assistance. With this arrangement, the control system may rely less upon remote assistance over time to perform deliveries or other potential tasks.

[0003] In one aspect, an example method is provided. The method includes receiving a request for a vehicle to navigate a target location. The method further includes determining a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location, wherein the ANN comprises at least one of a first input node configured to receive as input sensor data representing the first segment of the target location from a sensor on the vehicle, and a second input node configured to receive as input one or more locomotive capabilities of the vehicle. The method also includes determining a confidence level associated with the navigation path. Based on the determined confidence level, the method additionally includes selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance. The method further includes causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.

[0004] In another aspect, an example system is provided. The system includes a vehicle that includes a sensor configured to collect sensor data representing a target location and a control system. The control system may be configured to receive a request for the vehicle to navigate the target location. The control system may be further configured to determine a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location, wherein the ANN includes an input node configured to receive as input the sensor data representing the target location from the sensor on the vehicle. The control system may also be configured to determine a confidence level associated with the navigation path. Based on the determined confidence level, the control system may additionally be configured to select a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance. The control system may also be configured to cause the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.

[0005] In a further aspect, a non-transitory computer readable medium is provided. The non-transitory computer readable medium has stored therein instructions executable by one or more processors to cause a computing system to perform functions. The functions include receiving a request for a vehicle to navigate a target location. The functions further include determining a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location. The functions also include determining a confidence level associated with the navigation path. Based on the determined confidence level, the functions additionally include selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance. The functions further include causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle. Selecting the navigation mode for the vehicle includes: determining that the confidence level is greater than a first predefined confidence level threshold and less than a second predefined confidence level; based on determining that the confidence level is greater than the first predefined confidence level threshold and less than the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle that follows a plurality of waypoints, wherein selecting, as the navigation mode, autonomous control by a control system on the vehicle that follows a plurality of waypoints includes: based on determining that the confidence level is less than a third predefined confidence level between the first predefined confidence level threshold and the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle to traverse a series of waypoints generated by a remote operator; and based on determining that the confidence level is not less than a third predefined confidence level between the first predefined confidence level threshold and the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle to traverse a series of waypoints generated by the control system on the vehicle and confirmed by a remote operator.

[0005a] In a further aspect, there is provided a non-transitory computer readable medium having stored therein program instructions executable by a computing system to cause the computing system to perform operations, the operations comprising:

receiving a request for a vehicle to navigate a target location;

determining a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location, wherein determining the navigation path using an ANN comprises using a generative adversarial network (GAN), wherein the GAN comprises a path-planning model trained to generate navigation paths and a discriminator model trained to distinguish between operator-provided navigation paths and navigation paths generated by the path-planning model;

determining a confidence level associated with the navigation path;

based on the determined confidence level, selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance; and

causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.

[0006] In a further example, a system is provided that includes means for receiving a request for a vehicle to navigate a target location. The system further includes means for determining a navigation path for the vehicle to traverse a first segment of the target location based on prior navigation paths determined to traverse segments similar to the first segment of the target location. The system also includes means for determining a confidence level associated with the navigation path. Based on the determined confidence level, the system additionally includes means for selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance. The system further includes means for causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.

[0007] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further

CLAIMS

What is claimed is:

1. A method comprising:

receiving a request for a vehicle to navigate a target location;

determining a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location, wherein the ANN comprises at least one of a first input node configured to receive as input sensor data representing the first segment of the target location from a sensor on the vehicle, and a second input node configured to receive as input one or more locomotive capabilities of the vehicle;

determining a confidence level associated with the navigation path;

based on the determined confidence level, selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance; and

causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.

2. The method of claim 1, wherein determining the navigation path further comprises determining a distribution of navigation paths and associated probabilities using a probabilistic path-finding model, wherein the confidence level is further based on the distribution of navigation paths and associated probabilities.

3. The method of claim 1, wherein determining the navigation path comprises using a generative adversarial network (GAN), wherein the GAN comprises a path-planning model trained to generate navigation paths and a discriminator model trained to distinguish between operator-provided navigation paths and navigation paths generated by the path-planning model.

4. The method of claim 1, wherein the prior navigation paths comprise paths navigated by a remote operator of the vehicle.

5. The method of claim 1, wherein the prior navigation paths comprise paths navigated by one or more vehicles other than the vehicle.

6. The method of claim 1, wherein the prior navigation paths comprise paths input by an operator at a user interface for simulating vehicle delivery.

7. The method of claim 1, further comprising:

determining that the confidence level is greater than a predefined confidence level threshold; and

based on determining that the confidence level is greater than the predefined

confidence level threshold, selecting, as the navigation mode, autonomous control by a control system on the vehicle to traverse the first segment of the target location.

8. The method of claim 1, further comprising:

determining that the confidence level is less than a predefined confidence level threshold; and

based on determining that the confidence level is less than the predefined confidence level threshold, selecting, as the navigation mode, remote control of the vehicle by a remote operator to traverse the first segment of the target location.

9. The method of claim 1,wherein selecting the navigation mode for the vehicle includes:

determining that the confidence level is greater than a first predefined confidence level threshold and less than a second predefined confidence level; and

based on determining that the confidence level is greater than the first predefined confidence level threshold and less than the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle that follows a plurality of waypoints.

10. The method of claim 1, further comprising:

determining a second navigation path for the vehicle to traverse a second segment of the target location;

determining a second confidence level associated with the determined second navigation path for the vehicle to traverse the second segment of the target location;

based on the determined second confidence level, selecting a different navigation mode for the vehicle from the plurality of navigation modes; and

causing the vehicle to traverse the second segment of the target location using a different level of remote assistance corresponding to the selected different navigation mode for the vehicle.

11. The method of claim 10, wherein each of the first segment and the second segment comprise a discrete surface for the vehicle to traverse at the target location.

12. The method of claim 1, wherein the segments similar to the first segment of the target location have a similar topology as the first segment of the target location.

13. The method of claim 1, wherein the segments similar to the first segment of the target location comprise a same surface material as the first segment of the target location.

14. The method of claim 1, wherein the segments similar to the first segment of the target location comprise the first segment of the target location.

15. A system comprising:

a vehicle that includes a sensor configured to collect sensor data representing a target location; and

a control system configured to:

receive a request for the vehicle to navigate the target location;

determine a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location, wherein the ANN includes an input node configured to receive as input the sensor data representing the target location from the sensor on the vehicle;

determine a confidence level associated with the navigation path;

based on the determined confidence level, select a navigation mode for the

vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance; and

cause the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.

16. A non-transitory computer readable medium having stored therein program instructions executable by a computing system to cause the computing system to perform operations, the operations comprising:

receiving a request for a vehicle to navigate to a target location;

determining a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location;

determining a confidence level associated with the distribution of navigation paths;

based on the determined confidence level, selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance; and

causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle;

wherein selecting the navigation mode for the vehicle includes:

determining that the confidence level is greater than a first predefined confidence level threshold and less than a second predefined confidence level;

based on determining that the confidence level is greater than the first predefined confidence level threshold and less than the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle that follows a plurality of waypoints, wherein selecting, as the navigation mode, autonomous control by a control system on the vehicle that follows a plurality of waypoints includes:

based on determining that the confidence level is less than a third predefined confidence level between the first predefined confidence level threshold and the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle to traverse a series of waypoints generated by a remote operator; and

based on determining that the confidence level is not less than a third predefined confidence level between the first predefined confidence level threshold and the second predefined confidence level, selecting, as the navigation mode, autonomous control by a control system on the vehicle to traverse a series of waypoints generated by the control system on the vehicle and confirmed by a remote operator.

17. A non-transitory computer readable medium having stored therein program instructions executable by a computing system to cause the computing system to perform operations, the operations comprising:

receiving a request for a vehicle to navigate a target location;

determining a navigation path for the vehicle to traverse a first segment of the target location using an artificial neural network (ANN) trained based on a plurality of prior navigation paths previously determined for traversal of segments similar to the first segment of the target location, wherein determining the navigation path using an ANN comprises using a generative adversarial network (GAN), wherein the GAN comprises a path-planning model trained to generate navigation paths and a discriminator model trained to distinguish between operator-provided navigation paths and navigation paths generated by the path-planning model;

determining a confidence level associated with the navigation path;

based on the determined confidence level, selecting a navigation mode for the vehicle from a plurality of navigation modes corresponding to a plurality of levels of remote assistance; and

causing the vehicle to traverse the first segment of the target location using a level of remote assistance corresponding to the selected navigation mode for the vehicle.