WHAT IS CLAIMED IS:

1. A computer-implemented method for improving markerless motion analysis, the method comprising:

   receiving three-dimensional (3D) position data of reference landmarks fixed to a rigid body in a linked segment rigid body system captured by at least one camera, wherein the 3D position data is insufficient to construct 3D orientation information for at least one segment of the linked segment rigid body system, and the linked segment rigid body system includes two or more points on at least two directly or indirectly kinematically-constrained segments;

   with probabilistic mapping, producing model equations for the 3D position data;

   deriving, using the model equations, 3D kinematic data of—one or more segments of the linked segment rigid body system, wherein the deriving includes analyzing the two or more points on the at least two directly or indirectly kinematically-constrained segments to achieve dependent segment reference frames that make use of an additional constraint that complements detail provided by directly observable body-fixed points, and wherein the 3D kinematic data includes 3D orientation information for the at least one segment of the linked segment rigid body system; and

   providing the 3D kinematic data for display to evaluate motion performance.

2. The method according to claim 1,

   wherein the at least one camera is a single camera, and

   wherein the method further comprises:

   capturing, using a single camera, a first image and a second image of the linked segment rigid body system at a first time and a second time different from the first time.

3. The method according to claim 2, wherein the first image and the second image are captured using markerless motion capture.

4. The method according to claim 1, wherein receiving position data of the reference landmarks includes:

   receiving, for at least two separate points in time, at least two key points of a first segment of the linked segment rigid body system and at least two key points of a second segment of the linked segment rigid body system, a key point corresponding to

a position of a part of the linked segment rigid body system captured by the at least one camera.

5. The method according to claim 4, further comprising:

   defining a first axis between the at least two key points of each segment;

   defining a temporary axis mid-points of each of first axes,

   defined a second axis for each segment, orthogonal to the temporary axis and the respective first axis of each segment; and

   defining a third axis for each segment orthogonal to the first axes and the second axes.

6. The method according to claim 5, further comprising:

   generating three-dimensional angular kinematics for the first segment and the second segment based the at least two key points of the first segment, the at least two key points of the second segment from the at least two separate points in time and based on the defined first, second, and third axes of the key points.

7. The method according to claim 1, wherein producing the model equations includes using a neural network model, and wherein the method further comprises:

   receiving a plurality of example datasets including a plurality of position data of joint centers of a body in motion; and

   training the neural network model using the plurality of example datasets, the neural network model configured to output the model equations.

8. The method according to claim 7, further comprising:

   constructing the neural network model, including a plurality of neurons, configured to output the model equations, the plurality of neurons arranged in a plurality of layers, including at least one hidden layer, and being connected by a plurality of connections.

9. The method according to claim 1, wherein deriving the 3D kinematic data using the model equations includes using the probabilistic mapping to enhance the 3D kinematic data.

10. A system for improving markerless motion analysis, the system including:

a data storage device that stores instructions for improving markerless motion analysis; and

a processor configured to execute the instructions to perform a method including:

receiving three-dimensional (3D) position data of reference landmarks fixed to a rigid body in a linked segment rigid body system captured by at least one camera, wherein the 3D position data is insufficient to construct 3D orientation information for at least one segment of the linked segment rigid body system, and the linked segment rigid body system includes two or more points on at least two directly or indirectly kinematically-constrained segments;

with probabilistic mapping, producing model equations for the 3D position data;

deriving, using the model equations, 3D kinematic data of—one or more segments of the linked segment rigid body system, wherein the deriving includes analyzing the two or more points on the at least two directly or indirectly kinematically-constrained segments to achieve dependent segment reference frames that make use of an additional constraint that complements detail provided by directly observable body-fixed points, and wherein the 3D kinematic data includes 3D orientation information for the at least one segment of the linked segment rigid body system; and

providing the 3D kinematic data for display to evaluate motion performance.

11. The system according to claim 10,

wherein the at least one camera is a single camera, and

wherein the method further comprises:

capturing, using a single camera, a first image and a second image of the linked segment rigid body system at a first time and a second time different from the first time.

12. The system according to claim 11, wherein the first image and the second image are captured using markerless motion capture.

13. The system according to claim 10, wherein receiving position data of the reference landmarks includes:

receiving, for at least two separate points in time, at least two key points of a first segment of the linked segment rigid body system and at least two key points of a second segment of the linked segment rigid body system, a key point corresponding to a position of a part of linked segment rigid body system captured by the at least one camera.

14. The system according to claim 13, further comprising:

defining a first axis between the at least two key points of each segment;

defining a temporary axis mid-points of each of first axes,

defined a second axis for each segment, orthogonal to the temporary axis and the respective first axis of each segment; and

defining a third axis for each segment orthogonal to the first axes and the second axes.

15. The system according to claim 14, further comprising:

generating three-dimensional angular kinematics for the first segment and the second segment based the at least two key points of the first segment, the at least two key points of the second segment from the at least two separate points in time and based on the defined first, second, and third axes of the key points.

16. The system according to claim 10, wherein producing, the model equations, includes using a neural network model, and

wherein the method further comprises:

receiving a plurality of example datasets including a plurality of position data of joint centers of a body in motion; and

training the neural network model using the plurality of example datasets, the neural network model configured to output the model equations.

17. The system according to claim 16, further comprising:

constructing the neural network model, including a plurality of neurons, configured to output the model equations, the plurality of neurons arranged in a plurality of layers, including at least one hidden layer, and being connected by a plurality of connections.

18. The system according to claim 10, wherein deriving the 3D kinematic data using the model equations includes using the probabilistic mapping to enhance the 3D kinematic data.

19. A non-transitory computer-readable storage device storing instructions that, when executed by a computer, cause the computer to perform a method for improving markerless motion analysis, the method including:

receiving three-dimensional (3D) position data of reference landmarks fixed to a rigid body in a linked segment rigid body system captured by at least one camera, wherein the 3D position data is insufficient to construct 3D orientation information for at least one segment of the linked segment rigid body system, and the linked segment rigid body system includes two or more points on at least two directly or indirectly kinematically-constrained segments;

with probabilistic mapping, producing model equations for the 3D position data;

deriving, using the model equations, 3D kinematic data of—one or more segments of the linked segment rigid body system, wherein the deriving includes analyzing the two or more points on the at least two directly or indirectly kinematically-constrained segments to achieve dependent segment reference frames that make use of an additional constraint that complements detail provided by directly observable body-fixed points, and wherein the 3D kinematic data includes 3D orientation information for the at least one segment of the linked segment rigid body system; and

providing the enhanced 3D kinematic data for display to evaluate motion performance.

20. The computer-readable storage device according to claim 19, wherein the at least one camera is a single camera, wherein the method further comprises:

capturing, using a single camera, a first image and a second image of the linked segment rigid body system at a first time and a second time different from the first time, and

wherein the first image and the second image are captured using markerless motion capture.