

Claims

1. A method of determining a trajectory of a target object, comprising:

i) receiving a plurality of source images of the target object captured by
an image capturing device;

ii) generating corresponding augmented images from the plurality of
source images using a data augmentation model trained using a plurality of
training images, each augmented image including an augmented target object
label associated with the respective target object in the plurality of source
images; and

iii) tracking movement of the augmented target object label in the
corresponding augmented images using an object detector instead of tracking
movement of the target object, in order to determine the trajectory of the
target object.

2. A method of determining a trajectory of a target object according to claim 1,
further comprising generating a plurality of binary saliency region images from
the plurality of source images by discarding pixels of the plurality of source
images having a saliency level below a threshold, and generating the
corresponding augmented images from both the plurality of source images and
the plurality of binary saliency region images using the data augmentation
model.

3. A method of determining a trajectory of a target object according to claim 1
or 2,
wherein the augmented target object label comprises a bounding box
around the target object.

4. A method of determining a trajectory of a target object according to claim 3, wherein the bounding box comprises a colour indicating a category to which the target object belongs.
- 5 5. A method of determining a trajectory of a target object according to claim 3 or 4, wherein the bounding box comprises at least one contour and wherein tracking movement of the augmented target object label comprises detecting the at least one contour.
- 10 6. A method of determining a trajectory of a target object according to claim 5, wherein the bounding box comprises a plurality of contours including an external contour, and wherein tracking movement of the augmented target object label further comprises: detecting the external contour of the bounding box; detecting all of the plurality of contours in the augmented
15 image to obtain an all-contours detection result; and subtracting the external contour from the all-contours detection result.
- 20 7. A method of determining a trajectory of a target object according to any one of the preceding claims, further comprising training the data augmentation model to generate the corresponding augmented images directly from the plurality of source images.
- 25 8. A method of determining a trajectory of a target object according to claim 7, wherein training the data augmentation model comprises:
receiving the plurality of training images;
receiving a plurality of annotated images of the target object, each annotated image including an annotated target object label associated with the respective target object suitable for movement tracking by the object detector
30 instead of the target object;

generating corresponding augmented training images from the plurality of training images using the data augmentation model; and

updating the data augmentation model to minimize a discriminability between the augmented training images and the plurality of annotated images.

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9. A method of determining a trajectory of a target object according to claim 8, wherein the discriminability between the augmented training images and the annotated images is determined by inputting the augmented training images and the plurality of annotated images into a discriminator model, and wherein the method further comprises training the discriminator model concurrently with the data augmentation model to determine if an input image to the discriminator model is one of the augmented training images or one of the plurality of annotated images.

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10. A method of determining a trajectory of a target object according to claim 8 or 9, further comprising generating the plurality of annotated images from the plurality of training images by annotating the training images.

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11. A method of determining a trajectory of a target object according to any one of claims 8 to 10, wherein training the data augmentation model further comprises: generating a plurality of binary saliency region training images from the plurality of training images by discarding pixels of the plurality of training images having a saliency level below a threshold;

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generating the corresponding augmented training images from the plurality of training images and the plurality of binary saliency region training images using the data augmentation model;

generating a plurality of augmented binary saliency region images from the augmented training images by discarding pixels of the augmented training images having the saliency level below the threshold, and

updating the data augmentation model to minimize a background preserving loss quantifying a dissimilarity between the plurality of augmented binary saliency region images and the plurality of binary saliency region training images.

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12. A method of determining a trajectory of a target object according to claim 8 or 9, further comprising obtaining the plurality of annotated images by annotating images not belonging to the plurality of training images.

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13. A method of determining a trajectory of a target object according to any one of claims 8 to 12, further comprising selecting the plurality of training images based on a visibility of the target object in each of the plurality of training images.

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14. A method of determining a trajectory of a target object according to any one of the preceding claims, wherein tracking movement of the augmented target object label in the corresponding augmented images using the object detector further comprises determining a current location of the target object label in a current image of the plurality of augmented images and assigning the current location to the trajectory if the current location is closer to a previous location of the target object label previously assigned to the trajectory in a previous image than other locations of the target object label in the previous image previously assigned to other trajectories.

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15. A method of determining a trajectory of a target object according to claim 14, wherein the current location is assigned to the trajectory if a distance between the current and previous location of the target object label is below a threshold and to a temporary trajectory otherwise.

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16. A method of training a data augmentation model for use in determining a trajectory of a target object, the method comprising:

i) receiving a plurality of training images of a target object;

5 ii) receiving a plurality of annotated images of the target object, each annotated image including an annotated target object label associated with the respective target object suitable for movement tracking by an object detector instead of the target object;

iii) generating corresponding augmented images from the plurality of training images using the data augmentation model; and

10 iv) training the data augmentation model to minimize a discriminability between the augmented images and the plurality of annotated images and thereby generate augmented images including an augmented target object label associated with the respective target object suitable for movement tracking by the object detector instead of the target object in order to
15 determine the trajectory of the target object.

17. A method of training a data augmentation model according to claim 16,

wherein the discriminability between the augmented images and the plurality of annotated images is determined by inputting the augmented
20 images and the plurality of annotated images into a discriminator model, and wherein the method further comprises training the discriminator model concurrently with the data augmentation model to determine if an input image to the discriminator model is one of the augmented images or one of the plurality of annotated images.

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18. A method of training a data augmentation model according to claim 16 or 17, further comprising generating the plurality of annotated images from the plurality of training images by annotating the training images.

19. A method of training a data augmentation model according to any one of claims 16 to 18, further comprising:
generating a plurality of binary saliency region training images from the plurality of training images by discarding pixels of the plurality of training
5 images having a saliency level below a threshold;
generating the corresponding augmented images from the plurality of training images and the plurality of binary saliency region training images using the data augmentation model;
generating a plurality of augmented binary saliency region images from
10 the augmented images by discarding pixels of the augmented images having the saliency level below the threshold, and wherein
training the data augmentation model further comprises minimising a background preserving loss quantifying a dissimilarity between the plurality of augmented binary saliency region images and the plurality of binary saliency
15 region training images.

20. A method of training a data augmentation model according to claim 16 or 17, wherein the plurality of annotated images is obtained by annotating images not belonging to the plurality of training images.

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21. A method of training a data augmentation model according to any one of claims 16 to 20, further comprising selecting the plurality of training images based on a visibility of the target object in each of the plurality of training images.

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22. A system for determining a trajectory of a target object, comprising:
an image capturing device operable to capture a plurality of source images of the target object;
a processor configured to perform a method of determining a trajectory
30 of a target object according to any one of claims 1 to 15; and

an output configured to output information regarding the trajectory of the target object.

23. A vehicle, comprising:

- 5 a system for determining a trajectory of a target object according to claim 22; and
- a controller configured to control an operation of the vehicle based on the information regarding the trajectory of the target object.

10 24. A system for training a data augmentation model for use in determining a trajectory of a target object, comprising:

- an image capturing device configured to capture a plurality of training images of the target object;
- a processor configured to perform a method of training a data augmentation model according any one of claims 16 to 21; and
- 15 an output configured to output the trained data augmentation model.

25. A tangible or intangible computer readable medium configured to cause a processor to perform a method of determining a trajectory of a target

20 object according to any one of claims 1 to 15.

26. A tangible or intangible computer readable medium configured to cause a processor to perform a method of training a data augmentation model according to any one of claims 16 to 21.