

FORM RECOGNITION METHODS, FORM EXTRACTION METHODS AND APPARATUSES THEREOF

TECHNICAL FIELD

5 **[0001]** The present disclosure relates to computer vision technology, and more particularly to a form recognition method, a form extraction method and apparatuses thereof.

BACKGROUND

10 **[0002]** At present, OCR (Optical Character Recognition) technology is generally used to recognize scanned images of text data. Using this technology can recognize most of text characters, but cannot recognize a form image properly because the form image is often garbled during the recognition.

15 **[0003]** Therefore, how to improve the recognition accuracy of a form image is an urgent problem to be solved in this field.

SUMMARY

[0004] Embodiments of the present disclosure provide a form recognition solution and a form extraction solution.

20 **[0005]** In a first aspect, there is provided a form recognition method, including: performing a form line extraction process on a to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result includes a plurality of first form lines and/or a plurality of first form line intersections; performing a correction process on the to-be-recognized form image
25 based on the form line extraction result of the to-be-recognized form image and a preset form template, wherein the preset form template has a plurality of preset second form lines and/or a plurality of preset second form line intersections; and performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

30 **[0006]** In combination with any implementation provided by the present disclosure, performing a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template includes: performing a matching process on the plurality of first form lines and the

plurality of second form lines to obtain a matching result of the form lines, and/or performing a matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections; and performing a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line intersections.

[0007] In combination with any implementation provided by the present disclosure, performing a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line intersections includes: obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines includes the matching result of a plurality of form line pairs of the plurality of first form lines and the plurality of second form lines, and the matching result of the form line intersections includes the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections; and performing a correction process on the to-be-recognized form image according to the transformation parameter.

[0008] In combination with any implementation provided by the present disclosure, obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections includes: obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on matched form line pairs in the plurality of form line pairs, and/or based on matched form line intersection pairs in the plurality of form line intersection pairs.

[0009] In combination with any implementation provided by the present disclosure, the matching result of the form lines includes matching confidence levels of the plurality of form line pairs, and the matching result of the form line intersections includes matching confidence levels of the plurality of form line intersection pairs,

[0010] obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections includes: obtaining the transformation parameter based on the form line pairs with a matching confidence level higher than a

first preset value among the plurality of form line pairs, and/or based on the form line intersection pairs with a matching confidence level higher than a second preset value among the plurality of form line intersection pairs.

5 [0011] In combination with any implementation provided by the present disclosure, obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections includes: determining a target area based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines and/or the form line intersections in the target area satisfies a preset condition; and obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections in the target area.

15 [0012] In combination with any implementation provided by the present disclosure, the preset condition includes any one or more: a number of matching form line pairs and/or matching form line intersection pairs in the target area satisfies a first condition; and a matching confidence level corresponding to matching form line pairs and/or matching form line intersection pairs in the target area satisfies a second condition.

20 [0013] In combination with any implementation provided by the present disclosure, the preset form template includes at least two template areas, obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections includes: obtaining the transformation parameter corresponding to each of the at least two template areas based on the matching result of the form lines and/or the matching result of the form line intersections; and performing a correction process on the to-be-recognized form image according to the transformation parameter includes: according to the transformation parameter corresponding to each of the at least two template areas, performing a correction process on an area of the to-be-recognized form image corresponding to each of the at least two template areas.

25 [0014] In combination with any implementation provided by the present disclosure, performing a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template includes: in response to a ratio of matching form line pairs in the plurality of first form

lines reaching a first ratio value, and/or in response to a ratio of matching form line intersection pairs in the plurality of first form line intersections reaching a second ratio value, performing a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and the preset form template.

5 [0015] In combination with any implementation provided by the present disclosure, performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result includes: performing text detection on the corrected form image to obtain a plurality of text detection boxes of the to-be-recognized form image; performing text recognition on the plurality of text detection boxes to obtain a text recognition result; and obtaining the form recognition result based on an intersection-over-union ratio between the plurality of text detection boxes and a plurality of form boxes defined by the plurality of first form lines.

10 [0016] In combination with any implementation provided by the present disclosure, performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result includes: determining at least one to-be-detected target form box from a plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template; performing text recognition on the at least one target form box, to obtain a text recognition result of each target form box in the at least one target form box; and obtaining the form recognition result based on the text recognition result of the at least one target form box.

15 [0017] In combination with any implementation provided by the present disclosure, determining at least one to-be-detected target form box from a plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template includes: receiving a recognition condition entered by a user; and determining at least one target form box from a plurality of form boxes of the preset form template based on the recognition condition.

20 [0018] In combination with any implementation provided by the present disclosure, the method further includes: setting an attribute for the target form box; obtaining the form recognition result based on the text recognition result of the at least one target form box includes: obtaining the form recognition result based on the attribute of the target form box and the text recognition result of the target form box.

5 [0019] In combination with any implementation provided by the present disclosure, the method further includes: performing a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image; and performing a correction process on the form line extraction result of the reference form image to obtain the preset form template based on user input.

10 [0020] In a second aspect, there is provided a form recognition method, including: performing a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image; generating a form template based on the form line extraction result, wherein the form template includes a plurality of second form lines and/or a plurality of second form line intersections; and performing a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template.

15 [0021] In combination with any implementation provided by the present disclosure, generating a form template based on the form line extraction result includes: displaying the form line extraction result; and generating a form template based on the form line extraction result in response to receiving confirmation instruction from a user.

20 [0022] In combination with any implementation provided by the present disclosure, generating a form template based on the form line extraction result includes: performing an adjustment process on the form line extraction result to obtain an adjustment result in response to receiving an adjustment instruction from a user; and generating the form template based on the adjustment result.

25 [0023] In combination with any implementation provided by the present disclosure, the method further includes: receiving a recognition instruction from a user, wherein the recognition instruction is used to indicate a target form entry in the form template that needs to be recognized; and performing a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template includes: performing a text recognition process on the target form entry in the to-be-recognized form image based on the form template, to obtain a form recognition result.

30 [0024] In combination with any implementation provided by the present disclosure, performing a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template includes: performing a form line extraction process on the to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result

includes a plurality of first form lines and/or a plurality of first form line intersections; obtaining a transformation parameter based on a plurality of second form lines and/or a plurality of second form line intersections included in the form template, and the form line extraction result of the to-be-recognized form image; and performing a text
5 recognition process on the to-be-recognized form image to obtain a form recognition result according to the transformation parameter.

[0025] In combination with any implementation provided by the present disclosure, obtaining a transformation parameter based on a plurality of second form lines and/or a plurality of second form line intersections included in the form template, and the form
10 line extraction result of the to-be-recognized form image, includes: performing a matching process on the plurality of first form lines and the plurality of second form lines to obtain a matching result of the form lines, and/or performing a matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections; and obtaining a
15 transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines includes the matching result of a plurality of form line pairs of the plurality of first form lines and the plurality of second form lines, and the matching result of the form line intersections
20 includes the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections.

[0026] In combination with any implementation provided by the present disclosure, obtaining a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result
25 of the form line intersections includes: determining a target area based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines and/or the form line intersections in the target area satisfies a preset condition; and obtaining a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the
30 form lines and/or the matching result of the form line intersections in the target area.

[0027] In combination with any implementation provided by the present disclosure, the preset condition includes any one or more: a number of matching form line pairs and/or matching form line intersection pairs in the target area satisfies a first condition;

and a matching confidence level corresponding to matching form line pairs and/or matching form line intersection pairs in the target area satisfies a second condition.

[0028] In combination with any implementation provided by the present disclosure, performing a text recognition process on the to-be-recognized form image to obtain a form recognition result according to the transformation parameter includes: performing a correction process on the to-be-recognized form image according to the transformation parameter; and performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

[0029] In a third aspect, there is provided a form extraction method, including: determining a plurality of directional single-connected chains in a to-be-recognized form image; performing a first merging process on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments; performing an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among a plurality of i-th merged line segments, to obtain at least one (i+1)-th merged line segment; and obtaining a form line extraction result of the form image based on the merging result of N times of merging process, where i and N are integers, and i is greater than 1 and less than N.

[0030] In combination with any implementation provided by the present disclosure, the method further includes: extending at least one end of the i-th merged line segment with at least one pixel to obtain an extended line segment of the i-th merged line segment; determining at least two i-th merged line segments that satisfy the merging condition from the plurality of i-th merged line segments based on the extended line segment of each i-th merged line segment in the plurality of i-th merged line segments.

[0031] In combination with any implementation provided by the present disclosure, the merging condition includes any one or more of: a minimum distance between end points of two to-be-merged objects is less than a first threshold; a maximum distance between the end points of the two to-be-merged objects is less than a second threshold; and a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects is less than the second threshold; wherein the to-be-merged object is a directional single-connected chain or an i-th merged line segment.

[0032] In a fourth aspect, there is provided a form recognition apparatus, including: a processing unit configured to perform a form line extraction process on a to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result includes a plurality of first form lines and/or a plurality of first form line intersections; a correction unit configured to perform a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template, wherein the preset form template has a plurality of preset second form lines and/or a plurality of preset second form line intersections; and a recognition unit configured to perform a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

[0033] In a fifth aspect, there is provided a form recognition apparatus, including: an extraction unit configured to perform a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image; a generation unit configured to generate a form template based on the form line extraction result, wherein the form template includes a plurality of second form lines and/or a plurality of second form line intersections; and a recognition unit configured to perform a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template.

[0034] In a sixth aspect, there is provided a form extraction apparatus, including: a determination unit configured to determine a plurality of directional single-connected chains in a to-be-recognized form image; a first merging unit configured to perform a first merging process on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments; a second merging unit configured to perform an $(i+1)$ -th merging process on at least two i -th merged line segments that satisfy the merging condition among a plurality of i -th merged line segments, to obtain at least one $(i+1)$ -th merged line segment; and an obtaining unit configured to obtain a form line extraction result of the form image based on the merging result of N times of merging process, where i and N are integers, and i is greater than 1 and less than N .

[0035] In a seventh aspect, there is provided a form recognition device, including a memory and a processor, wherein the memory is configured to store computer instructions executable by the processor, and when the computer instructions are

executed, the processor is configured to implement the form recognition method according to any implementation provided by the present disclosure.

[0036] In an eighth aspect, there is provided a form extraction device, including a memory and a processor, wherein the memory is configured to store computer instructions executable by the processor, and when the computer instructions are executed, the processor is configured to implement the form extraction method according to any implementation provided by the present disclosure.

[0037] In a ninth aspect, there is provided a computer-readable storage medium with a computer program stored thereon, wherein the program is executed by a processor to implement the form recognition method according to any implementation provided by the present disclosure.

[0038] In a tenth aspect, there is provided a computer-readable storage medium with a computer program stored thereon, wherein the program is executed by a processor to implement the form extraction method according to any implementation provided by the present disclosure.

[0039] In the form recognition solution according to one or more embodiments of the present disclosure, the to-be-recognized form image is corrected based on the form line extraction result of the form image and the preset form template, and the corrected image is subjected to the text recognition process to obtain the form recognition result.

Using the preset form template, the recognition of any corresponding form can be realized, and the recognition speed is fast; by correcting the to-be-recognized form image using the preset form template, the accuracy and robustness of the form recognition can be improved.

[0040] It is to be understood that the above general descriptions and the below detailed descriptions are merely exemplary and explanatory, and are not intended to limit the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate examples consistent with the present disclosure and, together with the description, serve to explain the principles of the disclosure.

[0042] FIG. 1 is a flowchart illustrating a form recognition method according to an embodiment of the present disclosure.

- [0043] FIG. 2A shows an exemplary form extraction result of a to-be-recognized form image.
- [0044] FIG. 2B shows a preset form template corresponding to FIG. 2A.
- [0045] FIG. 3 shows a schematic diagram of modifying a preset form template.
- 5 [0046] FIG. 4 is a flowchart illustrating another form recognition method according to an embodiment of the present disclosure.
- [0047] FIG. 5 shows an exemplary form template.
- [0048] FIG. 6 is a flowchart illustrating a form extraction method according to an embodiment of the present disclosure.
- 10 [0049] FIG. 7 shows a schematic diagram of an exemplary directional single-connected chain.
- [0050] FIG. 8A shows a schematic diagram of an exemplary extraction result of a directional single-connected chain.
- [0051] FIG. 8B shows a schematic diagram of merging the directional single-connected chains in FIG. 8A.
- 15 [0052] FIG. 8C shows a schematic diagram of merging the line segments in FIG. 8B.
- [0053] FIG. 9 is a schematic diagram illustrating determining a merging condition according to an embodiment of the present disclosure.
- [0054] FIG. 10 is a schematic diagram illustrating a form recognition process according to an embodiment of the present disclosure.
- 20 [0055] FIG. 11 is a schematic diagram illustrating a form recognition apparatus according to an embodiment of the present disclosure.
- [0056] FIG. 12 is a schematic diagram illustrating a form extraction apparatus shown in an embodiment of the present disclosure.
- 25 [0057] FIG. 13 is a schematic structural diagram illustrating a form recognition device according to an embodiment of the present disclosure.
- [0058] FIG. 14 is a schematic structural diagram illustrating a form extraction device according to an embodiment of the present disclosure.

30 **DETAILED DESCRIPTION OF THE EMBODIMENTS**

[0059] Examples will be described in detail herein, with the illustrations thereof represented in the drawings. When the following descriptions involve the drawings, like numerals in different drawings refer to like or similar elements unless otherwise

indicated. The embodiments described in the following examples do not represent all embodiments consistent with the present disclosure. Rather, they are merely examples of apparatuses and methods consistent with some aspects of the present disclosure as detailed in the appended claims.

5 [0060] It should be understood that the technical solutions provided by the embodiments of the present disclosure are mainly applied to the detection of small and slender objects in images, but the embodiments of the present disclosure do not limit this.

10 [0061] FIG. 1 shows a flowchart illustrating a form recognition method according to some embodiments of the present disclosure. As shown in FIG. 1, the method includes steps 101 to 103.

15 [0062] At step 101, a form line extraction process is performed on a to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, where the form line extraction result includes a plurality of first form lines and/or a plurality of first form line intersections.

20 [0063] In the embodiments of the present disclosure, various methods can be used to perform the form line extraction process on the to-be-recognized form image, so as to obtain the form line extraction result of the to-be-recognized form image. The embodiments of the present disclosure do not intend to limit the specific method for obtaining the form line extraction result.

25 [0064] The obtained form line extraction result can include a plurality of form lines and/or a plurality of form line intersections. In order to distinguish from other form lines and intersections described as below, the form line intersections and the form lines in the form line extraction result can be referred to as first form lines and first form line intersections.

30 [0065] FIG. 2A shows an exemplary form line extraction result of a to-be-recognized form image. As shown in FIG. 2A, the exemplary form line extraction result includes first form lines 20A-29A. From the obtained first form lines, a plurality of first form line intersections can also be obtained. In FIG. 2A, the obtained first form lines constitute a plurality of form boxes.

[0066] At step 102, based on the form line extraction result of the to-be-recognized form image and a preset form template, a correction process is performed on the to-be-recognized form image.

[0067] The layout of the preset form template and the layout of the form in the to-be-recognized form image can be the same or similar, or partially the same or similar.

[0068] FIGS. 2A and 2B show the situation where the form line extraction result is the same as the preset form template. The preset form template shown in FIG. 2B has
5 preset second form lines 20B-29B, and can also have a plurality of preset second form line intersections. The plurality of preset second form lines constitute a plurality of form boxes. The plurality of form boxes in FIG. 2A have a one-to-one correspondence with the plurality of form boxes in FIG. 2B.

[0069] Based on a correspondence relationship between the form line extraction result
10 of the form image and the preset form template, the to-be-recognized form image can be corrected. The correction process includes rotation, stretch, and offset of the to-be-recognized form image, so as to make the form lines in the form image as straight as possible.

[0070] At step 103, a text recognition process is performed on the corrected to-be-
15 recognized form image, to obtain a form recognition result.

[0071] For the corrected form image, the form lines are straight to a certain extent through the correction. Correspondingly, the text contents in the same row and/or the same column in the corrected form image are aligned to a certain extent. Therefore, by performing text recognition of the form image after the form image is corrected, the
20 form recognition result can be obtained more accurately and quickly.

[0072] In the embodiments of the present disclosure, the to-be-recognized form image is corrected based on the form line extraction result of the form image and the preset form template, and the form recognition result is obtained by performing the text recognition on the corrected form image. Using the preset form template, the
25 recognition of any corresponding form can be realized, and the recognition speed is fast; by correcting the to-be-recognized form image using the preset form template, the accuracy and robustness of the form recognition can be improved.

[0073] In some embodiments, the form image can be corrected in the following manner.

[0074] First, a matching process is performed on the plurality of first form lines and
30 the plurality of second form lines to obtain a matching result of the form lines, and/or a matching process is performed on the plurality of first form line intersections and the

plurality of second form line intersections, to obtain a matching result of the form line intersections.

[0075] Next, based on the matching result of the form lines and/or the matching result of the form line intersections, the to-be-recognized form image is corrected.

5 [0076] Taking FIGS. 2A and 2B as an example, the plurality of first form lines 20A-29A shown in FIG. 2A and the second form lines 20B-29B shown in FIG. 2B are matched, that is, a correspondence relationship between the first form lines and the second form lines is determined. For example, the first form line 20A corresponds to the second form line 20B, the first form line 21A corresponds to the second form line
10 21B, and so on. Similar to the matching of the form lines, the matching of the form line intersections is to determine a correspondence relationship between the plurality of first form line intersections extracted in the form image and the plurality of second form line intersections in the preset form template.

[0077] In addition, it is also possible to perform matching on the first form lines in
15 the form image and the second form lines in the preset form template, and the first form line intersections in the form image and the second form line intersections in the preset form template in a collective way, to obtain a matching result of the form lines and a matching result of the form line intersections together.

[0078] In the embodiments of the present disclosure, the to-be-recognized form image
20 is corrected based on the matching result of the form lines and/or the matching result of the form line intersections. In this way, the shape and distribution of the first form lines and/or the first form line intersections in the corrected form image are approximate to the preset form template, thereby achieving the form recognition result more quickly and accurately.

25 [0079] In some embodiments, a transformation parameter between the to-be-recognized form image and the preset form template can be obtained based on the matching result of the form lines and/or the matching result of the form line intersections, and according to the transformation parameter, a correction process is performed on the to-be-recognized form image. The matching result of the form lines
30 includes the matching result of form line pairs of the plurality of first form lines and the plurality of second form lines, and the matching result of the form line intersections includes the matching result of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections.

[0080] Since the transformation parameter is obtained based on the matching result of the form lines and/or the matching result of the form line intersections, by the correction process of the to-be-recognized form image based on the transformation parameter, the shape and distribution of the first form lines and/or the first form line intersections in the transformed form image are made more approximate to the preset form template, thereby achieving the form recognition result more quickly and accurately.

[0081] According to the matching result of the form lines, it can be determined a plurality of form line pairs of the form image and of the preset form template which are successfully matched. Each form line pair includes a first form line and a second form line matched with the first form line. When the positions and directions of each first form line and of each second form line are known, the transformation parameter determined by such form line pairs can be obtained. The transformation parameter can include, for example, a transformation matrix, and each element of the transformation matrix is determined by the position and direction relationship of the first form lines and the second form lines in each form line pair. Similarly, according to the matching result of the form line intersections, the transformation parameter between the form image and the preset form template can also be determined; according to both of the matching result of the form lines and the matching result of the form line intersections, the transformation parameter between the form image and the preset form template can also be determined.

[0082] Through each matched form line pair and/or each matched form line intersection pair, the transformation parameter can be obtained, which can realize all-round correction of the to-be-recognized form image. For example, the to-be-recognized form image can be rotated such that the extension direction of each first form line is consistent with the preset form template; the to-be-recognized form image can be stretched such that curved first form line is straightened, and so on.

[0083] In some embodiments, the matching result of the form lines further includes matching confidence levels of the plurality of form line pairs, and the matching result of the form line intersections further includes matching confidence levels of the plurality of form line intersection pairs. Based on form line pairs with a matching confidence level higher than a first preset value among the plurality of form line pairs, and/or based on form line intersection pairs with a matching confidence level higher

than a second preset value among the plurality of form line intersection pairs, the transformation parameter is obtained.

5 **[0084]** Assuming that the first preset value is 90% and the second preset value is 85%, in the following, taking FIG. 2A and FIG. 2B as an example, a matching result between the first form lines 20A~29A in FIG. 2A and the second form lines 20B~29B in FIG. 2B can include form line pairs (20A, 20B), (21A, 21B), ... (29A, 29B), and the matching confidence level of each form line pair can be determined, for example, the matching confidence level of (20A, 20B) is 95%, the matching confidence level of (21A, 21B) is 85%, and so on. Therefore, the transformation parameter can be obtained from the form line pairs with a matching confidence level of more than 90%. Similarly, it is also possible to obtain the transformation parameter from the form line intersection pairs with a matching confidence level of more than 85%; and it is also possible to obtain the transformation parameter from both of the form line pairs with a matching confidence level of more than 90% and the form line intersection pairs with a matching confidence level of more than 85%.

15 **[0085]** By using form line pairs and/or form line intersection pairs with a matching confidence level higher than the preset value to obtain transformation parameter, the accuracy of the transformation parameter can be improved, such that the corrected form image can be more approximate to the preset form template.

20 **[0086]** In some cases, the to-be-recognized form image may be in a non-planar shape, and the first form lines contained therein can extend in the same direction in a certain area, but not in the same direction in the entire area. In response to this situation, transformation parameters corresponding to a plurality of areas in the preset template can be used respectively to correct the corresponding parts of the form image.

25 **[0087]** In some embodiments, a target area in the preset form template can be determined based on the matching result of the form lines and/or the matching result of the form line intersections; and based on the matching result of the form lines and/or the matching result of the form line intersections in the target area, a transformation parameter between the to-be-recognized form image and the preset form template can be obtained. The matching result corresponding to the form lines and/or the form line intersections in the target area satisfies a preset condition.

30 **[0088]** The preset condition can include any one or more the following: the number (ratio) of matching form line pairs and/or matching form line intersection pairs in the

target area satisfying a first condition; and the matching confidence level corresponding to the matching form line pairs and/or matching form line intersection pairs in the target area satisfying a second condition.

5 [0089] Assuming that the number satisfying the first condition is larger than 10, or the ratio (the number against the total number of form lines and/or the total number of form line intersections) is higher than 50%, and the matching confidence level satisfying the second condition means the matching confidence level is higher than 90%. When the matching result of form lines and/or the matching result of form line intersections between the form image and the preset form template is known, for the
10 preset form template, an area with a number of matching form lines and/or matching form line intersections being larger than 10 (the ratio thereof being higher than 50%) in the preset form template is determined as the target area. Alternatively, an area with a matching confidence level corresponding to the matching form line pairs and/or the matching form line intersection pairs being higher than 90% in the preset form template
15 is determined as the target area. Alternatively, an area with a ratio higher than 50% and a matching confidence level corresponding to the matching form line pairs and/or the matching form line intersection pairs being higher than 90% in the preset form template is determined as the target area.

20 [0090] When the preset form template includes at least two template areas, a corresponding target area can be determined for each template area, and based on the matching result corresponding to the form lines and/or the form line intersections in the target area of each template area, the transformation parameter corresponding to each template area is obtained.

25 [0091] In the embodiments of the present disclosure, corresponding transformation parameters are obtained for a plurality of template areas in the preset form template, thereby realizing independent correction of each part of the to-be-recognized form image. When the various parts of the overall form image are deformed and distorted inconsistently, a better correction effect can be achieved.

30 [0092] In one example, in response to the ratio of matching form line pairs in the plurality of first form lines reaching a first ratio value, and/or in response to the matching form line intersection pairs in the plurality of first form line intersections reaching a second ratio value, based on the form line extraction result of the to-be-

recognized form image and the preset form template, a correction process is performed on the to-be-recognized form image.

[0093] For example, when the ratio of the matching form line pairs in the first form lines reaches 50%, and/or the ratio of the matching form line intersection pairs in the first form line intersections reaches 50%, it is confirmed that the to-be-recognized form image is successfully matched with the preset form template, and the to-be-recognized form image can be corrected based on the form line extraction result of the to-be-recognized form image and the preset form template.

[0094] When the form image is successfully matched with the preset form template, a further correction process of the to-be-recognized form image can be performed to ensure the accuracy of the correction process and the accuracy of the form recognition result.

[0095] In some embodiments, text detection is performed on the corrected form image to obtain a plurality of text detection boxes of the to-be-recognized form image.

According to the relative position of each text detection box, the form boxes, which are defined by the plurality of first form lines, corresponding to the text detection boxes are determined. Next, text recognition is performed on the plurality of text detection boxes to obtain a text recognition result. Finally, the form recognition result is obtained based on an intersection-over-union ratio between the plurality of text detection boxes and the plurality of form boxes defined by the plurality of first form lines. For example, when the intersection-over-union ratio between the text detection box and the corresponding form box is greater than 60%, it is determined that the content in the text detection box does belong to the form box, so the text recognition result in the text detection box is filled into the corresponding form box.

[0096] After performing the above operations on the text detection box, the correspondence between the text recognition result in the text detection box and the form box can be realized to obtain the form recognition result.

[0097] In the embodiments of the present disclosure, the form recognition result is obtained based on the intersection-over-union ratio of the text detection box and the form box, which ensures the correspondence between the content in the text detection box and the form box, and improves the accuracy of the form recognition result.

[0098] In some embodiments, at least one to-be-detected target form box can be determined from the plurality of form boxes defined by the plurality of first form lines

in the to-be-recognized form image based on the preset form template. Next, text recognition is performed on the at least one target form box, to obtain a text recognition result of each target form box in the at least one target form box. Finally, based on the text recognition result of the at least one target form box, the form recognition result is obtained.

[0099] When the target to be recognized includes the content of a certain number of form boxes instead of the content of the entire form, the speed and efficiency of form recognition can be improved by determining the to-be-detected target form boxes for text recognition.

[0100] In the embodiments of the present disclosure, the to-be-detected target form boxes can be determined by a preset form template, such that text recognition is performed on the target form boxes, and the form recognition result of these target form boxes are obtained.

[0101] In some embodiments, at least one target form box in the plurality of form boxes of the preset form template can be determined by a recognition condition input by a user. Taking FIG. 2B as an example, the recognition condition from the user can be to recognize the text content of the form box corresponding to an account name and an account number, and then it can be determined that the target form box to be detected is the form box corresponding to the account name (not the form box where the "account name" is located, but the form box where the content corresponding to the "account name" is located), and the form box corresponding to the account number (not the form box where the "account number" is located, but the form box where the content corresponding to the "account number" is located).

[0102] In some embodiments, a certain attribute can be set for the target form box, and the form recognition result can be obtained based on the attribute of the target form box and the text recognition result of the target form box.

[0103] For example, in the preset form template, the target form box to be detected is selected as the form box corresponding to the content of the account number, and the attribute of the target form box is set to "account number", then when text recognition is performed on the target form box, the attribute "account number" of the target form box and the content of the form box are used as the form recognition result.

[0104] In some embodiments, the preset form template can be obtained from a reference form image. The reference form image refers to a form image that has the

same or similar layout, or partially the same or similar layout, as the to-be-recognized form image.

[0105] First, a form line extraction process can be performed on the reference form image to obtain a form line extraction result of the reference form image. The method of performing the form line extraction process can be the same as or different from the form line extraction process method used at step 101, which is not limited in this embodiment.

[0106] For the form line extraction result, the user input can be used to modify the form line extraction result to obtain a preset form template with clearer form lines. For example, it is possible to manually redraw the lines by operating the mouse on the basis of the original form line extraction result.

[0107] FIG. 3 shows a schematic diagram of modifying a preset form template. In FIG. 3, the form lines 30, 31, 32, 34, 35, 39 are form lines after the modification process, and the other form lines are not modified. It can be seen from FIG. 3 that the modified form lines are clearer than the unmodified form lines. Therefore, the quality of the preset form template obtained by modifying the form line extraction result is improved.

[0108] Those skilled in the art should understand that FIGS. 2B and 3 are only for illustration, and whether the content in the form is clear does not affect the understanding of the solutions of the embodiments of the present disclosure.

[0109] FIG. 4 is a flowchart illustrating another form recognition method shown in an embodiment of the present disclosure. As shown in FIG. 4, the method includes steps 401 to 403.

[0110] At step 401, a form line extraction process is performed on a reference form image to obtain a form line extraction result of the reference form image.

[0111] In the embodiments of the present disclosure, the reference form image can be any form image, and the reference form image can be subjected to a form line extraction process in a variety of ways, so as to obtain the form line extraction result of the reference form image. The embodiments of the present disclosure do not intend to limit the specific method for obtaining the form line extraction result.

[0112] An example of the form line extraction result of the reference form image is shown in FIG. 5, which includes the second form lines 50-59.

[0113] At step 402, a form template is generated based on the form line extraction result, where the form template includes a plurality of second form lines and/or a plurality of second form line intersections.

5 [0114] Taking the form line extraction result shown in FIG. 5 as an example, the form template generated based on the second form lines 50~59 can include the second form lines 50~59, can also include a plurality of second form line intersections obtained from the second form lines, and can also include both of the second form lines 50~59 and the plurality of second form line intersections.

10 [0115] In the generated form template, the plurality of second form lines constitutes a plurality of form boxes.

[0116] In some embodiments, after the form line extraction result is obtained at step 401, the form line extraction result can be displayed, for example, the form line extraction result shown in FIG. 5 is displayed; and in response to receiving confirmation instruction from the user, a form template is generated based on the form line extraction

15 result.

[0117] After obtaining the form line extraction result, the form template is generated after confirmation of the user, the accuracy of the generated form template can be ensured.

[0118] In some embodiments, after the form line extraction result is obtained at step

20 401, in response to receiving an adjustment instruction from the user, the form line extraction result is adjusted to obtain an adjustment result; and the form template is generated based on the adjustment result.

[0119] By adjusting the form line extraction result and then generating the form template, the accuracy of the generated form template can be ensured.

25 [0120] At step 403, based on the form template, a text recognition process is performed on the to-be-recognized form image to obtain the form recognition result.

[0121] The layout of the to-be-recognized form image and the layout of the form template can be the same or similar, or partially the same or similar.

[0122] In the embodiments of the present disclosure, the form template is generated

30 based on the form line extraction result of the reference form image, to realize the recognition of the to-be-recognized form image, and the recognition speed and the accuracy is high. In some embodiments, the method further includes receiving a recognition instruction from the user, where the recognition instruction is used to

indicate a target form entry in the form template that needs to be recognized; and based on the form template, a text recognition process is performed on the target form entry in the to-be-recognized form image, to obtain a form recognition result.

5 **[0123]** The user can instruct to set one or more form boxes in the form template as target form entries that need to be recognized. When performing the text recognition process on the to-be-processed form image, corresponding form boxes in the to-be-recognized form image can be determined according to the target form entries in the form template, and a text recognition process can be performed on the content in the form boxes, to obtain the form recognition result.

10 **[0124]** By setting the target form entry to be recognized, and performing text recognition on the corresponding form box in the to-be-recognized form image, the recognition efficiency of the form can be improved.

15 **[0125]** FIG. 6 is a flowchart illustrating a form extraction method shown in an embodiment of the present disclosure. The method is used to perform a form line extraction process on the to-be-recognized form image to obtain the form line extraction result of the to-be-recognized form image. As shown in FIG. 6, the method includes steps 601-604.

[0126] At step 601, a plurality of directional single-connected chains in a to-be-recognized form image is determined.

20 **[0127]** The directional single-connected chain is composed of connected runs in the corresponding direction, and the run is a continuous pixel strip. A directional single-connected chain usually includes a horizontal single-connected chain and a longitudinal single-connected chain. Correspondingly, the run also usually includes a horizontal run and a longitudinal run.

25 **[0128]** FIG. 7 shows a schematic diagram of an exemplary directional single-connected chain. FIG. 7 contains a plurality of longitudinal runs. For example, the run 71 is a longitudinal run, where the pixel 72 is the start pixel of the run; the pixel 73 is the end pixel of the run. For the longitudinal run, the start pixel and the end pixel are aligned in the longitudinal direction (not shown in FIG. 7). Similarly, for the horizontal run, the start pixel and the end pixel are aligned in the horizontal direction. As shown
30 in FIG. 7, a plurality of horizontally connected longitudinal runs in the box 74 constitute a horizontal single-connected chain. In the same way, a plurality of longitudinally

connected horizontal runs constitutes a longitudinal connected chain (not shown in FIG. 7).

5 **[0129]** In some embodiments, a plurality of directional connected chains in the form image can be determined in the following manner. First, binary data of the to-be-recognized form image is obtained. That is, all pixels in the form image are binarized, and each pixel is either a black pixel or a white pixel. In the binarized form image, the black form lines correspond to black pixels, and the background part corresponds to white pixels. It is also possible to make the black form lines correspond to white pixels, and the background part correspond to black pixels. Next, according to the binary data,
10 a plurality of runs along a first direction is obtained. Then, according to at least two runs connected in a second direction of the plurality of runs, the plurality of directional single-connected chains are determined.

15 **[0130]** When the first direction is the longitudinal direction and the second direction is the horizontal direction, a plurality of longitudinal runs are obtained, and a plurality of horizontal single-connected chains are determined based on at least two longitudinal runs connected in the horizontal direction; When the first direction is the horizontal direction and the second direction is the longitudinal direction, a plurality of horizontal runs are obtained, and a plurality of longitudinal single-connected chains are determined based on at least two horizontal runs connected in the longitudinal direction.

20 **[0131]** In some embodiments, a first run of the plurality of runs can also be removed to obtain a plurality of remaining runs, where one side of the first run has at least two adjacent runs. According to at least two runs connected in the second direction of the plurality of remaining runs, the plurality of directional single-connected chains are determined.

25 **[0132]** Any one of the runs within a directional single-connected chain (except both ends) has only one run adjacent thereto on either side. As shown in FIG. 7, the run 71 inside the directional single-connected chain has one run adjacent thereto on either side. The run 75 has two adjacent runs on the left side, and the run 76 also has two adjacent runs on the left side. Therefore, the run 75 and the run 76 can be removed, and the
30 remaining runs can be used to determine the directional single-connected chain.

[0133] In the form detection, it is difficult to separate the form line and the text when they stick or overlap with each other, which leads to the difficulty of detecting the form line. Corresponding to form line extraction using a directional single-connected chain,

when there is a text that is stuck or overlapped with the form line, there are two or more adjacent runs on both sides or on one side of the corresponding run. Such a run can be filtered out, such that the form lines can be extracted more accurately and the text can be avoided from being deleted by mistake.

5 **[0134]** Through the above method, it is possible to determine the plurality of directional single-connected chains included in the form image, including a plurality of horizontal single-connected chains and a plurality of longitudinal single-connected chains. FIG. 8A shows a schematic diagram of a plurality of directional single-connected chains obtained from a form image. For apparent illustration, these
10 directional single-connected chains are exemplarily represented with black background and white pixels.

[0135] At step 602, a first merging process is performed on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments.

15 **[0136]** Due to the influence of noise, the plurality of directional single-connected chains determined from the form image can be broken, as shown in FIG. 8A, so the broken directional single-connected chains need to be merged to solve the problem of breaking form lines.

[0137] In order to avoid merging two or more directional single-connected chains that
20 do not originally belong to the same form line, a reasonable merging condition needs to be set. According to a distance, positions, a slope and other information of the two directional single-connected chains, it can be decided whether the two directional single-connected chains satisfy the merging condition. For a plurality of directional single-connected chains, if each of the plurality of directional single-connected chains
25 satisfies the merging condition with any of the others, it can be said that the plurality of directional single-connected chains comply with the merging condition, and the first merging process is performed on the plurality of directional single-connected chains. After merging all the directional single-connected chains in the image that satisfy the merging condition, a plurality of first merged line segments can be obtained.

30 **[0138]** Take the plurality of directional connected chains shown in FIG. 8A as an example, where the chain 81 and the chain 82 satisfy the merging condition, and the chain 82 and the chain 83 satisfy the merging condition, then the chain 81, chain 82 and

chain 83 are said to satisfy the merging condition, and these three directional single-connected chains are merged to obtain a first merged line segment 84 (see FIG. 8B).

[0139] In some embodiments, at least two directional single-connected chains can be merged in the following way. First, a midpoint of each run in each directional single-connected chain is determined, and the midpoints of the plurality of runs included in the plurality of directional single-connected chains are fit to obtain the first merged line segment.

[0140] FIG. 7 shows a schematic diagram of line segments obtained by fitting the midpoints of a plurality of runs. As shown in FIG. 7, black dots in the runs represents the midpoints of the runs. By fitting the midpoints of the runs, the corresponding line segment (the location of the dashed line is the location of the line segment obtained by fitting) can be obtained. Information such as the end points and slope of the line segment obtained by the fitting can also be stored for use in the subsequent further merging process.

[0141] In some embodiments, the merging condition includes any one or more of the following: a minimum distance between the end points of the two to-be-merged objects being less than a first threshold; a maximum distance between the end points of the two to-be-merged objects being less than a second threshold; and a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects being less than a second threshold; where the to-be-merged object is a directional single-connected chain or an i-th merged line segment.

[0142] Taking the directional single-connected chain 91 and the directional single-connected chain 92 shown in FIG. 9 as an example, the merging condition includes any one or more of the following: a minimum distance $d1$ between the end points of the chain 91 and the chain 92 being less than a first threshold; a maximum distance $d2$ between the end points of the chain 91 and the chain 92 being less than a second threshold; and a maximum distance $d3$ from the end points of the chain 91 and the chain 92 to a connection line corresponding to $d2$ being less than a second threshold. The first threshold and the second threshold can be specifically set according to the accuracy requirements for form line extraction.

[0143] At step 603, at least two i -th merged line segments that satisfy the merging condition among the plurality of i -th merged line segments are subjected to an $(i+1)$ -th merging process, to obtain at least one $(i+1)$ -th merged line segment.

[0144] For the plurality of first merged line segments obtained at step 602, the
5 merging can be continued according to the merging condition. In the $(i+1)$ -th merging process, at least two i -th merged line segments that satisfy the merging condition are merged to obtain at least one $(i+1)$ -th merged line segment.

[0145] In some embodiments, at least two i -th merged line segment can be merged in the following manner to obtain the $(i+1)$ th merged line segment: determining a
10 midpoint of each run in the directional single-connected chain included in the i -th merged line segment, and fitting the midpoints of the plurality of runs included in the i -th merged line segments to be merged, to obtain the $(i+1)$ -th merged line segment.

[0146] In some embodiments, at least one end of the i -th merged line segment can be extended with at least one pixel to obtain an extended line segment of the i -th merged
15 line segment; based on the extended line segment of each i -th merged line segment in the plurality of i -th merged line segments, at least two i -th merged line segments that satisfy the merging condition are determined from the plurality of i -th merged line segments.

[0147] For example, for the fourth merging process, either end of the third merged
20 line segment can be extended by three pixels, to obtain the extended line segment of the third merged line segment. By deciding whether the extended line segments of the plurality of third merged line segments satisfy the merging condition, and performing a merging process on the third merged line segments that satisfy the merging condition, a plurality of fourth merged line segments can be obtained.

[0148] Due to the influence of noise, the originally continuous line segment can be broken, and the span of the break can be too large to satisfy the merging condition. By extending the line segment to determine whether it satisfies the merging condition, this
25 problem can be solved, and the extracted form line is more complete.

[0149] At step 604, based on the merging result of the N times of merging process,
30 the form line extraction result of the to-be-recognized form image is obtained, where i and N are integers, and i is greater than 1 and less than N .

[0150] FIG. 8C shows an exemplary form line extraction result. As shown in FIG. 8C, by extending the merged line segment to further determine whether the merging condition is satisfied, the break of the form line can be further repaired.

[0151] It should be understood that the form extraction method provided in the embodiment of the present disclosure can be applied to any form image, for example, the to-be-recognized form image or the reference form image mentioned above, which is not limited in the embodiment of the present disclosure.

[0152] FIG. 10 is a schematic diagram of a form recognition process according to an embodiment of the present disclosure. As shown in FIG. 10, the form recognition process mainly includes three stages: a preset template making stage, a preset template correction stage, and a form image recognition stage.

[0153] In the preset template making stage, first a reference form image is uploaded, which has a layout the same or partially the same as the layout of the to-be-recognized form image. Next, the reference form image is corrected, for example, perspective transformation is performed, or the deformation is adjusted, such that the form lines in the reference form image are straight and the form box shape is regular. After that, a preset template can be made by drawing the form lines in the form, or the preset template can be made by extracting the form lines in the reference form image. For the form boxes defined by a plurality of form lines, a preset number of form boxes with preset positions can be selected as the target form boxes to be detected for text content recognition in the subsequent form image recognition stage.

[0154] When the form image recognition result does not satisfy expectations, it enters the preset template correction stage. It is possible to edit the already drawn form lines, such as redrawing the form lines, or bolding or straightening the form lines to obtain a clearer and straighter form lines. After correcting the form lines, it is also possible to reselect a target form box to redefine the area to be recognized.

[0155] When the form image recognition result satisfies expectations, it can enter the form image recognition stage. The uploaded form image to be recognized can be recognized individually, or a plurality of form images can be recognized in batches, for example, through API to achieve batch recognition.

[0156] FIG. 11 provides a form recognition apparatus. As shown in FIG. 11, the apparatus can include: a processing unit 1101 configured to perform a form line extraction process on a to-be-recognized form image to obtain a form line extraction

result of the to-be-recognized form image, where the form line extraction result includes a plurality of first form lines and/or a plurality of first form line intersections; a correction unit 1102 configured to, based on the form line extraction result of the to-be-recognized form image and a preset form template, perform a correction process on the to-be-recognized form image, where the preset form template has a plurality of preset second form lines and/or a plurality of preset second form line intersections; a recognition unit 1103 configured to perform a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

[0157] In some embodiments, the correction unit 1102 is specifically configured to perform a matching process on the plurality of first form lines and the plurality of second form lines to obtain a matching result of the form lines, and/or perform a matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections; and based on the matching result of the form lines and/or the matching result of the form line intersections, correct the to-be-recognized form image.

[0158] In some embodiments, when the correction unit 1102 is configured to perform a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit 1102 is specifically configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, where the matching result of the form lines includes the matching result of a plurality of form line pairs of the plurality of first form lines and the plurality of second form lines, and the matching result of the form line intersections includes the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections; and according to the transformation parameter, perform a correction process on the to-be-recognized form image.

[0159] In some embodiments, when the correction unit 1102 is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit 1102 is specifically configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on matched form line pairs in the plurality of form line pairs,

and/or based on matched form line intersection pairs in the plurality of form line intersection pairs.

5 [0160] In some embodiments, the matching result of the form lines includes matching confidence levels of the plurality of form line pairs, and the matching result of the form line intersections further includes matching confidence levels of the plurality of form line intersection pairs. When the correction unit 1102 is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit 1102 is specifically configured to obtain
10 the transformation parameter based on the form line pairs with a matching confidence level higher than a first preset value among the plurality of form line pairs, and/or based on the form line intersection pairs with a matching confidence level higher than a second preset value among the plurality of form line intersection pairs.

15 [0161] In some embodiments, when the correction unit 1102 is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit 1102 is specifically configured to determine a target area in the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, where the matching
20 result of the form lines and/or the form line intersections in the target area satisfies a preset condition; and obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result corresponding to the form lines and/or the matching result of the form line intersections in the target area.

25 [0162] In some embodiments, the preset form template includes at least two template areas, and when the correction unit 1102 is configured to determine a target area in the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit 1102 is specifically configured to obtain a corresponding target area for each of the at least two template areas based
30 on the matching result of the form lines and/or the matching result of the form line intersections, and obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections in the target area includes:

obtaining the transformation parameter corresponding to each template area based on the matching result corresponding to the form lines and/or the form line intersections in the target area of each of the at least two template areas.

5 [0163] In some embodiments, the preset condition can include any one or more the following: the number (ratio) of matching form line pairs and/or matching form line intersection pairs in the target area satisfying a first condition; and the matching confidence level corresponding to the matching form line pairs and/or matching form line intersection pairs in the target area satisfying a second condition.

10 [0164] In some embodiments, when the correction unit 1102 is configured to, based on the form line extraction result of the to-be-recognized form image and a preset form template, perform a correction process on the to-be-recognized form image, the correction unit 1102 is specifically configured to, in response to the ratio of matching form line pairs in the plurality of first form lines reaching a first ratio value, and/or in response to the ratio of matching form line intersection pairs in the plurality of first
15 form line intersections reaching a second ratio value, based on the form line extraction result of the to-be-recognized form image and the preset form template, perform a correction process on the to-be-recognized form image.

[0165] In some embodiments, the recognition unit 1101 is specifically configured to perform text detection on the corrected form image to obtain a plurality of text detection
20 boxes of the to-be-recognized form image; perform text recognition on the plurality of text detection boxes to obtain a text recognition result; and obtain the form recognition result based on an intersection-over-union ratio between the plurality of text detection boxes and the plurality of form boxes defined by the plurality of first form lines.

[0166] In some embodiments, the recognition unit 1101 is specifically configured to
25 determine at least one to-be-detected target form box from the plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template; perform text recognition on the at least one target form box, to obtain a text recognition result of each target form box in the at least one target form box; and based on the text recognition result of the at least one target form box, obtain
30 the form recognition result.

[0167] In some embodiments, when the recognition unit 1101 is configured to determine at least one to-be-detected target form box from the plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on

the preset form template, the recognition unit 1101 is specifically configured to determine at least one to-be-detected target form box from the plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template.

5 [0168] In some embodiments, the apparatus further includes a setting unit configured to set an attribute for the target form box, and when the recognition unit is configured to, based on the text recognition result of the at least one target form box, obtain the form recognition result, the recognition unit is specifically configured to obtain the form recognition result based on the attribute of the target form box and the text recognition
10 result of the target form box.

[0169] In some embodiments, the apparatus further includes a template obtaining unit configured to perform a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image; and based on user input, perform a correction process on the form line extraction result of the reference form
15 image, to obtain the preset form template.

[0170] FIG. 12 shows a schematic diagram of a form extraction apparatus according to an embodiment of the present disclosure. As shown in FIG. 12, the apparatus includes: a determination unit 1201 configured to determine a plurality of directional single-connected chains in a to-be-recognized form image; a first merging unit 1202
20 configured to perform a first merging process on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments; a second merging unit 1203 configured to perform an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among the plurality of i-th
25 merged line segments, to obtain at least one (i+1)-th merged line segment; an obtaining unit 1204 configured to, based on the merging result of the N times of merging process, obtain the form line extraction result of the to-be-recognized form image, where i and N are integers, and i is greater than 1 and less than N.

[0171] In some embodiments, the apparatus further includes an extension unit
30 configured to extend at least one end of the i-th merged line segment with at least one pixel to obtain an extended line segment of the i-th merged line segment; based on the extended line segment of each i-th merged line segment in the plurality of i-th merged

line segments, determine at least two i -th merged line segments that satisfy the merging condition from the plurality of i -th merged line segments.

[0172] In some embodiments, when the form line extraction unit is configured to determine a plurality of directional single-connected chains in a to-be-recognized form image, the form line extraction unit is specifically configured to obtain binary data of the to-be-recognized form image; according to the binary data, obtain a plurality of runs along a first direction; and according to at least two runs connected in a second direction of the plurality of runs, determine the plurality of directional single-connected chains.

[0173] In some embodiments, the apparatus further includes a removing unit configured to remove a first run of the plurality of runs, to obtain a plurality of remaining runs, where one side of the first run has at least two adjacent runs. When the form line extraction unit is configured to according to at least two runs connected in a second direction of the plurality of runs, determine the plurality of directional single-connected chains, the form line extraction unit is specifically configured to according to at least two runs connected in the second direction of the plurality of remaining runs, determine the plurality of directional single-connected chains.

[0174] In some embodiments, the merging condition includes any one or more of the following: a minimum distance between the end points of the two to-be-merged objects being less than a first threshold; a maximum distance between the end points of the two to-be-merged objects being less than a second threshold; and a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects being less than a second threshold; where the to-be-merged object is a directional single-connected chain or an i -th merged line segment.

[0175] In some embodiments, when the form line extraction unit is configured to perform an $(i+1)$ -th merging process on at least two i -th merged line segments, to obtain at least one $(i+1)$ -th merged line segment, the form line extraction unit is specifically configured to determine a midpoint of each run in the directional single-connected chain included in the i -th merged line segments, and perform fitting according to the midpoints of the plurality of runs included in the i -th merged line segments to be merged, to obtain the $(i+1)$ -th merged line segment.

[0176] It should be understood that the apparatus provided in the embodiments of the present disclosure can be used to execute any of the foregoing embodiments and

methods, and accordingly include modules or units for executing the steps and/or processes in any of the foregoing embodiments and methods. For brevity, the details of which will be omitted.

5 [0177] FIG. 13 is a form recognition device provided by at least one embodiment of the present disclosure. The device includes a memory and a processor. The memory is configured to store computer instructions that can be executed on the processor. The processor is configured to, when executing the computer instructions, implement the form recognition method according to any embodiment of the present disclosure.

10 [0178] FIG. 14 is a form extraction device provided by at least one embodiment of the present disclosure. The device includes a memory and a processor. The memory is configured to store computer instructions that can be executed on the processor. The processor is configured to, when executing the computer instructions, implement the form extraction method according to any embodiment of the present disclosure.

15 [0179] At least one embodiment of the present disclosure further provides a computer-readable storage medium on which a computer program is stored, and when the program is executed by a processor, the form recognition method according to any embodiment of the present disclosure is implemented.

20 [0180] At least one embodiment of the present disclosure further provides a computer-readable storage medium on which a computer program is stored, and when the program is executed by a processor, the form extraction method according to any embodiment of the present disclosure is implemented.

25 [0181] Those skilled in the art should understand that one or more embodiments of this specification can be provided as a method, a system, or a computer program product. Therefore, one or more embodiments of this specification can adopt the form of a complete hardware embodiment, a complete software embodiment, or an embodiment combining software and hardware. Moreover, one or more embodiments of this specification may adopt the form of a computer program product implemented on one or more computer-usable storage media (including but not limited to disk storage, CD-ROM, optical storage, etc.) containing computer-usable program code.

30 [0182] Embodiments of this specification also provide a computer-readable storage medium storing a computer program, which when executed by a processor, implement the steps of the method for detecting a driver's gaze area described in any embodiment of this specification, and/or the steps of the method for training the neural network of

the driver's gaze area described in any embodiment of this specification. Wherein "and/or" means at least one of the two, for example, "A and/or B" includes three options: A, B, and "A and B".

5 **[0183]** The various embodiments in this specification are described in a progressive manner, and the same or similar parts between the various embodiments can be referred to each other. Each embodiment focuses on the differences from other embodiments. In particular, as for the data processing device embodiment, since it is basically similar to the method embodiment, the description is relatively simple, and for related parts, reference can be made to the partial description of the method embodiment.

10 **[0184]** The foregoing describes specific embodiments of this specification. Other embodiments are within the scope of the appended claims. In some cases, the actions or steps described in the claims can be performed in a different order than in the embodiments and still achieve desired result. In addition, the processes depicted in the drawings do not necessarily require the specific order or sequential order shown to
15 achieve the desired result. In some embodiments, multitasking and parallel process are also possible or can be advantageous.

[0185] The embodiments of the subject and functional operations described in this specification can be implemented in the following: digital electronic circuits, tangible computer software or firmware, computer hardware including the structures disclosed
20 in this specification and their structural equivalents, or a combination of one or more thereof. The embodiments of the subject matter described in this specification can be implemented as one or more computer programs, that is, one or more modules of computer program instructions encoded on a tangible non-transitory program carrier to be executed by a data processing device or to control the operation of the data
25 processing device. Alternatively or in addition, the program instructions can be encoded on artificially generated propagated signals, such as machine-generated electrical, optical or electromagnetic signals, which are generated to encode information and transmit it to a suitable receiver device to be executed by the processing device. The computer storage medium can be a machine-readable storage device, a machine-
30 readable storage substrate, a random or serial access memory device, or a combination of one or more thereof.

[0186] The process and logic flows described in this specification can be executed by one or more programmable computers executing one or more computer programs to

perform corresponding functions by operating according to input data and generating output. The process and logic flow can also be executed by a dedicated logic circuit, such as FPGA (Field Programmable Gate Array) or ASIC (Application Specific Integrated Circuit), and the device can also be implemented as a dedicated logic circuit.

5 **[0187]** Computers suitable for executing computer programs include, for example, general-purpose and/or special-purpose microprocessors, or any other type of central processing unit. Generally, the central processing unit will receive instructions and data from a read-only memory and/or random access memory. The basic components of a computer include a central processing unit for implementing or executing instructions
10 and one or more memory devices for storing instructions and data. Generally, the computer will also include one or more mass storage devices for storing data, such as magnetic disks, magneto-optical disks, or optical disks, or the computer will be operatively coupled to this mass storage device to receive data from or send data to it, or both. However, the computer does not have to have such equipment. In addition, the
15 computer can be embedded in another device, such as a mobile phone, a personal digital assistant (PDA), a mobile audio or video player, a game console, a global positioning system (GPS) receiver, or a portable storage device with a universal serial bus (USB) flash drive, to name a few.

[0188] Computer-readable media suitable for storing computer program instructions
20 and data include all forms of non-volatile memories, media, and memory devices, including, for example, semiconductor memory devices (such as EPROM, EEPROM, and flash memory devices), magnetic disks (such as internal Hard disk or removable disk), magneto-optical disk and CD ROM and DVD-ROM disk. The processor and the memory can be supplemented by or incorporated into a dedicated logic circuit.

25 **[0189]** Although this specification contains many specific implementation details, these should not be construed as limiting the scope of any invention or the scope of protection, but are mainly used to describe the features of specific embodiments of a particular invention. Certain features described in a plurality of embodiments in this specification can also be implemented in combination in a single embodiment. On the
30 other hand, various features described in a single embodiment can also be implemented in a plurality of embodiments separately or in any suitable sub-combination. In addition, although features can function in certain combinations as described above and even initially claimed as such, one or more features from the claimed combination can in

some cases be removed from the combination, and the claimed combination of protection can be directed to a sub-combination or a variant of the sub-combination.

5 [0190] Similarly, although operations are depicted in a specific order in the drawings, this should not be understood as requiring these operations to be performed in the specific order shown or sequentially, or requiring all illustrated operations to be performed, to achieve the desired result. In some cases, multitasking and parallel process can be advantageous. In addition, the separation of various system modules and components in the above embodiments should not be understood as requiring such separation in all embodiments, and it should be understood that the described program
10 components and systems can usually be integrated together in a single software product, or packaged into a plurality of software products.

[0191] Thus, specific embodiments of the subject matter have been described. Other embodiments are within the scope of the appended claims. In some cases, the actions recited in the claims can be performed in a different order and still achieve desired result.
15 In addition, the processes depicted in the drawings are not necessarily in the specific order or sequential order shown in order to achieve the desired result. In some implementations, multitasking and parallel process can be advantageous.

WHAT IS CLAIMED IS:

1. A form recognition method, comprising:

5 performing a form line extraction process on a to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result comprises a plurality of first form lines and/or a plurality of first form line intersections;

10 performing a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template, wherein the preset form template has a plurality of preset second form lines and/or a plurality of preset second form line intersections; and

performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

15 2. The method according to claim 1, wherein performing a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template comprises:

performing a matching process on the plurality of first form lines and the plurality of second form lines to obtain a matching result of the form lines, and/or performing a
20 matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections; and

performing a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line
25 intersections.

3. The method according to claim 2, wherein performing a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line intersections comprises:

30 obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines comprises the matching result of a plurality of form line pairs of the plurality of

first form lines and the plurality of second form lines, and the matching result of the form line intersections comprises the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections; and

- 5 performing a correction process on the to-be-recognized form image according to the transformation parameter.

4. The method according to claim 3, wherein obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the
10 matching result of the form lines and/or the matching result of the form line intersections comprises:

obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on matched form line pairs in the plurality of form line pairs, and/or based on matched form line intersection pairs in the plurality of form
15 line intersection pairs.

5. The method according to claim 3 or 4, wherein
obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the
20 matching result of the form line intersections comprises:

obtaining the transformation parameter based on the form line pairs with a matching confidence level higher than a first preset value among the plurality of form line pairs, and/or based on the form line intersection pairs with a matching confidence level higher than a second preset value among the plurality of form line intersection
25 pairs.

6. The method according to any one of claims 3 to 5, wherein obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections comprises:
30

determining a target area based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines and/or the form line intersections in the target area satisfies a preset condition; and

obtaining a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections in the target area.

5 7. The method according to claim 6, wherein the preset condition comprises any one or more:

 a number of matching form line pairs and/or matching form line intersection pairs in the target area satisfies a first condition; and

 a matching confidence level corresponding to matching form line pairs and/or
10 matching form line intersection pairs in the target area satisfies a second condition.

 8. The method according to any one of claims 3 to 7, wherein the preset form template comprises at least two template areas,

 obtaining a transformation parameter between the to-be-recognized form image
15 and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections comprises:

 obtaining the transformation parameter corresponding to each of the at least two template areas based on the matching result of the form lines and/or the matching result of the form line intersections; and

20 performing a correction process on the to-be-recognized form image according to the transformation parameter comprises:

 according to the transformation parameter corresponding to each of the at least two template areas, performing a correction process on an area of the to-be-recognized form image corresponding to each of the at least two template areas.

25

 9. The method according to any one of claims 1 to 8, wherein performing a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template comprises:

30 in response to a ratio of matching form line pairs in the plurality of first form lines reaching a first ratio value, and/or in response to a ratio of matching form line intersection pairs in the plurality of first form line intersections reaching a second ratio value, performing a correction process on the to-be-recognized form image based on

the form line extraction result of the to-be-recognized form image and the preset form template.

10. The method according to any one of claims 1 to 9, wherein performing a text
5 recognition process on the corrected to-be-recognized form image, to obtain a form recognition result comprises:

performing text detection on the corrected form image to obtain a plurality of text detection boxes of the to-be-recognized form image;

performing text recognition on the plurality of text detection boxes to obtain a text
10 recognition result; and

obtaining the form recognition result based on an intersection-over-union ratio between the plurality of text detection boxes and a plurality of form boxes defined by the plurality of first form lines.

15 11. The method according to any one of claims 1 to 9, wherein performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result comprises:

determining at least one to-be-detected target form box from a plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image
20 based on the preset form template;

performing text recognition on the at least one target form box, to obtain a text recognition result of each target form box in the at least one target form box; and

obtaining the form recognition result based on the text recognition result of the at least one target form box.

25 12. The method according to claim 11, wherein determining at least one to-be-detected target form box from a plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template comprises:

30 receiving a recognition condition entered by a user; and

determining at least one target form box from a plurality of form boxes of the preset form template based on the recognition condition.

13. The method according to claim 11 or 12, further comprising: setting an attribute for the target form box;

obtaining the form recognition result based on the text recognition result of the at least one target form box comprises:

5 obtaining the form recognition result based on the attribute of the target form box and the text recognition result of the target form box.

14. The method according to any one of claims 1 to 13, further comprising:

performing a form line extraction process on a reference form image to obtain a
10 form line extraction result of the reference form image; and

performing a correction process on the form line extraction result of the reference form image to obtain the preset form template based on user input.

15. The method according to any one of claims 1 to 14, wherein performing a form
15 line extraction process on a to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image comprises:

determining a plurality of directional single-connected chains in the to-be-recognized form image;

performing a first merging process on at least two directional single-connected
20 chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments;

performing an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among a plurality of i-th merged line segments, to obtain at least one (i+1)-th merged line segment; and

25 obtaining the form line extraction result of the to-be-recognized form image based on the merging result of N times of merging process, wherein i and N are integers, and i is greater than 1 and less than N.

16. The method according to claim 15, further comprising:

30 extending at least one end of the i-th merged line segment with at least one pixel to obtain an extended line segment of the i-th merged line segment;

determining at least two i-th merged line segments that satisfy the merging condition from the plurality of i-th merged line segments based on the extended line segment of each i-th merged line segment in the plurality of i-th merged line segments.

5 17. The method according to claim 15 or 16, wherein the merging condition comprises any one or more of:

 a minimum distance between end points of two to-be-merged objects being less than a first threshold;

 a maximum distance between the end points of the two to-be-merged objects being
10 less than a second threshold; and

 a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects being less than the second threshold;

 wherein the to-be-merged object is a directional single-connected chain or an i-th
15 merged line segment.

 18. A form recognition method, comprising:

 performing a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image;

20 generating a form template based on the form line extraction result, wherein the form template comprises a plurality of second form lines and/or a plurality of second form line intersections; and

 performing a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template.

25

 19. The method according to claim 18, wherein generating a form template based on the form line extraction result comprises:

 displaying the form line extraction result; and

 generating a form template based on the form line extraction result in response to
30 receiving confirmation instruction from a user.

 20. The method according to claim 18, wherein generating a form template based on the form line extraction result comprises:

performing an adjustment process on the form line extraction result to obtain an adjustment result in response to receiving an adjustment instruction from a user; and generating the form template based on the adjustment result.

- 5 21. The method according to any one of claims 18 to 20, further comprising:
receiving a recognition instruction from a user, wherein the recognition instruction is used to indicate a target form entry in the form template that needs to be recognized;
and
performing a text recognition process on a to-be-recognized form image to obtain
10 the form recognition result based on the form template comprises:
performing a text recognition process on the target form entry in the to-be-recognized form image based on the form template, to obtain a form recognition result.

- 15 22. The method according to any one of claims 18 to 21, wherein performing a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image comprises:
determining a plurality of directional single-connected chains in the reference form image;
performing a first merging process on at least two directional single-connected
20 chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments;
performing an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among a plurality of i-th merged line segments, to obtain at least one (i+1)-th merged line segment; and
25 obtaining the form line extraction result of the reference form image based on the merging result of N times of merging process, where i and N are integers, and i is greater than 1 and less than N.

- 30 23. The method according to claim 22, further comprising:
extending at least one end of the i-th merged line segment with at least one pixel to obtain an extended line segment of the i-th merged line segment;

determining at least two i-th merged line segments that satisfy the merging condition from the plurality of i-th merged line segments based on the extended line segment of each i-th merged line segment in the plurality of i-th merged line segments.

5 24. The method according to claim 22 or 23, wherein the merging condition comprises any one or more of:

 a minimum distance between end points of two to-be-merged objects is less than a first threshold;

 a maximum distance between the end points of the two to-be-merged objects is less
10 than a second threshold; and

 a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects is less than the second threshold;

 wherein the to-be-merged object is a directional single-connected chain or an i-th
15 merged line segment.

 25. The method according to any one of claims 18 to 24, wherein performing a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template comprises:

20 performing a form line extraction process on the to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result comprises a plurality of first form lines and/or a plurality of first form line intersections;

 obtaining a transformation parameter based on a plurality of second form lines
25 and/or a plurality of second form line intersections included in the form template, and the form line extraction result of the to-be-recognized form image; and

 performing a text recognition process on the to-be-recognized form image to obtain a form recognition result according to the transformation parameter.

30 26. The method according to claim 25, wherein obtaining a transformation parameter based on a plurality of second form lines and/or a plurality of second form line intersections included in the form template, and the form line extraction result of the to-be-recognized form image, comprises:

performing a matching process on the plurality of first form lines and the plurality of second form lines to obtain a matching result of the form lines, and/or performing a matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections;

5 and

obtaining a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines comprises the matching result of a plurality of form line pairs of the plurality of first form lines and the plurality of second form lines, and the matching result of the form line intersections comprises the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections.

15 27. The method according to claim 26, wherein obtaining a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result of the form line intersections comprises:

determining a target area based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines and/or the form line intersections in the target area satisfies a preset condition; and

20 obtaining a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result of the form line intersections in the target area.

25

28. The method according to claim 27, wherein the preset condition comprises any one or more:

a number of matching form line pairs and/or matching form line intersection pairs in the target area satisfies a first condition; and

30 a matching confidence level corresponding to matching form line pairs and/or matching form line intersection pairs in the target area satisfies a second condition.

29. The method according to any one of claims 25 to 28, wherein performing a text recognition process on the to-be-recognized form image to obtain a form recognition result according to the transformation parameter comprises:

- 5 performing a correction process on the to-be-recognized form image according to the transformation parameter; and
- performing a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

30. A form extraction method, comprising:

- 10 determining a plurality of directional single-connected chains in a to-be-recognized form image;
- performing a first merging process on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments;
- 15 performing an $(i+1)$ -th merging process on at least two i -th merged line segments that satisfy the merging condition among a plurality of i -th merged line segments, to obtain at least one $(i+1)$ -th merged line segment; and
- obtaining a form line extraction result of the form image based on the merging result of N times of merging process, where i and N are integers, and i is greater than 1
- 20 and less than N .

31. The method according to claim 30, further comprising:

- extending at least one end of the i -th merged line segment with at least one pixel to obtain an extended line segment of the i -th merged line segment;
- 25 determining at least two i -th merged line segments that satisfy the merging condition from the plurality of i -th merged line segments based on the extended line segment of each i -th merged line segment in the plurality of i -th merged line segments.

32. The method according to claim 30 or 31, wherein the merging condition comprises any one or more of:

- a minimum distance between end points of two to-be-merged objects is less than a first threshold;

a maximum distance between the end points of the two to-be-merged objects is less than a second threshold; and

5 a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects is less than the second threshold;

wherein the to-be-merged object is a directional single-connected chain or an i-th merged line segment.

33. A form recognition apparatus, comprising:

10 a processing unit configured to perform a form line extraction process on a to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result comprises a plurality of first form lines and/or a plurality of first form line intersections;

15 a correction unit configured to perform a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template, wherein the preset form template has a plurality of preset second form lines and/or a plurality of preset second form line intersections; and

20 a recognition unit configured to perform a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

34. The apparatus according to claim 33, wherein the correction unit is specifically configured to:

25 perform a matching process on the plurality of first form lines and the plurality of second form lines to obtain a matching result of the form lines, and/or perform a matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections; and

30 perform a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line intersections.

35. The apparatus according to claim 34, wherein when the correction unit is configured to perform a correction process on the to-be-recognized form image based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit is specifically configured to:

5 obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines comprises the matching result of a plurality of form line pairs of the plurality of first form lines and the plurality of second form lines, and the matching result of the
10 form line intersections comprises the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections; and

 perform a correction process on the to-be-recognized form image according to the transformation parameter.

15

36. The apparatus according to claim 35, wherein when the correction unit is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit is specifically
20 configured to:

 obtain a transformation parameter between the to-be-recognized form image and the preset form template based on matched form line pairs in the plurality of form line pairs, and/or based on matched form line intersection pairs in the plurality of form line intersection pairs.

25

37. The apparatus according to claim 35 or 36, wherein the matching result of the form lines comprises matching confidence levels of the plurality of form line pairs, and the matching result of the form line intersections comprises matching confidence levels of the plurality of form line intersection pairs,

30 when the correction unit is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit is specifically configured to:

obtain the transformation parameter based on the form line pairs with a matching confidence level higher than a first preset value among the plurality of form line pairs, and/or based on the form line intersection pairs with a matching confidence level higher than a second preset value among the plurality of form line intersection pairs.

5

38. The apparatus according to any one of claims 35 to 37, wherein when the correction unit is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit is specifically configured to:

determine a target area in the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result corresponding to the form lines and/or the form line intersections in the target area satisfies a preset condition; and

15 obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result corresponding to the form lines and/or the matching result of the form line intersections in the target area.

39. The apparatus according to claim 38, wherein the preset condition comprises any one or more:

a number of matching form line pairs and/or matching form line intersection pairs in the target area satisfies a first condition; and

a matching confidence level corresponding to matching form line pairs and/or matching form line intersection pairs in the target area satisfies a second condition.

25

40. The apparatus according to any one of claims 35 to 39, wherein the preset form template comprises at least two template areas,

when the correction unit is configured to obtain a transformation parameter between the to-be-recognized form image and the preset form template based on the matching result of the form lines and/or the matching result of the form line intersections, the correction unit is specifically configured to:

30

obtain the transformation parameter corresponding to each of the at least two template areas based on the matching result of the form lines and/or the matching result of the form line intersections; and

5 according to the transformation parameter corresponding to each of the at least two template areas, perform a correction process on an area of the to-be-recognized form image corresponding to each of the at least two template areas.

41. The apparatus according to any one of claims 33 to 40, wherein when the correction unit is configured to perform a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and a preset form template, the correction unit is specifically configured to:

10 in response to a ratio of matching form line pairs in the plurality of first form lines reaching a first ratio value, and/or in response to a ratio of matching form line intersection pairs in the plurality of first form line intersections reaching a second ratio value, perform a correction process on the to-be-recognized form image based on the form line extraction result of the to-be-recognized form image and the preset form template.

42. The apparatus according to any one of claims 33 to 41, wherein the recognition unit is specifically configured to:

20 perform text detection on the corrected form image to obtain a plurality of text detection boxes of the to-be-recognized form image;

 perform text recognition on the plurality of text detection boxes to obtain a text recognition result; and

25 obtain the form recognition result based on an intersection-over-union ratio between the plurality of text detection boxes and a plurality of form boxes defined by the plurality of first form lines.

43. The apparatus according to any one of claims 33 to 41, wherein the recognition unit is specifically configured to:

30 determine at least one to-be-detected target form box from a plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template;

perform text recognition on the at least one target form box, to obtain a text recognition result of each target form box in the at least one target form box; and
obtain the form recognition result based on the text recognition result of the at least one target form box.

5

44. The apparatus according to claim 43, wherein when the recognition unit is configured to determine at least one to-be-detected target form box from a plurality of form boxes defined by the plurality of first form lines in the to-be-recognized form image based on the preset form template, the recognition unit is specifically configured to:

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receive a recognition condition entered by a user; and
determine at least one target form box from a plurality of form boxes of the preset form template based on the recognition condition.

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45. The apparatus according to claim 43 or 44, further comprising a setting unit configured to set an attribute for the target form box;

wherein when the recognition unit is configured to obtain the form recognition result based on the text recognition result of the at least one target form box, the recognition unit is specifically configured to:

20

obtain the form recognition result based on the attribute of the target form box and the text recognition result of the target form box.

46. The apparatus according to any one of claims 33 to 45, further comprising a template obtaining unit configured to:

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perform a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image; and

perform a correction process on the form line extraction result of the reference form image to obtain the preset form template based on user input.

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47. The apparatus according to any one of claims 33 to 46, further comprising a form line extraction unit configured to:

determine a plurality of directional single-connected chains in the to-be-recognized form image;

perform a first merging process on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments;

5 perform an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among a plurality of i-th merged line segments, to obtain at least one (i+1)-th merged line segment; and

obtain the form line extraction result of the to-be-recognized form image based on the merging result of N times of merging process, wherein i and N are integers, and i is greater than 1 and less than N.

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48. The apparatus according to claim 47, further comprising an extension unit configured to:

extend at least one end of the i-th merged line segment with at least one pixel to obtain an extended line segment of the i-th merged line segment;

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determine at least two i-th merged line segments that satisfy the merging condition from the plurality of i-th merged line segments based on the extended line segment of each i-th merged line segment in the plurality of i-th merged line segments.

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49. The apparatus according to claim 47 or 48, wherein the merging condition comprises any one or more of:

a minimum distance between end points of two to-be-merged objects being less than a first threshold;

a maximum distance between the end points of the two to-be-merged objects being less than a second threshold; and

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a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects being less than the second threshold;

wherein the to-be-merged object is a directional single-connected chain or an i-th merged line segment.

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50. A form recognition apparatus, comprising:

an extraction unit configured to perform a form line extraction process on a reference form image to obtain a form line extraction result of the reference form image;

a generation unit configured to generate a form template based on the form line extraction result, wherein the form template comprises a plurality of second form lines and/or a plurality of second form line intersections; and

5 a recognition unit configured to perform a text recognition process on a to-be-recognized form image to obtain the form recognition result based on the form template.

51. The apparatus according to claim 50, wherein the generation unit is specifically configured to:

10 display the form line extraction result; and
generate a form template based on the form line extraction result in response to receiving confirmation instruction from a user.

52. The apparatus according to claim 50, wherein when the generation unit is configured to generate a form template based on the form line extraction result in
15 response to receiving confirmation instruction from a user, the generation unit is specifically configured to:

perform an adjustment process on the form line extraction result to obtain an adjustment result in response to receiving an adjustment instruction from a user; and
20 generate the form template based on the adjustment result.

53. The apparatus according to any one of claims 50 to 52, further comprising:
a receiving unit configured to receive a recognition instruction from a user, wherein the recognition instruction is used to indicate a target form entry in the form template that needs to be recognized; and
25 the recognition unit is specifically configured to perform a text recognition process on the target form entry in the to-be-recognized form image based on the form template, to obtain a form recognition result.

54. The apparatus according to any one of claims 50 to 53, wherein the extraction
30 unit is specifically configured to:
determine a plurality of directional single-connected chains in the reference form image;

perform a first merging process on at least two directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments;

5 perform an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among a plurality of i-th merged line segments, to obtain at least one (i+1)-th merged line segment; and

obtain the form line extraction result of the reference form image based on the merging result of N times of merging process, where i and N are integers, and i is greater than 1 and less than N.

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55. The apparatus according to any one of claims 50 to 54, further comprising an extension unit configured to:

extend at least one end of the i-th merged line segment with at least one pixel to obtain an extended line segment of the i-th merged line segment;

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determine at least two i-th merged line segments that satisfy the merging condition from the plurality of i-th merged line segments based on the extended line segment of each i-th merged line segment in the plurality of i-th merged line segments.

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56. The apparatus according to claim 54 or 55, wherein the merging condition comprises any one or more of:

a minimum distance between end points of two to-be-merged objects is less than a first threshold;

a maximum distance between the end points of the two to-be-merged objects is less than a second threshold; and

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a maximum distance from the end points of the two to-be-merged objects to a connection line corresponding to the maximum distance between the end points of the two to-be-merged objects is less than the second threshold;

wherein the to-be-merged object is a directional single-connected chain or an i-th merged line segment.

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57. The apparatus according to any one of claims 50 to 53, wherein the recognition unit is specifically configured to:

perform a form line extraction process on the to-be-recognized form image to obtain a form line extraction result of the to-be-recognized form image, wherein the form line extraction result comprises a plurality of first form lines and/or a plurality of first form line intersections;

5 obtain a transformation parameter based on a plurality of second form lines and/or a plurality of second form line intersections included in the form template, and the form line extraction result of the to-be-recognized form image; and

perform a text recognition process on the to-be-recognized form image to obtain a form recognition result according to the transformation parameter.

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58. The apparatus according to claim 57, wherein when the recognition unit is configured to obtain a transformation parameter based on a plurality of second form lines and/or a plurality of second form line intersections included in the form template, and the form line extraction result of the to-be-recognized form image, the recognition
15 unit is specifically configured to:

perform a matching process on the plurality of first form lines and the plurality of second form lines to obtain a matching result of the form lines, and/or perform a matching process on the plurality of first form line intersections and the plurality of second form line intersections, to obtain a matching result of the form line intersections;

20 and

obtain a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines comprises the matching result of a plurality of form line pairs of the plurality of first
25 form lines and the plurality of second form lines, and the matching result of the form line intersections comprises the matching result of a plurality of form line intersection pairs of the plurality of first form line intersections and the plurality of second form line intersections.

30 59. The apparatus according to claim 57, wherein:

when the recognition unit is configured to obtain a transformation parameter between the to-be-recognized form image and the form template based on the matching

result of the form lines and/or the matching result of the form line intersections, the recognition unit is specifically configured to:

- 5 determine a target area based on the matching result of the form lines and/or the matching result of the form line intersections, wherein the matching result of the form lines and/or the form line intersections in the target area satisfies a preset condition; and
 obtain a transformation parameter between the to-be-recognized form image and the form template based on the matching result of the form lines and/or the matching result of the form line intersections in the target area.

10 60. The apparatus according to claim 59, wherein the preset condition comprises any one or more:

- a number of matching form line pairs and/or matching form line intersection pairs in the target area satisfies a first condition; and
 a matching confidence level corresponding to matching form line pairs and/or
15 matching form line intersection pairs in the target area satisfies a second condition.

 61. The apparatus according to any one of claims 57 to 60, wherein when the recognition unit is configured to perform a text recognition process on the to-be-recognized form image to obtain a form recognition result according to the
20 transformation parameter, the recognition unit is specifically configured to:

- perform a correction process on the to-be-recognized form image according to the transformation parameter; and
 perform a text recognition process on the corrected to-be-recognized form image, to obtain a form recognition result.

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62. A form extraction apparatus, comprising:
 a determination unit configured to determine a plurality of directional single-connected chains in a to-be-recognized form image;
 a first merging unit configured to perform a first merging process on at least two
30 directional single-connected chains that satisfy a merging condition among the plurality of directional single-connected chains, to obtain a plurality of first merged line segments;

a second merging unit configured to perform an (i+1)-th merging process on at least two i-th merged line segments that satisfy the merging condition among a plurality of i-th merged line segments, to obtain at least one (i+1)-th merged line segment; and
an obtaining unit configured to obtain a form line extraction result of the form
5 image based on the merging result of N times of merging process,
where i and N are integers, and i is greater than 1 and less than N.

63. The apparatus according to claim 62, further comprising an extension unit
configured to:
10 extend at least one end of the i-th merged line segment with at least one pixel to
obtain an extended line segment of the i-th merged line segment;
determine at least two i-th merged line segments that satisfy the merging condition
from the plurality of i-th merged line segments based on the extended line segment of
each i-th merged line segment in the plurality of i-th merged line segments.

15 64. The apparatus according to claim 62 or 63, wherein the merging condition
comprises any one or more of:
a minimum distance between end points of two to-be-merged objects is less than a
first threshold;
20 a maximum distance between the end points of the two to-be-merged objects is less
than a second threshold; and
a maximum distance from the end points of the two to-be-merged objects to a
connection line corresponding to the maximum distance between the end points of the
two to-be-merged objects is less than a second threshold;
25 wherein the to-be-merged object is a directional single-connected chain or an i-th
merged line segment.

65. A form recognition device, comprising a memory and a processor, wherein the
memory is configured to store computer instructions executable by the processor, and
30 when the computer instructions are executed, the processor is configured to implement
the method according to any one of claims 1-17.

66. A form recognition device, comprising a memory and a processor, wherein the memory is configured to store computer instructions executable by the processor, and when the computer instructions are executed, the processor is configured to implement the method according to any one of claims 18-29.

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67. A form extraction device, comprising a memory and a processor, wherein the memory is configured to store computer instructions executable by the processor, and when the computer instructions are executed, the processor is configured to implement the method according to any one of claims 30 to 32.

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68. A computer-readable storage medium with a computer program stored thereon, wherein the program is executed by a processor to implement the method according to any one of claims 1 to 17.

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69. A computer-readable storage medium with a computer program stored thereon, wherein the program is executed by a processor to implement the method according to any one of claims 18 to 29.

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70. A computer-readable storage medium with a computer program stored thereon, wherein the program is executed by a processor to implement the method according to any one of claims 30 to 32.