

# CLAIMS

1. A character recognition apparatus which carries out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

first character recognition means for carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from a first end of the character string; and

second character recognition means for carrying out the character recognition processing for each of second characters different from the first characters,

wherein the first character recognition means sets a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters, carries out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value, determines the character recognition result of the first character based on the calculated evaluation values, and determines a first optimal character area size as an optimal character area size from among the various character area sizes, and

wherein the second character recognition means sets a plurality of second character areas having the first optimal character area size for each of positions on the gray-scale image, carries out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value, and determines the character recognition result of the

second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas.

5 2. The character recognition apparatus according to claim 1, wherein the first character recognition means determines a character position of each of the first characters based on the evaluation values, and determines an optimal character spacing size showing  
10 an optimal character spacing from the determined character positions, and

wherein the second character recognition means sets positions of the plurality of second character areas based on the optimal character spacing  
15 size.

3. The character recognition apparatus according to claim 1, wherein the first character recognition means ranks the character recognition result obtained  
20 for each of the positions of the plurality of first character areas, based on the evaluation values,

wherein the first character recognition means extracts the character recognition results corresponding to top  $m_c$  ( $m_c$  is a predetermined integer  
25 greater than  $N_c$ ) evaluation values from among the character recognition results obtained for the positions of the plurality of first character areas and having a first rank for each position, and calculates a first average as an average of the  
30 evaluation values of the  $m_c$  character recognition results, and

wherein the first character recognition means determines the character area size corresponding to the highest first average as an optimal character area  
35 size.

4. The character recognition apparatus according to claim 3, wherein the first character recognition means generates an evaluation value - brightness value conversion plot image as an image in which pixels  
5 having brightness values corresponding to the evaluation values of the  $m_c$  character recognition results are positioned on the position of the character area corresponding to each of the  $m_c$  character recognition results in each of the character area sizes, and carries out binarization processing to  
10 the evaluation value - brightness value conversion plot image to generate a binarized image,

wherein the first character recognition means carries out labeling processing to the binarized image  
15 to give a label to each of sets of concatenated pixels of an identical color, and calculates a second average as an average of the evaluation values of the character recognition results corresponding to the pixels which belongs to each of the labels,

20 wherein the first character recognition means calculates a distance between a gravity position of each of the labels and a gravity position of another label sequentially from the label having a higher second average, and repeatedly carries out processing  
25 which removes each label when the distance to the gravity position of the other label is shorter than a predetermined threshold value, until  $N_c$  labels are left,

wherein the first character recognition means  
30 selects the pixel having the highest evaluation value of the character recognition profit result corresponding to each label, of the pixels belonging to each of the  $N_c$  remaining labels, determines the position of the pixel having the highest evaluation  
35 value as the character position of the first character, and determines the optimal character

spacing size which is an optimal character spacing from the determined character position, and

wherein the second character recognition means sets the position of the plurality of second character areas based on the optimal character spacing size.

5. The character recognition apparatus according to any one of claims 1 to 4, further comprising:

10 third character recognition means for carrying out the character recognition processing for third characters of the  $N_c$  characters of the character string from a second end opposite to the first end;

fourth character recognition means for carrying out the character recognition processing for 15 fourth characters which are characters of the character string other than the  $N_c$  characters from the second end; and

final character recognition result determining means,

wherein the third character recognition means sets a plurality of third character areas of various character area sizes for each of positions on the gray-scale image in the character recognition 25 processing of the third characters, carries out the character recognition processing to each of the plurality of third character areas to calculate a character recognition result and an evaluation value, and determines the character recognition results of 30 the third characters and a second optimal character area size as sizes of optimal character areas based on the calculated evaluation values,

wherein the fourth character recognition means sets a plurality of fourth character areas 35 having the second optimal character area size for each of positions on the gray-scale image, carries out the

character recognition processing to each of the plurality of fourth character areas to calculate a character recognition result and an evaluation value, and determines the character recognition results of the fourth characters based on the character recognition results and the evaluation values calculated for the plurality of fourth character areas, and

wherein the final character recognition result determining means determines, when the character recognition result of a specific character of the character string which is obtained by the first character recognition means and the second character recognition means coincides with the character recognition result of the specific character which is obtained by the third character recognition means and the fourth character recognition means, the coinciding character recognition result as a final character recognition result of the specific character, and determines, when does not coincide, one having a higher evaluation value, of the character recognition result of the specific character which is obtained by the first character recognition means and the second character recognition means and the character recognition result of the specific character which is obtained by the third character recognition means and the fourth character recognition means, as a final character recognition result of the specific character.

6. The character recognition apparatus according to any one of claims 1 to 4, wherein the first character recognition means comprises memory means for storing similar character data indicating similar characters, and

wherein the first character recognition means

determines an optimal character area size, without using character recognition results and evaluation values for the similar characters, among the character recognition results obtained by carrying out the character recognition processing to each of the plurality of first character areas.

7. A character recognition apparatus which carries out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

first character recognition means for carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from an end of the character string; and

second character recognition means for carrying out the character recognition processing for a second character different from the first characters,

wherein the first character recognition means sets a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters, carries out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value, determines the character recognition result of the first character and a character position of the first character based on the calculated evaluation values, and determines an optimal character spacing size from the determined character positions, and

wherein the second character recognition means sets a plurality of second character areas for

each of positions on the gray-scale image according to the optimal character spacing size, carries out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value, and determines the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas.

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8. A character recognition method of carrying out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction,

15 comprising:

carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from an end of the character string; and

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carrying out the character recognition processing for a second character different from the first characters,

wherein said carrying out the character recognition processing for each of first characters

25 comprises:

setting a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first

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characters;

carrying out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value;

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determining the character recognition result of the first character based on the calculated

evaluation values; and

determines a first optimal character area size from among the various character area sizes, and

wherein said carrying out the character  
5 recognition processing for a second character comprises:

setting a plurality of second character areas having the first optimal character area size for each of positions on the gray-scale image;

10 carrying out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value; and

determining the character recognition result  
15 of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas.

20 9. A character recognition method of carrying out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

25 carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from an end of the character string; and

carrying out the character recognition  
30 processing for a second character different from the first characters,

wherein said carrying out the character recognition processing for each of first characters comprises:

35 setting a plurality of first character areas having various character area sizes for each of

positions on the gray-scale image in the character recognition processing for each of the first characters;

carrying out the character recognition  
5 processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value;

determining the character recognition result of the first character and a character position of the  
10 first character based on the calculated evaluation values; and

determining an optimal character spacing size from the determined character positions, and

wherein said carrying out the character  
15 recognition processing for a second character comprises:

setting a plurality of second character areas for each of positions on the gray-scale image according to the optimal character spacing size;

20 carrying out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value; and

determining the character recognition result  
25 of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas.

## CLAIMS

1. A character recognition apparatus which carries out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

first character recognition means for carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from a first end of the character string; and

second character recognition means for carrying out the character recognition processing for each of second characters different from the first characters,

wherein the first character recognition means sets a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters, carries out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value, determines the character recognition result of the first character based on the calculated evaluation values, and determines a first optimal character area size as an optimal character area size from among the various character area sizes,

wherein the second character recognition means sets a plurality of second character areas having the first optimal character area size for each of positions on the gray-scale image, carries out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value, and determines the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas,

wherein the first character recognition means ranks the character recognition result obtained for each of the positions of the plurality of first character areas, based on the evaluation values,

wherein the first character recognition means extracts the character recognition results corresponding to top  $m_c$  ( $m_c$  is a predetermined integer greater than  $N_c$ ) evaluation values from among the character recognition results obtained for the positions of the plurality of first character areas and having a first rank for each position, and calculates a first average as an average of the evaluation values of the  $m_c$  character recognition results,

wherein the first character recognition means determines the character area size corresponding to the highest first average as an optimal character area size,

wherein the first character recognition means generates an evaluation value - brightness value conversion plot image as an image in which pixels having brightness values corresponding to the

evaluation values of the  $m_c$  character recognition results are positioned on the position of the character area corresponding to each of the  $m_c$  character recognition results in each of the character area sizes, and carries out binarization processing to the evaluation value - brightness value conversion plot image to generate a binarized image,

wherein the first character recognition means carries out labeling processing to the binarized image to give a label to each of sets of concatenated pixels of an identical color, and calculates a second average as an average of the evaluation values of the character recognition results corresponding to the pixels which belongs to each of the labels,

wherein the first character recognition means calculates a distance between a gravity position of each of the labels and a gravity position of another label sequentially from the label having a higher second average, and repeatedly carries out processing which removes each label when the distance to the gravity position of the other label is shorter than a predetermined threshold value, until  $N_c$  labels are left,

wherein the first character recognition means selects the pixel having the highest evaluation value of the character recognition profit result corresponding to each label, of the pixels belonging to each of the  $N_c$  remaining labels, determines the position of the pixel having the highest evaluation value as the character position of the first character, and determines the optimal character spacing size which is an optimal character spacing from the determined character position, and

wherein the second character recognition means sets the position of the plurality of second character areas based on the optimal character spacing size.

2. A character recognition apparatus which carries out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

first character recognition means for carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from a first end of the character string; and

second character recognition means for carrying out the character recognition processing for each of second characters different from the first characters,

wherein the first character recognition means sets a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters, carries out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value, determines the character recognition result of the first character based on the calculated evaluation values,

and determines a first optimal character area size as an optimal character area size from among the various character area sizes,

wherein the second character recognition means sets a plurality of second character areas having the first optimal character area size for each of positions on the gray-scale image, carries out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value, and determines the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas,

wherein the first character recognition means determines a character position of each of the first characters based on the evaluation values, and determines an optimal character spacing size showing an optimal character spacing from the determined character positions, and

wherein the second character recognition means sets positions of the plurality of second character areas based on the optimal character spacing size.

3. A character recognition apparatus which carries out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

first character recognition means for carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from a first end of the character string; and

second character recognition means for carrying out the character recognition processing for each of second characters different from the first characters,

wherein the first character recognition means sets a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters, carries out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value, determines the character recognition result of the first character based on the calculated evaluation values, and determines a first optimal character area size as an optimal character area size from among the various character area sizes,

wherein the second character recognition means sets a plurality of second character areas having the first optimal character area size for each of positions on the gray-scale image, carries out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value, and determines the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas,

wherein the character recognition apparatus further comprises:

third character recognition means for carrying out the character recognition processing for third characters of the  $N_c$  characters of the character string from a second end opposite to the first end;

fourth character recognition means for carrying out the character recognition processing for fourth characters which are characters of the character string other than the  $N_c$  characters from the second end; and

final character recognition result determining means,

wherein the third character recognition means sets a plurality of third character areas of various character area sizes for each of positions on the gray-scale image in the character recognition processing of the third characters, carries out the character recognition processing to each of the plurality of third character areas to calculate a character recognition result and an evaluation value, and determines the character recognition results of the third characters and a second optimal character area size as sizes of optimal character areas based on the calculated evaluation values,

wherein the fourth character recognition means sets a plurality of fourth character areas having the second optimal character area size for each of positions on the gray-scale image, carries out the character recognition processing to each of the plurality of fourth character areas to calculate a character recognition result and an evaluation value, and determines the character recognition results of the fourth characters based on the character recognition results and the evaluation values calculated for the plurality of fourth character areas, and

wherein the final character recognition result determining means determines, when the character recognition result of a specific character of the character string which is obtained by the first character recognition means and the second character recognition means coincides with the character recognition result of the specific character which is obtained by the third character recognition means and the fourth character recognition means, the coinciding character recognition result as a final character recognition result of the specific character, and determines, when does not coincide, one having a higher evaluation value, of the character recognition result of the specific character which is obtained by the first character recognition means and the second character recognition means and the character recognition result of the specific character which is obtained by the third character recognition means and the fourth character recognition means, as a final character recognition result of the specific character.

4. The character recognition apparatus according to any one of claims 1 to 3, wherein the first character recognition means comprises memory means for storing similar character data indicating similar characters, and

wherein the first character recognition means determines an

optimal character area size, without using character recognition results and evaluation values for the similar characters, among the character recognition results obtained by carrying out the character recognition processing to each of the plurality of first character areas.

5. A character recognition apparatus which carries out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

first character recognition means for carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from an end of the character string; and

second character recognition means for carrying out the character recognition processing for a second character different from the first characters,

wherein the first character recognition means sets a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters, carries out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value, determines the character recognition result of the first character and a character position of the first character based on the calculated evaluation values, and determines an optimal character spacing size from the determined character positions, and

wherein the second character recognition means sets a plurality of second character areas for each of positions on the gray-scale image according to the optimal character spacing size, carries out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value, and determines the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas.

6. A character recognition method of carrying out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from an end of the character string; and

carrying out the character recognition processing for a second character different from the first characters,

wherein said carrying out the character recognition processing for each of first characters comprises:

setting a plurality of first character areas having various

character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters;

- carrying out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value;

- determining the character recognition result of the first character based on the calculated evaluation values; and

- determining a first optimal character area size from among the various character area sizes, and

- wherein said carrying out the character recognition processing for a second character comprises:

- setting a plurality of second character areas having the first optimal character area size for each of positions on the gray-scale image;

- carrying out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value; and

- determining the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas,

- wherein said carrying out the character recognition processing for each of first characters further comprises:

- ranking the character recognition result obtained for each of the positions of the plurality of first character areas, based on the evaluation values;

- extracting the character recognition results corresponding to top  $m_c$  ( $m_c$  is a predetermined integer greater than  $N_c$ ) evaluation values from among the character recognition results obtained for the positions of the plurality of first character areas and having a first rank for each position;

- calculating a first average as an average of the evaluation values of the  $m_c$  character recognition results; and

- determining the character area size corresponding to the highest first average as an optimal character area size,

- wherein said carrying out the character recognition processing for each of first characters further comprises:

- generating an evaluation value - brightness value conversion plot image as an image in which pixels having brightness values corresponding to the evaluation values of the  $m_c$  character recognition results are positioned on the position of the character area corresponding to each of the  $m_c$  character recognition results in each of the character area sizes;

- carrying out binarization processing to the evaluation value - brightness value conversion plot image to generate a binarized image;

- carrying out labeling processing to the binarized image to give a label to each of sets of concatenated pixels of an identical color;

calculating a second average as an average of the evaluation values of the character recognition results corresponding to the pixels which belongs to each of the labels;

calculating a distance between a gravity position of each of the labels and a gravity position of another label sequentially from the label having a higher second average;

repeatedly carrying out processing which removes each label when the distance to the gravity position of the other label is shorter than a predetermined threshold value, until  $N_c$  labels are left;

selecting the pixel having the highest evaluation value of the character recognition profit result corresponding to each label, of the pixels belonging to each of the  $N_c$  remaining labels;

determining the position of the pixel having the highest evaluation value as the character position of the first character; and

determining the optimal character spacing size which is an optimal character spacing from the determined character position, and

wherein said carrying out the character recognition processing for a second character further comprises:

setting the position of the plurality of second character areas based on the optimal character spacing size.

7. A character recognition method of carrying out character recognition processing to a gray-scale image obtained by picking up a character string of characters arranged in a specific direction, comprising:

carrying out the character recognition processing for each of first characters as  $N_c$  ( $N_c$  is an integer equal to or more than 2) characters from an end of the character string; and

carrying out the character recognition processing for a second character different from the first characters,

wherein said carrying out the character recognition processing for each of first characters comprises:

setting a plurality of first character areas having various character area sizes for each of positions on the gray-scale image in the character recognition processing for each of the first characters;

carrying out the character recognition processing to each of the plurality of first character areas to calculate a character recognition result and an evaluation value;

determining the character recognition result of the first character and a character position of the first character based on the calculated evaluation values; and

determining an optimal character spacing size from the determined character positions, and

wherein said carrying out the character recognition processing for a second character comprises:

setting a plurality of second character areas for each of

positions on the gray-scale image according to the optimal character spacing size;

carrying out the character recognition processing to each of the plurality of second character areas to calculate a character recognition result and an evaluation value; and

determining the character recognition result of the second character based on the character recognition result and the evaluation value which are calculated for each of the plurality of second character areas.