

What is claimed is:

1. A pixel-level object detection system that detects an object at a pixel level, comprising:

5 an imaging unit that acquires an inference image that is an image that captures the object;

an area detection unit that detects an area including the object from the inference image based on learning data;

10 a detail detection unit that detects the object from the inference image using only first local information which is information for each pixel of the inference image, wherein the detail detection unit creates a local detection map detecting the object as an output, by performing preprocessing for the first local information, calculating
15 a brightness of pixels included in the inference image, and calculating a distance between any pixel value and each pixel value of the inference image;

20 a result integration processing unit that integrates an output of the area detection unit with the output of the detail detection unit to output a segmentation map indicating, as a probability map, which pixel in the image corresponds to the object;

wherein the area detection unit includes a learning unit that generates an inference unit which infers pixels
25 corresponding to the object by machine learning using the

learning data of a learning database, and the inference unit executes processing of detecting the area including the object from the inference image, and

wherein the system further comprises a learning data creation unit that creates the learning data, including:

a second detail detection unit that detects the object from the learning image using only second local information which is information for each pixel of the learning image, wherein the second detail detection unit creates a local detection result, by performing preprocessing for the second local information, calculating a brightness of pixels included in the learning image, and calculating a distance between any pixel value and each pixel value of the learning image; and

a second result integration processing unit that integrates the local detection result obtained by the second detail detection unit and correct answer data input by a correct answer data input unit, and

the learning data creation unit refines the correct answer data.

2. The pixel-level object detection system according to claim 1,

wherein the detail detection unit detects the object using one pixel or multiple pixels, and

the area detection unit detects the area including the object using more pixels than the pixel or pixels used by the detail detection unit.

5 3. The pixel-level object detection system according to claim 1, further comprising:

 a learning data input unit that outputs the learning data that is an aggregation of pairs of learning images that are an image group acquired in advance and the correct
10 answer data including information on whether or not the pixels correspond to the object,

 wherein the learning database holds the learning data.

 4. The pixel-level object detection system according
15 to claim 1,

 wherein the detail detection unit includes:

 a preprocessing function of performing the preprocessing including filtering;

 a pixel brightness calculation function of
20 calculating the brightness of pixels included in the inference image; and

 a pixel distance calculation function of calculating the distance between any pixel value and each pixel value of the inference image.

5. The pixel-level object detection system according to claim 1, further comprising:

an image reduction unit that reduces a resolution of the inference image output by the imaging unit and inputs the reduced resolution to the area detection unit; and

an image enlargement unit that enlarges an area detection map output from the area detection unit.

6. The pixel-level object detection system according to claim 1, further comprising a GUI unit that displays the segmentation map on a screen,

wherein the GUI unit performs at least one of:

processing of displaying the segmentation map as a colored multi-tone image based on an object probability value output from the result integration processing unit on the screen;

processing of enlarging a part of the screen on the screen;

similar area selection processing of being capable at once of selecting adjacent pixel groups determined to be the same object on the screen;

processing of performing threshold processing on the segmentation map based on an object estimation probability value on the above screen; and

processing of editing the segmentation map.

7. The pixel-level object detection system according to claim 1, further comprising a GUI unit that displays the segmentation map on the screen,

5 wherein the GUI unit displays at least one of:

a first part that sets a first threshold required for threshold processing;

a second part that sets a type of the area detection unit;

10 a third part that sets a type of the detail detection unit; and

a fourth part that sets a second threshold required when the result integration processing unit integrates the local detection map with an area detection map.

15

8. The pixel-level object detection system according to claim 1,

wherein the result integration processing unit includes a GUI unit that outputs a structural deterioration degree as the segmentation map, and displays the segmentation map on a screen, and

the GUI unit includes:

a function of being capable of removing adjacent pixel groups which are determined to be the same object and
25 whose dimensions are smaller than a predetermined threshold

value among threshold-processed detection results, and
a straight-line removal function of removing a
threshold-processed detection area whose shape is a
straight line.

5

9. The pixel-level object detection system according
to claim 1,

wherein the result integration processing unit
includes a GUI unit that outputs a growth probability of
10 crops as the segmentation map, and displays the
segmentation map on a screen, and

the GUI unit includes a function of removing the
crops at a growth level below a threshold in threshold-
processed detection results.

15

10. A program causing a computer to function as a
pixel-level object detection system comprising:

an area detection unit that detects an area including
an object from an inference image based on learning data;

20 a detail detection unit that detects the object from
the inference image using only first local information
which is information for each pixel of the inference image,
wherein the detail detection unit creates a local detection
map detecting the object as an output, by performing
25 preprocessing for the first local information, calculating

a brightness of pixels included in the inference image, and calculating a distance between any pixel value and each pixel value of the inference image; and

a result integration processing unit that integrates
5 an output of the area detection unit with the output of the detail detection unit to output a segmentation map indicating, as a probability map, which pixel in the image corresponds to the object,

wherein the area detection unit includes a learning
10 unit that generates an inference unit which infers pixels corresponding to the object by machine learning using the learning data of a learning database, and the inference unit performs processing of detecting the area including the object from the inference image, and

15 wherein the program functions as the pixel-level object detection system includes a learning data creation unit that includes:

a second detail detection unit that detects the object from the learning image using only second local
20 information which is information for each pixel of the learning image, wherein the second detail detection unit creates a local detection result, by performing preprocessing for the second local information, calculating a brightness of pixels included in the learning image, and
25 calculating a distance between any pixel value and each

pixel value of the learning image; and

a second result integration processing unit that integrates the local detection result determined in the second detail detection unit and correct answer data input

5 by a correct answer data input unit, and

the learning data creation unit refines the correct answer data.

11. The program according to claim 10,

10 wherein the program functions as the pixel-level object detection system includes:

an image reduction unit that reduces a resolution of the inference image and inputs the reduced resolution to the area detection unit, and

15 an image enlargement unit that enlarges an area detection map output from the area detection unit.