

Claims

1. A method for providing an augmented input data to a convolutional neural network (CNN) comprising:
 - receiving, at a processor, a wafer image;
 - dividing, using the processor, the wafer image into a plurality of reference images, each reference image associated with a die in the wafer image;
 - receiving, at the processor, one or more test images;
 - creating a plurality of difference images, using the processor, by differencing the one or more test images with one or more of the plurality of reference images;
 - assembling, using the processor, the plurality of reference images and the plurality of difference images into the augmented input data for the CNN;
 - providing, using the processor, the augmented input data to the CNN;
 - creating a plurality of transposed images, using the processor, by transposing the plurality of reference images and the plurality of difference images with respect to the received one or more test images; and
 - assembling, using the processor, the plurality of transposed images into the augmented input data for the CNN;wherein the plurality of transposed images are transposed by a sub-pixel offset with respect to the received one or more test images.
2. The method of claim 1, further comprising:
 - performing, using an image data acquisition subsystem, a wafer scan;
 - converting, using an image data acquisition subsystem, the wafer scan into the wafer image; and
 - converting, using the image data acquisition subsystem, the wafer scan into the one or more test images.
3. The method of claim 1, further comprising:
 - creating a plurality of defect-of-interest (DOI) images, using the processor, by differencing one or more test images having a DOI with one or more of the plurality of the reference images and merging the differenced images with one or more of the plurality of test images; and
 - assembling, using the processor, the plurality of DOI images into the augmented

input data for the CNN.

4. The method of claim 1, further comprising:

creating a plurality of amplified images, using the processor, by multiplying pixel values of the plurality of reference images and the plurality of difference images by a constant or matrix; and
assembling, using the processor, the plurality of amplified images into the augmented input data for the CNN.

5. The method of claim 1, further comprising:

generating, using the processor, an electromagnetic simulation of the wafer image;
rendering, using the processor, the electromagnetic simulation;
combining, using the processor, the rendered electromagnetic simulation with the received wafer image to create an electromagnetic image;
dividing, using the processor, the electromagnetic image into a plurality of electromagnetic reference images, each electromagnetic reference image associated with a die in the electromagnetic image; and
assembling, using the processor, the plurality of electromagnetic reference images into the augmented input data for the CNN.

6. The method of claim 1, further comprising:

creating a plurality of defocused images, using the processor, by defocusing the plurality of reference images and the plurality of difference images; and
assembling, using the processor, the plurality of defocused images into the augmented input data for the CNN.

7. The method of claim 1, further comprising:

creating a plurality of illuminated images, using the processor, by varying an illumination value of the plurality of reference images and the plurality of difference images; and
assembling, using the processor, the plurality of illuminated images into the augmented input data for the CNN.

8. The method of claim 1, wherein the step of creating a plurality of difference images comprises differencing, using the processor, a test image with a median die reference image, a golden die reference image, a reference image based on a rendered design, or reference image from a same die row as the test image, a same die column as the test image, or any die in the wafer image.

9. A system for providing an augmented input data to a convolutional neural network (CNN) comprising:

a processor configured to execute one or more software modules, the one or more software modules configured to:
receive a wafer image, the wafer image containing one or more dies;
divide the wafer image into a plurality of reference images, each reference image associated with a die in the wafer image;
receive one or more test images;
create a plurality of difference images by differencing the one or more test images with one or more of the plurality of reference images;
assemble the plurality of reference images and the plurality of difference images into the augmented input data for the CNN; provide the augmented input data to the CNN;
create a plurality of transposed images by transposing the plurality of reference images and the plurality of difference images with respect to the received one or more test images; and
assemble the plurality of transposed images into the augmented input data for the CNN;
wherein the plurality of transposed images are transposed by a sub-pixel offset with respect to the received one or more test images.

10. The system of claim 9, wherein the one or more software modules are further configured to:
create a plurality of defect-of-interest (DOI) images by differencing one or more test

images having a DOI with one or more of the plurality of the reference images and merging the differenced images with one or more of the plurality of test images; and
assemble the plurality of DOI images into the augmented input data for the CNN.

11. The system of claim 10, further comprising a database in electronic communication with the processor and the image data acquisition subsystem, the database configured to store the wafer image, the plurality of reference images, the one or more test images, and the plurality of difference images.

12. The system of claim 11, wherein the database is also configured to store the CNN.

13. The system of claim 9, further comprising:
an image data acquisition subsystem in electronic communication with the processor;
wherein the image data acquisition subsystem is configured to perform a wafer scan;
wherein the one or more software modules are further configured to convert the wafer scan into the one or more test images; and

wherein the one or more software modules are further configured to convert the wafer scan into the wafer image.

14. The system of claim 9, wherein the one or more software modules are further configured to:
create a plurality of amplified images by multiplying pixel values of the plurality of reference images and the plurality of difference images by a constant or matrix; and
assemble the plurality of amplified images into the augmented input data for the CNN.

15. The system of claim 9, wherein the one or more software modules are further configured to:
generate an electromagnetic simulation of the wafer image;
render the electromagnetic simulation;
combine the rendered electromagnetic simulation with the received wafer image to create an electromagnetic image;
divide the electromagnetic image into a plurality of electromagnetic reference images, each electromagnetic reference image associated with a die in the electromagnetic image; and
assemble the plurality of electromagnetic reference images into the augmented input data for the CNN.

16. The system of claim 9, wherein the one or more software modules are further configured to:
create a plurality of defocused images by defocusing the plurality of reference images

and the plurality of difference images; and
assemble the plurality of defocused images into the augmented input data for the
CNN.

17. The system of claim 9, wherein the one or more software modules are further configured to:
create a plurality of illuminated images by varying an illumination value of the plurality
of reference images and the plurality of difference images; and
assemble the plurality of illuminated images into the augmented input data for the
CNN.

18. The system of claim 9, wherein the one or more software modules are configured to create a
plurality of difference images by differencing a test image with a median die reference image, a
golden die reference image, a reference image based on a rendered design, or reference image
from a same die row as the test image, a same die column as the test image, or any die in the
wafer image.