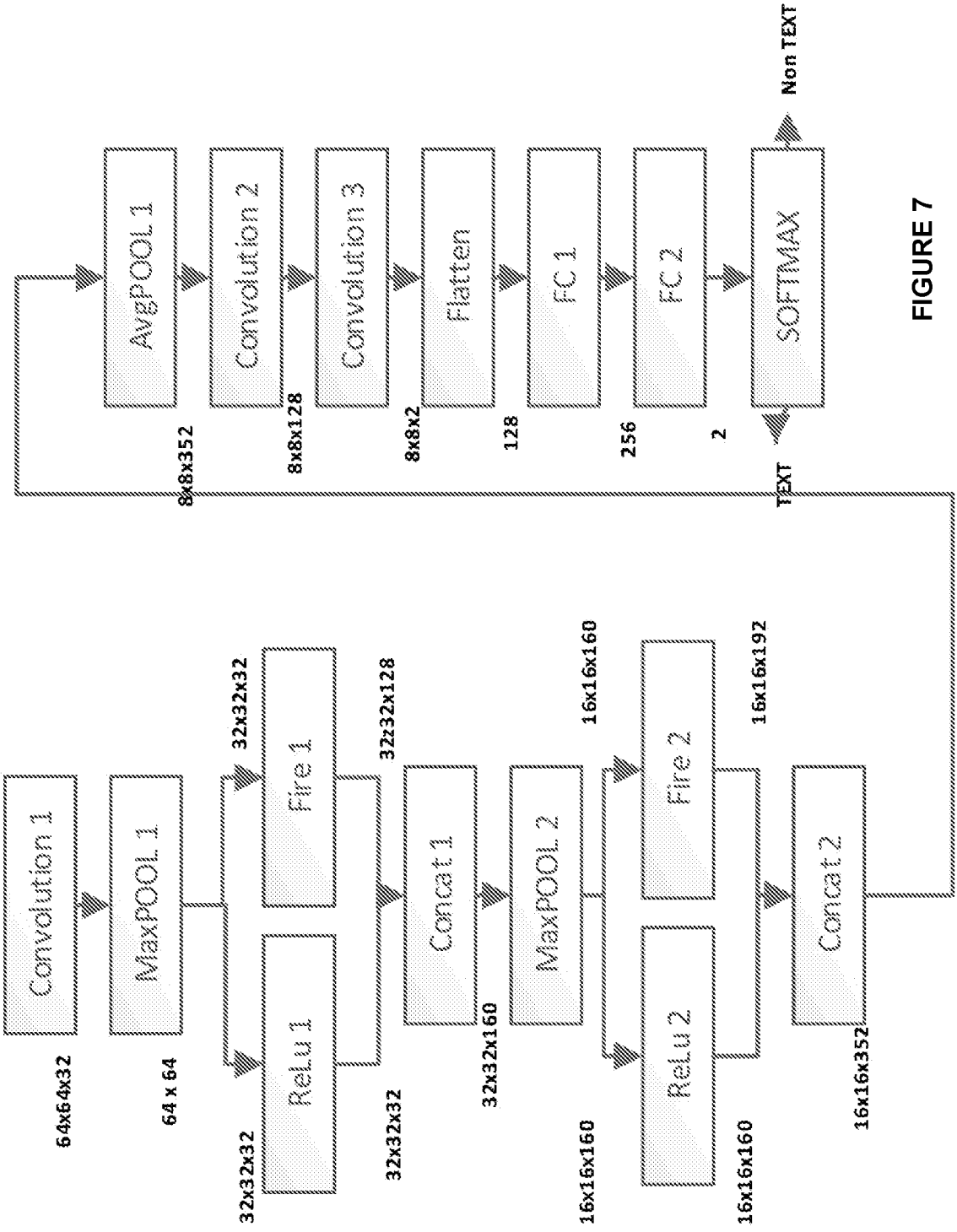
Convolution 1
64x64x32
MaxPOOL 1
64 x 64
32x32x32
Fire 1
32x32x128
Concat 1
32x32x160
MaxPOOL 2
16x16x160
Fire 2
16x16x192
Concat 2
16x16x352
ReLu 1
32x32x32
ReLu 2
16x16x160
AvgPOOL 1
8x8x352
Convolution 2
8x8x128
Convolution 3
8x8x2
Flatten
128
FC 1
256
FC 2
2
SOFTMAX
TEXT
Non TEXT

FIGURE 7

FIGURE 8A

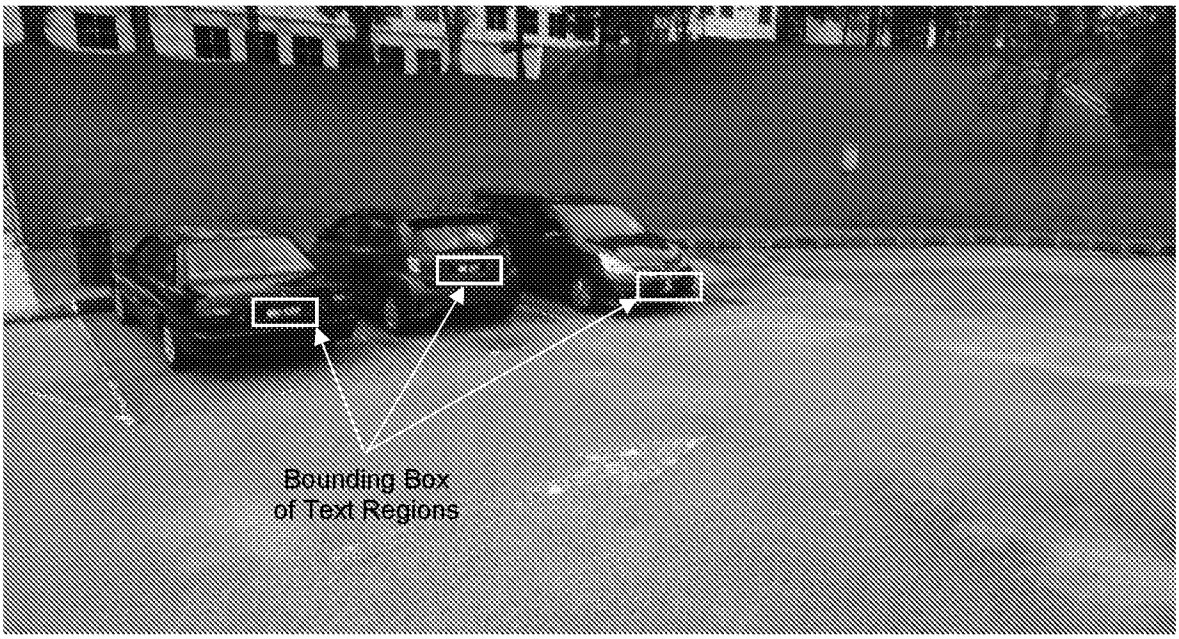

FIGURE 8B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2020/050188

A. CLASSIFICATION OF SUBJECT MATTER

G06K 9/32(2006.01)i; **G06N 3/08**(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(2006.01); G05D 1/02(2006.01); G06K 9/00(2006.01); G06K 9/20(2006.01); G06K 9/34(2006.01); G06K 9/46(2006.01); G06T 5/00(2006.01)

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: image, text region, phase congruency, edge detection, bounding box

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2019-0021066 A (SAMSUNG ELECTRONICS CO., LTD.) 05 March 2019 (2019-03-05) Paragraphs [0040]-[0050], [0061]-[0062]; claim 1; and figures 2a-2b, 6	1-10
A	US 2014-0072219 A1 (YIBIN TIAN) 13 March 2014 (2014-03-13) Claims 1-11; and figures 1(a)-2(d)	1-10
A	KR 10-2016-0043197 A (KUMOH NATIONAL INSTITUTE OF TECHNOLOGY INDUSTRY-ACADEMIC COOPERATION FOUNDATION) 21 April 2016 (2016-04-21) Paragraphs [0035]-[0075]; claims 1-11; and figures 4-9	1-10
A	US 2017-0371345 A1 (MOBILEYE VISION TECHNOLOGIES LTD.) 28 December 2017 (2017-12-28) Paragraphs [0153]-[0327]; claims 1-14; and figures 5A-28	1-10

☑ 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
22 April 2021	**22 April 2021**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **189 Cheongsa-ro, Seo-gu, Daejeon** **35208, Republic of Korea**	**PARK, Hye Lyun**
Facsimile No. **+82-42-481-8578**	Telephone No. **+82-42-481-3463**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2020/050188

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PETER KOVESI, Phase Congruency Detects Corners and Edges, Proc. VIIth Digital Image Computing: Techniques and Applications, Sydney, Australia, Vol 1, pp. 309-318, 12 December 2003 [Retrieved: 31 Mar 2021] from [https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.83.975&rep=rep1&type=pdf] Pages 309-317	1-10

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/MY2020/050188

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-2019-0021066 A	05 March 2019	EP 3660729 A1	03 June 2020
		EP 3660729 A4	09 December 2020
		US 2020-0210742 A1	02 July 2020
		WO 2019-039760 A1	28 February 2019
US 2014-0072219 A1	13 March 2014	JP 2014-057306 A	27 March 2014
		JP 5844783 B2	20 January 2016
		US 8818099 B2	26 August 2014
KR 10-2016-0043197 A	21 April 2016	KR 10-1578784 B1	18 December 2015
		KR 10-1625751 B1	31 May 2016
		KR 10-1696515 B1	13 January 2017
		KR 10-1696519 B1	24 January 2017
		KR 10-2016-0021605 A	26 February 2016
		KR 10-2016-0043198 A	21 April 2016
		US 2017-0337408 A1	23 November 2017
		WO 2016-028048 A1	25 February 2016
US 2017-0371345 A1	28 December 2017	CN 107438754 A	05 December 2017
		CN 108431549 A	21 August 2018
		CN 108431549 B	04 September 2020
		CN 108496178 A	04 September 2018
		CN 109416257 A	01 March 2019
		CN 109416257 B	07 July 2020
		CN 109643367 A	16 April 2019
		CN 109804223 A	24 May 2019
		CN 109891194 A	14 June 2019
		CN 110214264 A	06 September 2019
		CN 110264500 A	20 September 2019
		CN 110325823 A	11 October 2019
		CN 110345961 A	18 October 2019
		CN 110345961 B	16 October 2020
		CN 110345962 A	18 October 2019
		CN 110345963 A	18 October 2019
		CN 110383008 A	25 October 2019
		CN 110657820 A	07 January 2020
		CN 111351494 A	30 June 2020
		CN 111351495 A	30 June 2020
		CN 111380545 A	07 July 2020
		CN 112051855 A	08 December 2020
		CN 112146669 A	29 December 2020
		EP 3256816 A2	20 December 2017
		EP 3400419 A2	14 November 2018
		EP 3400556 A1	14 November 2018
		EP 3403216 A1	21 November 2018
		EP 3475659 A2	01 May 2019
		EP 3475659 B1	20 May 2020
		EP 3488384 A1	29 May 2019
		EP 3516361 A1	31 July 2019
		EP 3526548 A2	21 August 2019
		EP 3532801 A2	04 September 2019
		EP 3532801 B1	16 December 2020
		EP 3545265 A2	02 October 2019

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/MY2020/050188

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
		EP	3548845	A2	09 October 2019
		EP	3559600	A2	30 October 2019
		EP	3598074	A1	22 January 2020
		EP	3611472	A1	19 February 2020
		EP	3614105	A1	26 February 2020
		EP	3614106	A1	26 February 2020
		EP	3657130	A1	27 May 2020
		EP	3734504	A1	04 November 2020
		EP	3736537	A1	11 November 2020
		EP	3761226	A1	06 January 2021
		JP	2018-510373	A	12 April 2018
		JP	2019-509534	A	04 April 2019
		JP	2019-524525	A	05 September 2019
		JP	2019-525148	A	05 September 2019
		JP	2019-537080	A	19 December 2019
		JP	2020-015504	A	30 January 2020
		JP	2020-115136	A	30 July 2020
		JP	2020-115348	A	30 July 2020
		JP	2020-115349	A	30 July 2020
		JP	2020-187754	A	19 November 2020
		JP	2020-193984	A	03 December 2020
		JP	2020-194571	A	03 December 2020
		JP	2020-504860	A	13 February 2020
		JP	2020-506838	A	05 March 2020
		JP	2020-516971	A	11 June 2020
		JP	6708793	B2	10 June 2020
		KR	10-2017-0126909	A	20 November 2017
		KR	10-2019-0028386	A	18 March 2019
		KR	10-2019-0062390	A	05 June 2019
		KR	10-2019-0069384	A	19 June 2019
		KR	10-2019-0080885	A	08 July 2019
		KR	10-2019-0091366	A	05 August 2019
		KR	10-2019-0099088	A	23 August 2019
		KR	10-2019-0107057	A	18 September 2019
		KR	10-2019-0107071	A	18 September 2019
		KR	10-2020-0011566	A	03 February 2020
		KR	10-2020-0011593	A	03 February 2020
		KR	10-2020-0011612	A	03 February 2020
		KR	10-2020-0049888	A	08 May 2020
		KR	10-2020-0127218	A	10 November 2020
		KR	10-2020-0127219	A	10 November 2020
		US	10055653	B2	21 August 2018
		US	10082798	B2	25 September 2018
		US	10101744	B2	16 October 2018
		US	10107710	B2	23 October 2018
		US	10127465	B2	13 November 2018
		US	10133274	B2	20 November 2018
		US	10152649	B2	11 December 2018
		US	10162355	B2	25 December 2018
		US	10198001	B2	05 February 2019

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/MY2020/050188

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
		US	10248124	B2	02 April 2019
		US	10262217	B2	16 April 2019
		US	10296010	B2	21 May 2019
		US	10303959	B2	28 May 2019
		US	10317903	B2	11 June 2019
		US	10354157	B2	16 July 2019
		US	10365658	B2	30 July 2019
		US	10514705	B2	24 December 2019
		US	10558222	B2	11 February 2020
		US	10591929	B2	17 March 2020
		US	10606278	B2	31 March 2020
		US	10613532	B2	07 April 2020
		US	10627830	B2	21 April 2020
		US	10635110	B2	28 April 2020
		US	10649462	B2	12 May 2020
		US	10649463	B2	12 May 2020
		US	10698414	B2	30 June 2020
		US	10739782	B2	11 August 2020
		US	10782703	B2	22 September 2020
		US	10795375	B2	06 October 2020
		US	10832066	B2	10 November 2020
		US	10838426	B2	17 November 2020
		US	10845816	B2	24 November 2020
		US	10846542	B2	24 November 2020
		US	10860017	B2	08 December 2020
		US	2017-0008521	A1	12 January 2017
		US	2017-0008562	A1	12 January 2017
		US	2017-0010104	A1	12 January 2017
		US	2017-0010105	A1	12 January 2017
		US	2017-0010106	A1	12 January 2017
		US	2017-0010107	A1	12 January 2017
		US	2017-0010108	A1	12 January 2017
		US	2017-0010109	A1	12 January 2017
		US	2017-0010115	A1	12 January 2017
		US	2017-0010120	A1	12 January 2017
		US	2017-0010121	A1	12 January 2017
		US	2017-0010124	A1	12 January 2017
		US	2017-0010614	A1	12 January 2017
		US	2017-0010616	A1	12 January 2017
		US	2017-0010617	A1	12 January 2017
		US	2017-0010618	A1	12 January 2017
		US	2017-0031359	A1	02 February 2017
		US	2017-0154241	A1	01 June 2017
		US	2017-0193338	A1	06 July 2017
		US	2017-0248960	A1	31 August 2017
		US	2017-0336792	A1	23 November 2017
		US	2017-0336793	A1	23 November 2017
		US	2017-0336794	A1	23 November 2017
		US	2017-0336801	A1	23 November 2017
		US	2017-0364082	A1	21 December 2017

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/MY2020/050188

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
		US 2017-0371340 A1	28 December 2017
		US 2017-0371343 A1	28 December 2017
		US 2017-0371344 A1	28 December 2017
		US 2017-0371347 A1	28 December 2017
		US 2018-0023960 A1	25 January 2018
		US 2018-0023961 A1	25 January 2018
		US 2018-0024562 A1	25 January 2018
		US 2018-0024565 A1	25 January 2018
		US 2018-0024568 A1	25 January 2018
		US 2018-0025235 A1	25 January 2018
		US 2018-0032082 A1	01 February 2018
		US 2018-0080849 A1	22 March 2018
		US 2018-0101177 A1	12 April 2018
		US 2018-0120859 A1	03 May 2018
		US 2018-0217600 A1	02 August 2018
		US 2018-0304889 A1	25 October 2018
		US 2018-0307229 A1	25 October 2018
		US 2018-0307239 A1	25 October 2018
		US 2018-0307240 A1	25 October 2018
		US 2018-0314266 A1	01 November 2018
		US 2019-0026568 A1	24 January 2019
		US 2019-0243377 A1	08 August 2019
		US 2019-0286154 A1	19 September 2019
		US 2019-0286155 A1	19 September 2019
		US 2019-0286156 A1	19 September 2019
		US 2019-0286157 A1	19 September 2019
		US 2019-0291727 A1	26 September 2019
		US 2019-0294897 A1	26 September 2019
		US 2019-0295179 A1	26 September 2019
		US 2019-0299983 A1	03 October 2019
		US 2019-0329768 A1	31 October 2019
		US 2019-0329769 A1	31 October 2019
		US 2019-0329773 A1	31 October 2019
		US 2019-0329782 A1	31 October 2019
		US 2019-0329783 A1	31 October 2019
		US 2019-0333381 A1	31 October 2019
		US 2019-0384294 A1	19 December 2019
		US 2019-0384295 A1	19 December 2019
		US 2019-0384296 A1	19 December 2019
		US 2020-0064843 A1	27 February 2020
		US 2020-0064844 A1	27 February 2020
		US 2020-0073388 A1	05 March 2020
		US 2020-0201330 A1	25 June 2020
		US 2020-0319653 A1	08 October 2020
		US 2020-0326707 A1	15 October 2020
		US 2021-0056327 A1	25 February 2021
		US 9623905 B2	18 April 2017
		US 9631936 B2	25 April 2017
		US 9631943 B2	25 April 2017
		US 9665100 B2	30 May 2017

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/MY2020/050188

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
		US	9690293	B2	27 June 2017
		US	9696719	B2	04 July 2017
		US	9709986	B2	18 July 2017
		US	9760090	B2	12 September 2017
		US	9817399	B2	14 November 2017
		US	9939813	B2	10 April 2018
		US	9946260	B2	17 April 2018
		US	9977430	B2	22 May 2018
		WO	2016-130719	A2	18 August 2016
		WO	2016-130719	A3	15 September 2016
		WO	2017-118907	A1	13 July 2017
		WO	2017-120336	A2	13 July 2017
		WO	2017-120336	A3	24 August 2017
		WO	2017-122086	A1	20 July 2017
		WO	2017-175025	A2	12 October 2017
		WO	2017-175025	A3	14 December 2017
		WO	2018-005441	A2	04 January 2018
		WO	2018-005441	A3	07 June 2018
		WO	2018-015811	A1	25 January 2018
		WO	2018-057793	A1	29 March 2018
		WO	2018-069757	A2	19 April 2018
		WO	2018-069757	A3	18 April 2019
		WO	2018-081807	A2	03 May 2018
		WO	2018-081807	A3	28 June 2018
		WO	2018-115963	A2	28 June 2018
		WO	2018-115963	A3	27 September 2018
		WO	2018-132607	A2	19 July 2018
		WO	2018-132607	A3	23 August 2018
		WO	2018-132608	A2	19 July 2018
		WO	2018-132608	A3	23 August 2018
		WO	2018-132614	A2	19 July 2018
		WO	2018-132614	A3	23 August 2018