What is claimed is:

1. A tracking device for tracking a location and orientation of an object, the tracking device comprising:

one or more sides that define a predetermined shape;

a plurality of inertial measurement units (IMU) mounted to the one or more sides of the predetermined shape, wherein each IMU is configured to detect movement of the object and generate inertial output data representing the location and/or orientation of the object, wherein each IMU includes a first sub-sensor and a second sub-sensor, wherein each IMU is positioned at a predetermined distance and orientation relative to a center of mass of the tracking device;

a controller communicatively coupled to the plurality of IMUs, the controller configured to perform the steps of:

receiving first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs at a high sampling rate;

for each IMU:

generating calibrated inertial output data based on the first sub-sensor inertial output data and the second sub-sensor inertial output data;

cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data to identify and remove anomalies from the first sub-sensor inertial output data with the second sub-sensor inertial output data to generate decomposed inertial output data;

determining a positional and rotational state of the tracking device based on the decomposed inertial output data from each of the IMUs;

synthesizing first sub-sensor inertial output data and second sub-sensor inertial output data to create IMU synthesized data using a synthesizing methodology based on the positional and rotational state of the tracking device;

calculating a current tracking device rectified data output based on the data synthesized for each of the IMUs, a predetermined position of each of the IMUs and a predetermined orientation of each of the IMUs; and

calculating a current location and orientation of an object based on a difference between the current object rectified data output and a previous object rectified data output.

2. The tracking device of claim 1, wherein generating calibrated inertial output data includes using neural network weights to evaluate the first sub-sensor inertial output data and the second sub-sensor inertial output data, wherein the weights are adjusted at a learning rate based on the positional state of the tracking device, calculating a discrepancy value representative of a difference between an actual movement of the object and estimated movement of the object, and removing the discrepancy value from the calibrated inertial output data.

3. The tracking device of claim 2, wherein the weights applied to the neural network of first sub-sensor inertial output data and the second inertial output data are adjusted based on historical inertial output data from each of the first and second sub-sensors.

4. The tracking device of any of the preceding claims, wherein the decomposed inertial output data corresponding to the first sub-sensor is calibrated based on the second sub-sensor inertial output data.

5. The tracking device of any of the preceding claims, wherein cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data includes applying pattern recognition to the second sub-sensor inertial output data to generate the decomposed inertial output data representative of the first sub-sensor inertial output data.

6. The tracking device of any of the preceding claims, wherein the first sub-sensor inertial output data and the second sub-sensor inertial output data are filtered to minimize signal noise through signal conditioning.

7. The tracking device of any of claims 1-5, wherein the first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs is received periodically at less than approximately 1 ms for fast, continuous, high sampling rate.

8. The tracking device of any of claims 1-5, wherein first sub-sensor and second sub-sensor are each one of: accelerometer, magnetometer, gyroscope, altimeter, and/or pressure sensor; wherein the first sub-sensor is a different sensor type than the second sub-sensor.

9. The tracking device of any of the preceding claims, wherein the predetermined shape is one of: a plane, a tetrahedron, and a cube.

10. The tracking device of any of the preceding claims, wherein at least some of the IMUs used to calculate the rectified data output are oriented at different angles along two different axes relative to each other.

11. The tracking device of any of the preceding claims, wherein calculating the current position and orientation of the object based on the difference between the current object rectified data output and the previous object rectified data output include:

identifying an edge condition; and

blending the current object rectified data output and the previous object rectified data output to remove the edge condition.

12. A method of tracking a position and orientation of an object using a tracking device, the tracking device including one or more sides that define a predetermined shape, a plurality of inertial measurement units (IMU) mounted to the one or more sides of the predetermined shape, wherein each IMU includes a first sub-sensor and a second sub-sensor, wherein each IMU is positioned at a predetermined distance and orientation relative to a center of mass of the tracking device, and a controller communicatively coupled to the plurality of IMUs, the method comprising:

at each IMU, detecting movement of the object and generating inertial output data representing a position and/or orientation of the object;

at the controller:

receiving first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs;

for each IMU:

generating calibrated inertial output data based on the first sub-sensor inertial output data and the second sub-sensor inertial output data;

cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data to identify and remove anomalies from the first sub-sensor inertial output data with the second sub-sensor inertial output data to generate decomposed inertial output data;

determining a positional and rotational state of the tracking device based on the decomposed inertial output data from each of the IMUs;

synthesizing first sub-sensor inertial output data and second sub-sensor inertial output data to create IMU synthesized data using a synthesizing methodology based on the positional and rotational state of the tracking device;

calculating a current tracking device rectified data output based on the corrected movement synthesized for each of the IMUs, a predetermined position of each of the IMUs and a predetermined orientation of each of the IMUs; and

calculating a current location and orientation of an object based on a difference between the current object rectified data output and a previous object rectified data output.

13. The method of claim 12, wherein generating calibrated inertial output data includes using neural networks to apply weights to the first sub-sensor inertial output data and the second sub-sensor inertial output data, wherein the weights are adjusted at a learning rate based on the positional state of the tracking device, calculating a discrepancy value representative of a difference between an actual movement of the object and estimated movement of the object, and removing the discrepancy value from the calibrated inertial output data.

14. The method of claim 13, wherein the weights applied to the first sub-sensor inertial output data and the second inertial output data are adjusted based on historical inertial output data from each of the first and second sub-sensors.

15. The method of any of claims 12-14, wherein the decomposed inertial output data corresponding to the first sub-sensor is calibrated based on the second sub-sensor inertial output data.

16. The method of any of claims 12-15, wherein cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data includes applying pattern recognition to the second sub-sensor inertial output data to generate the decomposed inertial output data representative of the first sub-sensor inertial output data.

17. The method of any of claims 12-16, wherein the first sub-sensor inertial output data and the second sub-sensor inertial output data are filtered to minimize signal noise.

18. The method of any of claims 12-16, wherein the first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs is received periodically at less than approximately 1 ms for continuous, high sampling rate.

19. The method of any of claims 12-18, wherein the first sub-sensor and the second sub-sensor are each one of: accelerometer, magnetometer, gyroscope, altimeter, and/or pressure sensor; wherein the first sub-sensor is a different sensor type than the second sub-sensor.

20. The method of any of claims 12-19, wherein the predetermined shape is one of: a plane, a tetrahedron, and a cube.

21. The method of any of claims 12-20, wherein at least some of the IMUs used to calculate the rectified data output are oriented at different angles along two different axes relative to each other.

22. The method of any of claims 12-21, wherein calculating the current location and orientation of the object based on the difference between the current object rectified data output and the previous object rectified data output include:

identifying an edge condition; and

blending the current object rectified data output and the previous object rectified data output to remove the edge condition.

23. A non-transitory computer readable storage medium storing one or more computer programs configured for execution by a computer system including one or more processors, the one or more programs instructions that when executed cause the computer system to perform the methods of any of claims 12-22.

CLAIMS

1. A tracking device for tracking a location and orientation of an object, the tracking device comprising:

one or more sides that define a predetermined shape;

a plurality of inertial measurement units (IMU) mounted to the one or more sides of the predetermined shape, wherein each IMU is configured to detect movement of the object and generate inertial output data representing the location and/or orientation of the object, wherein each IMU includes a first sub-sensor and a second sub-sensor, wherein each IMU is positioned at a predetermined distance and orientation relative to a center of mass of the tracking device;

a controller communicatively coupled to the plurality of IMUs, the controller configured to perform the steps of:

receiving first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs;

for each IMU:

generating calibrated inertial output data based on the first sub-sensor inertial output data and the second sub-sensor inertial output data;

cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data to identify and remove anomalies from the first sub-sensor inertial output data with the second sub-sensor inertial output data to generate decomposed inertial output data;

determining a positional and rotational state of the tracking device based on the decomposed inertial output data from each of the IMUs;

synthesizing first sub-sensor inertial output data and second sub-sensor inertial output data to create IMU synthesized data using a synthesizing methodology based on the positional and rotational state of the tracking device;

calculating a current tracking device rectified data output based on the data synthesized for each of the IMUs, a predetermined position of each of the IMUs and a predetermined orientation of each of the IMUs; and

calculating a current location and orientation of the object based on a difference between the current tracking device rectified data output and a previous tracking device rectified data output.

2. The tracking device of claim 1, wherein generating calibrated inertial output data includes using neural network weights to evaluate the first sub-sensor inertial output data and the second sub-sensor inertial output data, wherein the weights are adjusted at a learning rate based on the positional state of the tracking device, calculating a discrepancy value representative of a difference between an actual movement of the object and estimated movement of the object, and removing the discrepancy value from the calibrated inertial output data.

3. The tracking device of claim 2, wherein the weights are further adjusted based on historical inertial output data from each of the first and second sub-sensors.

4. The tracking device of claim 1, wherein the decomposed inertial output data corresponding to the first sub-sensor is calibrated based on the second sub-sensor inertial output data.

5. The tracking device of claim 1, wherein cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data includes applying pattern recognition to the second sub-sensor inertial output data to generate the decomposed inertial output data.

6. The tracking device of claim 1, wherein the first sub-sensor inertial output data and the second sub-sensor inertial output data are filtered to minimize signal noise through signal conditioning.

7. The tracking device of claim 1, wherein the first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs is received periodically at less than approximately 1 ms.

8. The tracking device of claim 1, wherein first sub-sensor and second sub-sensor are each one of: accelerometer, magnetometer, gyroscope, altimeter, and/or pressure sensor; wherein the first sub-sensor is a different sensor type than the second sub-sensor.

9. The tracking device of claim 1, wherein the predetermined shape is one of: a plane, a tetrahedron, and a cube.

10. The tracking device of claim 1, wherein at least some of the IMUs used to calculate the rectified data output are oriented at different angles along two different axes relative to each other.

11. The tracking device of claim 1, wherein calculating the current position and orientation of the object based on the difference between the current tracking device rectified data output and the previous tracking device rectified data output include:

identifying an edge condition; and

blending the current tracking device rectified data output and the previous tracking device rectified data output to remove the edge condition.

12. A method of tracking a position and orientation of an object using a tracking device, the tracking device including one or more sides that define a predetermined shape, a plurality of inertial measurement units (IMU) mounted to the one or more sides of the predetermined shape, wherein each IMU includes a first sub-sensor and a second sub-sensor, wherein each IMU is positioned at a predetermined distance and orientation relative to a center of mass of the tracking device, and a controller communicatively coupled to the plurality of IMUs, the method comprising:

at each IMU, detecting movement of the object and generating inertial output data representing a position and/or orientation of the object;

at the controller:

receiving first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs;

for each IMU:

generating calibrated inertial output data based on the first sub-sensor inertial output data and the second sub-sensor inertial output data;

cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data to identify and remove anomalies from the first sub-sensor inertial

output data with the second sub-sensor inertial output data to generate decomposed inertial output data;

determining a positional and rotational state of the tracking device based on the decomposed inertial output data from each of the IMUs;

synthesizing first sub-sensor inertial output data and second sub-sensor inertial output data to create IMU synthesized data using a synthesizing methodology based on the positional and rotational state of the tracking device;

calculating a current tracking device rectified data output based on the IMU synthesized data for each of the IMUs, a predetermined position of each of the IMUs and a predetermined orientation of each of the IMUs; and

calculating a current location and orientation of the object based on a difference between the current tracking device rectified data output and a previous tracking device rectified data output.

13. The method of claim 12, wherein generating calibrated inertial output data includes using neural networks to apply weights to the first sub-sensor inertial output data and the second sub-sensor inertial output data, wherein the weights are adjusted at a learning rate based on the positional state of the tracking device, calculating a discrepancy value representative of a difference between an actual movement of the object and estimated movement of the object, and removing the discrepancy value from the calibrated inertial output data.

14. The method of claim 13, wherein the weights are further adjusted based on historical inertial output data from each of the first and second sub-sensors.

15. The method of claim 12, wherein the decomposed inertial output data corresponding to the first sub-sensor is calibrated based on the second sub-sensor inertial output data.

16. The method of claim 12, wherein cross-correlating the first sub-sensor inertial output data with the second sub-sensor inertial output data includes applying pattern recognition to the second sub-sensor inertial output data to generate the decomposed inertial output data.

17. The method of claim 12, wherein the first sub-sensor inertial output data and the second sub-sensor inertial output data are filtered to minimize signal noise.

18. The method of claim 12, wherein the first sub-sensor inertial output data and second sub-sensor inertial output data from each of the plurality of IMUs is received periodically at less than approximately 1 ms.

19. The method of claim 12, wherein the first sub-sensor and the second sub-sensor are each one of: accelerometer, magnetometer, gyroscope, altimeter, and/or pressure sensor; wherein the first sub-sensor is a different sensor type than the second sub-sensor.

20. The method of claim 12, wherein the predetermined shape is one of: a plane, a tetrahedron, and a cube.

21. The method of claim 12, wherein at least some of the IMUs used to calculate the rectified data output are oriented at different angles along two different axes relative to each other.

22. The method of claim 12, wherein calculating the current location and orientation of the object based on the difference between the current tracking device rectified data output and the previous tracking device rectified data output include:

identifying an edge condition; and

blending the current tracking device rectified data output and the previous tracking device rectified data output to remove the edge condition.

23. A non-transitory computer readable storage medium storing one or more computer programs configured for execution by a computer system including one or more processors, using a tracking device, the tracking device including one or more sides that define a predetermined shape, a plurality of inertial measurement units (IMU) mounted to the one or more sides of the predetermined shape, wherein each IMU includes a first sub-sensor and a second sub-sensor, wherein each IMU is positioned at a predetermined distance and orientation relative to a center of mass of the tracking device, and a controller communicatively coupled to the plurality of IMUs, the one or more computer programs that when executed cause the computer system to perform the method of claim 12.