Claims

1. A device for tracking human subjects, the device comprising:

a 3D depth tracker configured for:

capturing 3D mapping data of a space containing one or more human subjects;

constructing 3D stixel representations of the space from the 3D mapping data; and

generating a first track for each human subject in each 3D stixel representation, the first tracks for tracking the respective human subject;

a 2D laser tracker having a wider field of view than the 3D depth tracker, the 2D laser tracker configured for:

capturing 2D mapping data of the space;

constructing 2D representations of the space from the 2D mapping data; and

generating a second track for one or both legs of each human subject in each 2D representation, the second tracks for tracking the legs of the respective human subject; and

a track fusion module configured for:

associating the respective first tracks with the respective second tracks for each human subject; and

collaboratively tracking each human subject based on probabilistic aggregation of the respective associated first and second tracks.

2. The device according to claim 1, wherein the 3D depth tracker is further configured for:

detecting proposals of the human subjects from the 3D stixel representations based on prior human data,

wherein the first tracks are generated from the proposals.

3. The device according to claim 1, wherein the 2D laser tracker is further configured for:

segmenting each 2D representation into clusters;

computing a leg confidence score for each cluster; and

detecting the clusters that comprise legs of the human subjects based on the computed leg confidence scores of the clusters;

wherein the second tracks are generated from the detected clusters.

4. The device according to claim 1, wherein the device is a robotic device comprising a pursuit controller module configured for:

determining one of the tracked human subjects as a target; and

controlling motion of the robotic device to follow the target according to said collaborative tracking of the target.

5. The device according to claim 4, wherein the 3D depth tracker is further configured for re-identifying the target from the tracked human subjects based on feature data of the target for continuous tracking of the target.

6. The device according to claim 1, wherein the 3D depth tracker comprises an RGB-D camera.

7. The device according to claim 1, wherein the 2D laser tracker comprises a 2D LiDAR scanner.

8. A method for tracking human subjects, the method comprising:

capturing 3D mapping data of a space using a 3D depth tracker, the space containing one or more human subjects;

constructing 3D stixel representations of the space from the 3D mapping data;

generating a first track for each human subject in each 3D stixel representation, the first tracks for tracking the respective human subject; capturing 2D mapping data of the space using a 2D laser tracker having a wider field of view than the 3D depth tracker;

constructing 2D representations of the space from the 2D mapping data;

generating a second track for one or both legs of each human subject in each 2D representation, the second tracks for tracking the legs of the respective human subject;

associating the respective first tracks with the respective second tracks for each human subject; and

collaboratively tracking each human subject based on probabilistic aggregation of the respective associated first and second tracks.

9. The method according to claim 8, the method further comprising:

detecting proposals of the human subjects from the 3D stixel representations based on prior human data; and

wherein the first tracks are generated from the proposals.

10. The method according to claim 9, further comprising extracting feature data of the human subjects from the proposals.

11. The method according to claim 9 or 10, further comprising verifying, using a trained image classifier, the proposals that represent the human subjects.

12. The method according to claim 11, wherein the trained image classifier is based on a convolutional neural network.

13. The method according to claim 8, further comprising:

segmenting each 2D representation into clusters;

computing a leg confidence score for each cluster; and

detecting the clusters that comprise legs of the human subjects based on the computed leg confidence scores of the clusters;

wherein the second tracks are generated from the detected clusters.

14. The method according to claim 13, wherein the second tracks are generated using a set of predictive filters.

15. The method according to claim 14, wherein the set of predictive filters comprises:

a first Kalman filter for estimating a first Kalman track for the legs in the detected clusters; and

a second Kalman filter for estimating a second Kalman track for each human subject associated with the tracked legs,

wherein the second tracks are generated from the respective first and second Kalman tracks.

16. The method according to claim 8, wherein the first and second tracks are associated using a Global Nearest Neighbour (GNN) data association method.

17. The method according to claim 8 or 16, wherein said associating comprises computing a set of tracking confidence scores from the respective first and second tracks for each human subject.

18. The method according to claim 8, wherein the method is performed by a robotic device, the method further comprising:

determining one of the tracked human subjects as a target; and

controlling motion of the robotic device to follow the target according to said collaborative tracking of the target.

19. The method according to claim 18, further comprising re-identifying, using the 3D depth tracker, the target from the tracked human subjects based on feature data of the target for continuous tracking of the target.

20. The method according to claim 19, wherein said re-identifying uses a Siamese convolutional neural network.