Claims

1. A method of controlling a movement of a hybrid robot comprising a locomotion stimulation device carried by an animal, the method comprising:

monitoring, via a positioning component of an electronic backpack of the locomotion stimulation device of the hybrid robot, a position and an orientation of the electronic backpack of the locomotion stimulation device as a measure of a position and an orientation of the hybrid robot;

providing, via a stimulator of the electronic backpack of the locomotion stimulation device, a right-turn stimulus for stimulating turning to a right direction or a left-turn stimulus for stimulating turning to a left direction ~~stimulus~~ to the animal ~~based on~~when an angular difference between the orientation of the electronic backpack of the locomotion stimulation device with respect to a direct path from the position of the electronic backpack to a predetermined destination is determined to be greater than a pre-defined threshold for stimulating the animal to ~~move in a desired manner so as to control the movement of the hybrid robot~~turn to the right direction or turn to the left direction so as to steer the hybrid robot towards the predetermined destination;

monitoring, via the positioning component of the electronic backpack of the locomotion stimulation device of the hybrid robot, any one or a combination of an angular displacement, an angular velocity or an angular acceleration of the electronic backpack of the locomotion stimulation device as a measure of a corresponding one or a combination of an angular displacement, an angular velocity or an angular acceleration of a motion of the hybrid robot in response to the right-turn stimulus or the left-turn stimulus provided to the animal; and

ceasing provision of the right-turn stimulus or the left-turn stimulus to the animal from the stimulator of the electronic backpack of the locomotion stimulation device in response to the corresponding one or the combination of the angular displacement, the angular velocity or the angular acceleration of the motion of the hybrid robot being below a pre-defined minimum angular displacement, a pre-defined minimum angular velocity or a pre-defined minimum angular acceleration respectively ~~in a manner so as to allow the animal to roam freely~~;

providing an acceleration stimulus for a first predetermined period of time, via the stimulator of the electronic backpack of the locomotion stimulation device, to induce

acceleration of the animal after ceasing provision of the right-turn stimulus or the left-turn stimulus to the animal; and

ceasing provision of the acceleration stimulus to the animal from the stimulator of the electronic backpack of the locomotion stimulation device for a second predetermined period of time after the first predetermined period of time so as to allow the animal to roam freely.

2. The method as claimed in claim 1, ~~wherein providing the stimulus to the animal~~further comprising ~~comprises~~ providing a forward stimulus for stimulating movement in a forward direction when the angular difference is determined to be equal or less than a pre-defined threshold.

3. The method as claimed in claim 2, ~~wherein monitoring the one or the combination of the displacement, the velocity or the acceleration of the electronic backpack of the locomotion stimulation device~~ further comprising~~comprises~~ monitoring a corresponding one or a combination of a linear displacement, a linear velocity or a linear acceleration of the electronic backpack of the locomotion stimulation device as a measure of a corresponding one or a combination of a linear displacement, a linear velocity or a linear acceleration of a motion of the hybrid robot in response to the forward stimulus provided to the animal, and ceasing provision of the forward stimulus to the animal from the stimulator of the electronic backpack of the locomotion stimulation device in response to the corresponding one or the combination of the linear displacement, the linear velocity or the linear acceleration of the motion of the hybrid robot being below a pre-defined minimum linear displacement, a pre-defined minimum linear velocity or a pre-defined minimum linear acceleration respectively so as to allow the animal to roam freely~~wherein the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration is a pre-defined minimum linear displacement, a pre-defined minimum linear velocity or a pre-defined minimum linear acceleration~~.

~~4. The method as claimed in claim 1, wherein providing stimulus to the animal comprises providing a right-turn stimulus for stimulating turning to a right direction or a left-turn stimulus for stimulating turning to a left direction when the angular difference is greater than a pre-defined threshold .~~

~~5. The method as claimed in claim 4, wherein monitoring the one or the combination of the displacement, the velocity or the acceleration of the electronic backpack of the locomotion stimulation device comprises monitoring a corresponding one or a combination of an angular displacement, an angular velocity or an angular acceleration of the electronic backpack of the locomotion stimulation device, and wherein the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration is a pre-defined minimum angular displacement, a pre-defined minimum angular velocity or a pre-defined minimum angular acceleration.~~

~~6~~4. The method as claimed in ~~any one of~~ claim~~s 1 to 5~~3, wherein monitoring the position and the orientation of the electronic backpack of the locomotion stimulation device is resumed after a predetermined period of time of ceasing provision of the forward stimulus to the animal.

~~7~~5. The method as claimed in any one of claims 1 to ~~5~~4, ~~further comprising, in response to the corresponding one or the combination of the displacement, the velocity or the acceleration of the motion of the hybrid robot being below the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration respectively, providing an acceleration stimulus, via the stimulator of the electronic backpack of the locomotion stimulation device, to induce acceleration of the animal after ceasing provision of the stimulus to the animal and ceasing provision of the acceleration stimulus to the animal from the stimulator of the electronic backpack of the locomotion stimulation device after a first predetermined period of time of providing the acceleration stimulus, and~~ wherein monitoring the position and orientation of the electronic backpack of the locomotion stimulation device is resumed after ceasing provision of the acceleration stimulus to the animal for ~~a~~ the second predetermined period of time ~~of ceasing provision of the acceleration stimulus to the animal~~.

~~8~~6. The method as claimed in any one of claims 1 to ~~7~~5, wherein the hybrid robot is part of an animal locomotion control system, and wherein monitoring the position and the orientation of the electronic backpack of the locomotion stimulation device comprises

determining, via a processing unit of the animal locomotion control system, the angular difference between the orientation of the electronic backpack of the locomotion stimulation device with respect to the direct path from the position of the electronic backpack to the predetermined destination.

~~9~~7. The method as claimed in claim ~~8~~6, wherein providing the right-turn stimulus or the left-turn stimulus to the animal comprises

determining, via the processing unit of the animal locomotion control system, a stimulation control signal to be sent to the electronic backpack of the locomotion control device based on the angular difference for controlling the stimulator of the electronic backpack of the locomotion stimulation device to provide the right-turn stimulus or the left-turn stimulus to the animal, and

sending the stimulation control signal from the processing unit of the animal locomotion control system to the stimulator of the electronic backpack of the locomotion stimulation device.

~~10~~8. The method as claimed in claim ~~9~~7, wherein monitoring the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the electronic backpack of the locomotion stimulation device comprises

sending the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the electronic backpack of the locomotion stimulation device obtained from the positioning component of the electronic backpack of the locomotion stimulation device to the processing unit of the animal locomotion control system, and

comparing, via the processing unit of the animal locomotion control system, the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the electronic backpack of the locomotion stimulation device with the pre-defined minimum angular displacement, the pre-defined minimum angular velocity or the pre-defined minimum angular acceleration respectively.

~~11. The method as claimed in claim 10, wherein monitoring the one or the combination of the displacement, the velocity or the acceleration of the electronic backpack of the locomotion stimulation device further comprises~~

~~comparing, via the processing unit of the animal locomotion control system, the one or the combination of the displacement, the velocity or the acceleration of the electronic backpack of the locomotion stimulation device with the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration respectively.~~

~~12~~9. The method as claimed in claim ~~11~~8, wherein ceasing provision of the right-turn stimulus or the left-turn stimulus to the animal from the stimulator of the electronic backpack of the locomotion stimulation device comprises

sending, via the processing unit of the animal locomotion control system, a cease-stimulation control signal from the processing unit of the animal locomotion control system to the stimulator of the electronic backpack of the locomotion stimulation device when the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the electronic backpack of the locomotion stimulation device is less than the pre-defined minimum angular displacement, the pre-defined minimum angular velocity or the pre-defined minimum angular acceleration respectively.

~~13~~10. The method as claimed in claim ~~12 in combination with claim 7~~9, wherein providing the acceleration stimulus for the first predetermined period of time to induce acceleration of the animal comprises

sending an acceleration stimulation control signal from the processing unit of the animal locomotion control system to the stimulator of the electronic backpack of the locomotion stimulation device.

~~14~~11. The method as claimed in claim ~~13~~10, wherein ceasing provision of the acceleration stimulus for the second predetermined period of time to the animal from the stimulator of the electronic backpack of the locomotion stimulation device after the first predetermined period of time of providing the acceleration stimulus comprises

sending, via the processing unit of the animal locomotion control system, a cease-acceleration stimulation control signal from the processing unit of the animal locomotion control system to the stimulator of the electronic backpack of the locomotion stimulation device after the first predetermined period of time of providing the acceleration stimulus.

~~15~~12. The method as claimed in any one of claims 1 to ~~14~~11, wherein monitoring the position and the orientation of the electronic backpack of the locomotion stimulation device is resumed when the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the motion of the hybrid robot is equal or greater than the pre-defined minimum angular displacement, the pre-defined minimum angular velocity or the pre-defined minimum angular acceleration respectively.

~~16~~13. An animal locomotion control system for controlling a movement of a hybrid robot using an animal as a legged platform, the locomotion stimulation control system comprising:

a locomotion stimulation device carriable by the animal, the locomotion stimulation device comprising

an electronic backpack comprising

a support structure,

a positioning component coupled to the support structure, and

a stimulator coupled to the support structure, and

at least a pair of electrodes for direct contact with a body part of the animal, the at least a pair of electrodes being connected to the stimulator; and

a processing unit in communication with the locomotion stimulation device,

wherein the positioning component of the electronic backpack of the locomotion stimulation device is configured to monitor a position and an orientation of the electronic backpack of the locomotion stimulation device as a measure of a position and an orientation of the hybrid robot,

wherein the processing unit is configured to determine an angular difference between the orientation of the electronic backpack of the locomotion stimulation device with respect to the direct path from the position of the electronic backpack to the predetermined destination,

wherein the stimulator of the electronic backpack of the locomotion stimulation device is configured to provide a right-turn stimulus for stimulating turning to a right direction or a left-turn stimulus for stimulating turning to a left direction~~stimulus~~ to the animal ~~based on~~when the angular difference determined by the processing unit is greater than a pre-defined threshold for stimulating the animal to turn to the right direction or turn to the left direction so as to steer the hybrid robot towards the predetermined destination,

wherein the positioning component is further configured to monitor any one or a combination of an angular displacement, an angular velocity or an angular acceleration of the electronic backpack of the locomotion stimulation device as a measure of a corresponding one or a combination of an angular displacement, an angular velocity or an angular acceleration of a motion of the hybrid robot in response to the right-turn stimulus or the left-turn stimulus provided to the animal, and

wherein the stimulator of the electronic backpack of the locomotion stimulation device is configured to cease providing the right-turn stimulus or the left-turn stimulus to the animal in response to the corresponding one or the combination of the angular displacement, the angular velocity or the angular acceleration of the motion of the hybrid robot being below a pre-defined minimum angular displacement, a pre-defined minimum angular velocity or a pre-defined minimum angular acceleration respectively ~~such that the animal roam freely~~,

wherein the stimulator of the electronic backpack of the locomotion stimulation device is configured to provide an acceleration stimulus for a first predetermined period of time to induce acceleration of the animal after ceasing provision of the right-turn stimulus or the left-turn stimulus to the animal,

wherein the stimulator of the electronic backpack of the locomotion stimulation device is configured to cease providing the acceleration stimulus to the animal for a second predetermined period of time after the first predetermined period of time so as to allow the animal to roam freely.

~~17~~14. The system as claimed in claim ~~16~~13, wherein the stimulator of the electronic backpack of the locomotion device is configured to provide a forward stimulus for stimulating movement in a forward direction when the angular difference determined by the processing unit is equal or less than a pre-defined threshold,

wherein the positioning component is configured to monitor a corresponding one or a combination of a linear displacement, a linear velocity or a linear acceleration of the electronic backpack of the locomotion stimulation device in response to the forward stimulus provided to the animal, and wherein the stimulator of the electronic backpack of the locomotion device is configured to cease providing the forward stimulus to the animal in response to the corresponding one or the combination of the linear displacement, the linear velocity or the linear acceleration of the motion of the hybrid robot being below a

pre-defined minimum linear displacement, a pre-defined minimum linear velocity or a pre-defined minimum linear acceleration respectively so as to allow the animal to roam freely.

~~18. The system as claimed in claim 17, wherein the one or the combination of the displacement, the velocity or the acceleration of the electronic backpack of the locomotion stimulation device monitored by the positioning component is a corresponding one or a combination of a linear displacement, a linear velocity or a linear acceleration of the electronic backpack of the locomotion stimulation device, and wherein the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration is a pre-defined minimum linear displacement, a pre-defined minimum linear velocity or a pre-defined minimum linear acceleration.~~

~~19. The system as claimed in claim 16, wherein the stimulator of the electronic backpack of the locomotion device is configured to provide a right-turn stimulus for stimulating turning to a right direction or a left-turn stimulus for stimulating turning to a left direction when the angular difference determined by the processing unit is greater than a pre-defined threshold.~~

~~20. The system as claimed in claim 19, wherein the one or the combination of the displacement, the velocity or the acceleration of the electronic backpack of the locomotion stimulation device monitored by the positioning component is a corresponding one or a combination of an angular displacement, an angular velocity or an angular acceleration of the electronic backpack of the locomotion stimulation device, and wherein the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration is a pre-defined minimum angular displacement, a pre-defined minimum angular velocity or a pre-defined minimum angular acceleration.~~

~~21~~15. The system as claimed in ~~any one of~~ claim~~s 16 to 20~~14, wherein the positioning unit of the electronic backpack of the locomotion device is configured to resume monitoring of the position and the orientation of the electronic backpack of the locomotion stimulation device after the stimulator of the electronic backpack of the locomotion device ceases providing the forward stimulus to the animal for a predetermined period of time.

~~22~~16. The system as claimed in any one of claims ~~16~~ 13 to ~~20~~15, ~~wherein, in response to the corresponding one or the combination of the displacement, the velocity or the acceleration of the motion of the hybrid robot being below the pre-defined minimum displacement, the pre-defined minimum velocity or the pre-defined minimum acceleration respectively, the stimulator of the electronic backpack of the locomotion stimulation device is further configured to provide an acceleration stimulus to induce acceleration of the animal after ceasing provision of the stimulus to the animal and to cease provision of the acceleration stimulus to the animal after a first predetermined period of time of providing the acceleration stimulus, and~~ wherein the positioning unit of the electronic backpack of the locomotion device is configured to resume monitoring of the position and the orientation of the electronic backpack of the locomotion stimulation device after the stimulator of the electronic backpack of the locomotion device ceases providing the acceleration stimulus to the animal for ~~a~~ the second predetermined period of time.

~~23~~17. The system as claimed in any one of claims ~~16~~ 13 to ~~22~~16, wherein the processing unit of the animal locomotion control system is configured to send a stimulation control signal to the electronic backpack of the locomotion control device based on the angular difference determined so as to control the stimulator of the electronic backpack of the locomotion stimulation device to provide the right-turn stimulus or the left-turn stimulus to the animal.

~~24~~18. The system as claimed in any one of claims ~~16~~ 13 to ~~23~~17, wherein the processing unit of the animal locomotion control system is configured to compare the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the electronic backpack of the locomotion stimulation device with the pre-defined minimum angular displacement, the pre-defined minimum angular velocity or the pre-defined minimum angular acceleration respectively and send a cease-stimulation control signal to the stimulator of the electronic backpack of the locomotion stimulation device when the one or the combination of the angular displacement, the angular velocity or the angular acceleration of the electronic backpack of the locomotion stimulation device is less than the pre-defined minimum angular displacement, the pre-defined minimum angular velocity or the pre-defined minimum angular acceleration respectively.

~~25~~19. The system as claimed in claim ~~24~~ 18~~in combination with claim 22~~, wherein the processing unit of the animal locomotion control system is configured to send an acceleration stimulation control signal to the stimulator of the electronic backpack of the locomotion stimulation device after sending the cease-stimulation control signal,

wherein the processing unit of the animal locomotion control system is configured to send a cease-acceleration stimulation control signal to the stimulator of the electronic backpack of the locomotion stimulation device after the first predetermined period of time.

~~26. The system as claimed in claim 25, wherein the processing unit of the animal locomotion control system is configured to send a cease-acceleration stimulation control signal to the stimulator of the electronic backpack of the locomotion stimulation device after the first predetermined period of time.~~

~~27~~20. The system as claimed in any one of claims ~~16~~ 13 to ~~26~~19, wherein the stimulator of the electronic backpack comprises an electric stimulator,

wherein the electric stimulator of the electronic backpack comprises a voltage source to generate a voltage waveform output signal to be transmitted to the at least one electrode.

~~28. The system as claimed in claim 27, wherein the electric stimulator of the electronic backpack comprises a voltage source to generate a voltage waveform output signal to be transmitted to the at least one electrode.~~

~~29. The system as claimed in any one of claims 16 to 28, wherein the electronic backpack comprises one or more task-specific components coupled to the support structure.~~

~~30. The system as claimed in any one of claims 16 to 29, wherein the electronic backpack comprises a communication module to connect with the processing unit via a wired or wireless communication, the communication module being coupled to the support structure.~~

~~31. The system as claimed in any one of claims 16 to 30, wherein the positioning component comprises an inertial measurement unit.~~

~~32. The system as claimed in any one of claims 16 to 31, wherein the positioning component comprises a tracking unit of a global navigation satellite system, a global positioning system, a local positioning system, or an indoor positioning system.~~

~~33. The system as claimed in claim 32, further comprising one or more positioning reference units from which the positioning component of the locomotion control device determines the position of the electronic backpack via position fixing methods, wherein the positioning component of the locomotion control device and the one or more positioning reference units form a positioning system.~~