An electric skateboard including a deck, a wheel and an electric motor mounted to a drive truck, the wheel rotatably supported by the drive truck and the electric motor configured to drive the wheel, wherein the drive truck is mounted to the deck, a battery mounted to a power truck and configured to power the electric motor, wherein the power truck is mounted to the deck, and a processor configured to control operation of the electric motor.
PERSONAL TRANSPORT VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/542,810 filed 4 Oct. 2011, which is incorporated in its entirety by this reference.

TECHNICAL FIELD

[0002] This invention relates generally to the personal transportation field, and more specifically to a new and useful personal transport vehicle 100 in the personal transportation field.

BACKGROUND

[0003] Low-emission personal vehicles are becoming an increasingly popular means of transport. However, many of the existing solutions to personal transportation are large and bulky. The size of these solutions limits the mobility of a user, as the user cannot easily take the vehicle onto another mode of transportation, such as a train. Smaller conventional personal transport solutions, such as skateboards and bicycles, lack the range and speed bestowed by a motorized vehicle. Existing small personal transport solutions, such as electric skateboards, suffer from a lack of performance due to the stiffness of the drive train components and/or drastically limit the flexibility of use due to obstacles on the riding surface formed by drive train components.

[0004] Thus, there is a need in the personal transport field to create a new and useful high performance, mobile personal transport vehicle.

BRIEF DESCRIPTION OF THE FIGURES

[0005] FIG. 1 is a schematic representation of a variation of the personal transport vehicle.
[0006] FIG. 2 is a side view of a variation of the personal transport vehicle.
[0007] FIG. 3 is a side view of a variation of the personal transport vehicle with a user.
[0008] FIG. 4 is an exploded view of a variation of the personal transport vehicle.
[0009] FIGS. 5A, 5B, and 5C are end-on views of a variation of the personal transport vehicle steering to the left, straight, and right, respectively.
[0010] FIG. 6 is a schematic representation of a variation of the personal transport vehicle.
[0011] FIG. 7 is a schematic representation of a variation of the wheel bearing.
[0012] FIG. 8 is a top view of a variation of the personal transport vehicle with a force sensor control input.
[0013] FIG. 9 is a perspective view of a variation of the personal transport vehicle with a force sensor control input with an exploded view of a variation of the pressure sensor.
[0014] FIG. 10 is a schematic representation of the pressure sensor circuitry.
[0015] FIGS. 11A, 11B, and 11C are schematic representations of a rider signaling cruising, acceleration, and deceleration, respectively, for a variation of the personal transport vehicle.
[0016] FIG. 12 is a schematic representation of a variation of a control loop diagram for the processor.
[0017] FIG. 13 is a schematic representation of a second variation of the personal transport vehicle.
[0018] FIG. 14 is a schematic representation of a third variation of the personal transport vehicle.
[0019] FIG. 15 is a schematic representation of a fourth variation of the personal transport vehicle.
[0020] FIG. 16 is a schematic representation of a fifth variation of the personal transport vehicle.
[0021] FIG. 17 is a schematic representation of a sixth variation of the personal transport vehicle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] The following description of the preferred embodiments of the invention is not intended to limit the invention to these preferred embodiments, but rather to enable any person skilled in the art to make and use this invention.

[0023] As shown in FIG. 1, the personal transport vehicle 100 includes a support surface 200 and a drive train 110 coupled to the support surface 200. The drive train 110 includes a truck 300, a motor 500 configured to drive the wheel, a processor 600 configured to control motor operation, and an energy storage device 700 configured to provide power to the motor 500. The personal transport vehicle 100 preferably additionally includes a control input 800 that provides a control signal 802 to the processor 600. The personal transport vehicle 100 is preferably used to transport a user 10 (e.g., a rider), wherein the user 10 is preferably supported by the support surface 200 and moved by the drive train 110. The personal transport vehicle 100 preferably supports a standing user 10, but can alternatively support a prone user 10, sitting user 10, or can support the user 10 in any suitable position. The personal transport vehicle 100 is preferably a skateboard, but can alternatively be a scooter, skate, or any other suitable personal transport vehicle 100. This personal transport vehicle 100 can confer the benefits of a motorized means of transport while maintaining the ride and performance characteristics of a skateboard, such as unrestricted movement over the surface of the support surface 200 and flexibility and/or responsiveness of the support surface 200. The flexibility of the support surface 200 can be maintained by mounting all the stiff components of the vehicle to the trucks, mounting all or some of the stiff components adjacent the trucks and distal the lateral centerline of the support surface (e.g., the stiff components do not extend across the centerline), or through any other suitable means. The ride and performance of the skateboard are preferably further maintained by ensuring that the electrical components of the vehicle do not substantially touch or interfere with a substantially flat ground surface when the center of support surface is deformed to contact the ground surface. The personal transport vehicle 100 can be manufactured as a unit, including the support surface 200 and drive train 110, or can be manufactured and sold as a retrofit kit for a conventional deck that includes only the drive train no. When mounting the drive train 110 to a conventional deck, additional mounting holes preferably do not need to be created.

[0024] In operation, the drive train 10 preferably drives at least one vehicle 100 wheel 420 to move the vehicle 100 over a road surface 20. Alternatively, the user 10 can manually propel the vehicle 100 over the road surface 20. The user 10 preferably controls the velocity of the vehicle 100 through the control input 800, but can alternatively control the vehicle velocity manually (e.g., by pushing the vehicle 100 to accelerate or dragging a foot to slow down). As shown in FIGS. 5A-5C, the vehicle 100 is preferably steered based on the
weight distribution between the two longitudinal sides of the support surface 200, wherein increased weight on a given side preferably turns the vehicle 100 toward said side. Alternatively, the vehicle 100 can be steered through a steering mechanism 110, such as a set of handlebars, a steering wheel, or any other suitable steering mechanism 110.

[0025] As shown in FIGS. 1 to 3, the support surface 200 (e.g. deck) of the personal transport vehicle 100 functions to support the rider. The support surface 200 preferably has a first broad face configured to support the rider (riding surface 202), and a second broad face (bottom surface 204) opposing the first broad face. The support surface 200 preferably includes two sets of mounting points to which the drive train no can be mounted, one on each end of the support surface 200, but can alternatively include any suitable number of coupling mechanisms to couple with the drive train no. The support surface 200 is preferably flexible, but can alternatively be substantially stiff. In one variation, the support surface 200 can deflect more than one inch. In another variation, the support surface 200 can deflect enough to contact a flat surface between the front and rear wheels. In both variations, the deflection preferably does not incur any significant damage that would reduce the functionality of the support surface 200. The support surface 200 preferably cambered, and can have a positive camber or a negative camber. Alternatively, the support surface 200 can be a dropped deck 200, as shown in FIG. 6, wherein a plane extending through the majority of the support surface 200 body is offset from a plane extending between the support surface ends. The support surface 200 is preferably a conventional skateboard deck 200, more preferably a longboard deck 200, but can alternatively be a scooter deck 200, a skate, or any other suitable surface capable of supporting a user 10.

[0026] As shown in FIG. 1, the drive train 110 of the personal transport vehicle 100 functions to generate power and move the personal transport vehicle 100 over a road surface 20. The drive train no is preferably mounted to the support surface 200, but can alternatively be otherwise fastened to the support surface 200. When a single drive train no is used (e.g. wherein all the motors 500 of the vehicle 100 are located on a single truck 300), the drive train 110 is preferably mounted on the front end of the support surface 200, but can alternatively be mounted to the rear end of the support surface 200. As shown in FIG. 4, the drive train 110 preferably includes a truck 300; an energy storage device 700; a power train 120 including a wheel bearing 400, supported by the truck 300, and a motor 500; and a processor 600 that controls motor operation. However, the drive train 110 can include any suitable number of trucks 300, energy storage devices 700, motors 500, and processors 600. The drive train 110 preferably includes two sets of coaxial wheels 420, but can alternatively have one balancing wheel 420, two inline wheels 420, two coaxial wheels 420, or any other suitable number of wheels 420. The drive train 110 can alternatively include tracks (e.g. snow or off-road tracks), an impeller, or any other suitable drive mechanism. Drive train operation is preferably controlled by the processor 600, based on a signal 802 received from a control input 800. However, the drive train 110 can be controlled by any suitable means. The drive train 110 is preferably mounted to the support surface 200 such that the support surface flexibility is substantially maintained. In one variation of the vehicle 100, some or all of the drive train 110 components having broad mounting faces, such as the energy storage device 700 and the electronics (e.g. the processor 600 and motor controller 520), are substantially flexible. In another variation of the vehicle 100, the drive train no components are mounted adjacent to the support surface ends and distal from the support surface 200 center. In another variation of the vehicle 100, the drive train 110 components are statically fixed to less than 50% of a support surface broad face, more preferably to less than 30% of the support surface broad face. However, any suitable configuration of the drive train no components can be used.

[0027] The truck 300 of the drive train 110 functions to mount the wheels 420 to the support surface 200. In doing so, the truck 300 preferably rotatably supports the wheel bearings 400. The truck 300 can additionally function to support the motor 500, the energy storage device 700, the processor 600, and/or any other suitable drive train 110 component. The truck 300 can additionally function as a heat sink. The truck 300 preferably includes a hangar 310 that supports the wheel bearings 400, a base plate 320 that mounts the truck 300 to the support surface 200, bushings 330, and a kingpin 340 that extends through the bushings 330 to mount the hangar 310 to the base plate 320. The truck 300 can additionally include risers 350 that can be inserted between the base plate 320 and the support surface 200 to adjust the distance between the truck 300 and the support surface 200. The drive train 110 preferably includes two trucks 300, each mounted to an opposing end of the support surface 200 and oriented with the respective axle perpendicular to the longitudinal axis of the support surface 200, but can alternatively include a single truck 300 or any other suitable number of trucks mounted at any suitable position and angle relative to the support surface 200 longitudinal axis.

[0028] The hangar 310 of the truck 300 functions to connect the axle 312 to the base plate 320 of the truck 300. The hangar 310 can additionally function to mount the motor 500 and/or the energy storage device 700. However, the hangar 310 can be a standard hangar 310, or include any other suitable mounting or coupling mechanisms. The hangar 310 preferably includes two coaxial axes extending in opposite directions from the hangar body, wherein the axes 312 function to support the wheel bearing 400. The wheel bearings 400 are preferably rotatably coupled to the axle 312, such that the wheels 420 freely rotate about the axle 312. The wheel bearings 400 are preferably retained on the axle 312 by an axle nut, cotter pin, or other suitable fastening device. The hangar 310 preferably includes a mounting arm 314 extending from the hangar body to which the motor 500, the processor 600, and/or any other suitable electronic component is mounted, wherein the arm is preferably centered between the axes 312 but can alternatively be offset from the truck center. The mounting arm 314 preferably extends perpendicularly relative to the axes 312, and extends at an angle from the hangar body. However, the mounting arm 314 can be the hangar body, or extend from the hangar body at any suitable angle. The mounting arm 314 preferably includes at least one mounting hole or clip, and can include one or more slots extending longitudinally along the arm length, a series of mounting holes, grooves, or any other suitable adjustable mounting feature.

[0029] The bushing 330 functions to dampen vehicle 100 vibrations during vehicle use, and can function similar to a suspension system. However, the vehicle 100 can additionally and/or alternatively include a separate suspension system, such as a pneumatic suspension system, hydraulic suspension system, or any other suitable suspension system.
Each truck 300 preferably includes two bushings 330, wherein the first bushing 330 is preferably located between the base plate 320 and the hangar 310, and the second bushing 330 is preferably located between the kingpin 340 and the hangar 310. The bushing 330 can be conical, stepped, barrel, or have any other suitable shape. The bushing 330 can be of any suitable durometer. Alternatively, the bushing 330 can have an adjustable durometer, wherein the bushing 330 durometer can be adjusted based on the desired ride characteristics, determined vehicle 100 vibration (e.g. increased to increase vehicle 100 stability/dampen vibration, decreased when less vibration is sensed to increase vehicle 100 responsiveness, etc.), or adjusted based on any other suitable parameter. In this variation, the bushing 330 can be made of a material that changes stiffness dependent on the magnitude and/or direction of an applied electric current, wherein the processor 600 preferably controls the amount of current applied to the bushing 330. However, the bushing 330 durometer can be adjusted in any suitable manner.

[0030] The base plate 320 of the truck 300 functions to couple the hangar 310 to the support surface 200. The base plate 320 can additionally function as a heat sink for the electronic components of the drive train 110. The base plate 320 is preferably configured to mount to the bottom surface 204 of the support surface 200, but can alternatively mount to the riding surface 202, wherein the hangar 310 extends through the support surface 200 (e.g. a dropped truck 300 configuration). The base plate 320 preferably includes mounting features, such as screw holes, longitudinal slots, or grooves, but can alternatively include any suitable coupling feature. The base plate 320 can additionally include component-mounting features, such as screw holes, longitudinal slots, or grooves to which the motor 500 and/or battery 702 can mount. The base plate 320 is preferably a substantially solid piece of metal, but can alternatively be a hollow metal box that can function to store the electronic components of the drive train 110, be a solid plastic piece, or have any suitable configuration or be made of any suitable material.

[0031] The energy storage device 700 of the drive train 110 functions to provide power to the motor 500, and can additionally power the processor 600 and/or the control input 800. The energy storage device 700 is preferably a battery 702, more preferably a battery including a plurality of cells, but can alternatively be a fuel storage device or any other suitable device capable of storing energy in electrical, chemical, or mechanical form. The battery 702 preferably includes a plurality of prismatic cells stacked along the cell thicknesses, but can alternatively include a plurality of prismatic cells arranged in a single layer. The battery 702 is preferably a rechargeable battery 702, more preferably a battery 702 having lithium chemistry (e.g. lithium ion, lithium, etc.) but can alternatively be a battery 702 having any suitable chemistry. The battery 702 is preferably substantially flat and prismatic, but can alternatively be cylindrical or have any suitable form factor. The energy storage device 700 is preferably mounted to or coupled near the truck opposing that to which the motor 500 is mounted to achieve a more uniform weight distribution over the support surface, but can alternatively be mounted or coupled adjacent to the truck to which the motor 500 is mounted. The energy storage device 700 is preferably electrically connected to the motor 500 by one or more flexible wires, and can additionally be electrically connected by a flexible connection to the processor 600. The electrical connections are preferably fastened against the support surface 200 or integrated into the truck 300, but can alternatively be unrestrained. When the energy storage device 700 is mounted to a different truck than the motor 500, the electrical connections can extend along the riding surface, wherein the electrical connections preferably extend from the energy storage device to the riding surface through holes through the support surface, extend along the riding surface, and electrically contact the energy storage device 700 and motor 500 through holes through the support surface. However, the electrical connections can alternatively extend along the bottom surface. The electrical connections can include braided cable sleeving or any other suitable sleeving to facilitate electrical connection flexion with the support surface 200. The electrical connections can be arranged between the grip tape and the riding surface of the support surface 200 or can be located in any other suitable portion of the vehicle 100.

[0032] The energy storage device 700 is preferably movably coupled to the support surface 200, but can alternatively be rigidly fixed to the support surface 200. The energy storage device 700 is preferably mounted on a truck 300 (power truck), more preferably on the base plate 320 of a truck 300, but can alternatively be mounted on the hangar 310 of the truck 300 or integrated into any suitable portion of the truck 300 such that the energy storage device 700 can move relative to the support surface 200. When mounted to the base plate 320, the energy storage device 700 is preferably mounted to the broad face of the base plate 320 distal the support surface 200, but can alternatively be mounted to the broad face adjacent the support surface 200. A broad face of the energy storage device 700 is preferably mounted against the broad face of the base plate 320, but the edge of the energy storage device 700 can alternatively be mounted on the base plate 320, leaving the remainder of the energy storage device 700 free. The energy storage device 700 is preferably fastened to the truck 300 (e.g. using fasteners, such as screws, tie downs, etc.), but can alternatively be adhered or otherwise mounted to the truck 300. The energy storage device 700 can alternatively be used as or be mounted to the riser 350, wherein all or a portion of the energy storage device 700 is mechanically retained between the support surface 200 and the hangar 310. The truck to which the energy storage device 700 is mounted is preferably the rear truck, but can alternatively be mounted to the front truck of the vehicle. However, the energy storage device 700 can be movably supported by the support surface 200. In this variation, the energy storage device 700 is preferably coupled to the bottom surface 204, adjacent to a truck 300, such that the energy storage device 700 does not substantially impede support surface flexion. The energy storage device 700 is preferably coupled to the support surface 200 between the truck 300 and the support surface end, but can alternatively be coupled within the support surface area defined between the two trucks 300. The energy storage device 700 is preferably suspended from the support surface 200, such that the energy storage device 700 is decoupled in shear force from the support surface 200 and can shift or slide relative to the board. The energy storage device 700 is preferably suspended from the support surface 200 by a flexible suspension mechanism, such as a fabric net, a flexible casing such as a flexible plastic or fabric casing, or any other suitable flexible suspension mechanism. Alternatively, the energy storage device 700 can be suspended by a substantially stiff suspension mechanism, such as a substantially rigid box, wherein the energy storage device position within the stiff suspension mechanism can be retained by flexible dampeners.
within the suspension mechanism that permit board flexion relative to the energy storage device 700, such as rubber washers. Alternatively, the energy storage device 700 can be movably supported by the board by mounting an edge of the energy storage device 700 adjacent the truck 300 to the deck 200, such that the remainder of the energy storage device 700 is substantially free from the deck 200. The energy storage device 700 can alternatively be integrated into the support surface 200, such that the energy storage device 700 is preferably disposed between the riding surface and bottom surface, but can alternatively define one of said surfaces. However, the energy storage device can be rigidly mounted to the board, wherein an entire broad face of the energy storage device 700 is preferably coupled to the bottom surface 204. The energy storage device 700 can alternatively be supported by any other means by any other suitable vehicle component.

[0033] The power train 120 of the drive train has no functions to generate rotational power to drive a wheel 420, thereby propelling the vehicle 100 along a road surface 20. The power train 120 preferably drives one wheel 420, but can alternatively drive multiple wheels 420. The vehicle 100 preferably includes a first and second power train 120 driving a first and second wheel 420, respectively, wherein the first and second wheels 420 are preferably supported by a single truck 300. The vehicle 100 can alternatively include a single power train 120 driving a single wheel 420, a single power train 120 driving two wheels 420 supported by a singular truck 300 or by separate trucks 300, four power trains 120 individually driving four respective wheels 420, or include any suitable number of power trains 120 driving any suitable number of wheels 420.

[0034] The power train 120 preferably includes a wheel bearing 400 and a motor 500, wherein the motor 500 drives the wheel 420 through direct mechanical connection of drive components to the wheel 420 or drives the wheel 420 by driving the wheel bearing 400. The motor 500 can drive any suitable portion of the wheel, such as the wheel body. The power train 120 is preferably a positive drive, wherein the wheel bearing 400 includes a toothed wheel pulley 406 (gear), the motor 500 includes a toothed motor pulley 560 (gear) that rotates with the motor 500 shaft, and the power train 120 includes a toothed belt 122 or chain that passes around the wheel and motor pulleys. However, the power train 120 can be a negative drive, wherein the bearing and motor pulleys are smooth pulleys; a direct drive; a shaft drive; an offset parallel shaft drive; a gear transmission (e.g. a planetary gear drive), or have any other suitable power train configuration. The wheel pulley 406 is preferably located on the wheel bearing 400, but can alternatively be located on a separate component statically or movably coupled to the wheel 420. The wheel pulley is preferably substantially the same size as, or slightly smaller than, the motor pulley (e.g. 25% smaller), but can alternatively be any suitable size relative to the motor pulley. The power train is preferably located on a single truck (drive truck), but can alternatively be distributed between two trucks. The truck to which the power train is mounted is preferably the front truck of the vehicle, but can alternatively be the rear truck.

[0035] The wheel bearing 400 of the power train 120 functions to rotatably mount a wheel 420 to the axle 312. The wheel bearing 400 preferably includes an inner bearing surface 402 that rotatably mounts to the axle 312 and an outer bearing surface 404 that mounts to the wheel 420. The wheel bearing 400 can additionally include a third bearing surface that functions as a motor interface. The third bearing surface can be a smooth pulley, a toothed wheel pulley 406 (as shown in FIG. 7), a gear, or any other suitable component capable of transferring rotational energy from the motor 500. The third bearing surface is preferably coaxial with the inner and outer bearing surfaces 404, and is preferably located on the side of the wheel bearing 400 configured to mount proximal the hangar 310 of the truck 300. However, the third bearing surface can be axially offset from the inner and outer bearing surfaces. The wheel bearing 400 can be a shielded bearing, sealed bearing, Teflon-sealed bearing, rubber-sealed bearing, ceramic bearing, or any other suitable bearing.

[0036] The motor 500 of the power train 120 functions to generate the rotational force that rotates the wheel 420. The motor 500 can additionally function to generate energy, such as during controlled deceleration (e.g. braking). The motor 500 is preferably an electric motor, more preferably a permanent magnet motor, but can alternatively be a brushed DC motor, a brushless DC motor, a switched reluctance motor, a coreless DC motor, a synchronous AC motor, an induction motor, a stepper motor, or any other suitable electric motor. The motor 500 can alternatively be any other suitable rotary drive means. The motor 500 is preferably supported by the truck 300, and is preferably mounted to the hangar 310, but can alternatively be mounted to the base plate 320, integrated into the hangar 310 or base plate 320, or otherwise supported by the truck 300. The motor 500 can also be supported by a plate extending from the truck 300, between the wheel and the motor 500, such that the motor is supported on a first end by the hangar and on a second end by the plate. However, the motor can be otherwise mounted to the truck. The motor 500 is preferably supported by or located adjacent the truck 300 that supports the driven wheel 420, but can alternatively be supported by or located adjacent a separate truck 300.

[0037] The power train 110 can additionally include a tensioning mechanism that functions to control the belt tension of the positive drive. In one variation of the power train 120, the tensioning mechanism includes the motor 500, wherein the motor 500 is preferably adjustably mounted to the truck 300, wherein the motor position relative to the axle 312 and/or wheel bearing 400 can be adjusted. Adjustment of the motor position can be used to adjust the belt tension of the positive drive power train 120. The motor 500 is preferably adjustably mounted to the truck 300 by slotted mounting plates 502, wherein fasteners (e.g. bolts, screws, or pins) extend through the slots to couple to the truck 300. The motor 500 is preferably statically fixed to the mounting plates 502, wherein sliding of the mounting bracket 502 relative to the mounting arm 314 adjusts the motor position. Alternatively, the mounting plate can have a tongue that slides within a complementary groove on the truck 300, wherein the friction from a tightened fastener (e.g. screw) transiently retains the motor position. However, the motor 500 can be adjustably mounted to the truck 300 using any suitable mechanism. Alternatively, the motor 500 can be fixed to the truck 300, adjustably mounted to the support surface 200, fixed to the support surface 200 (e.g. adhered to the support surface 200), or otherwise coupled to the support surface 200. In another variation of the power train 120, the tensioning mechanism includes an idler wheel, wherein adjustment of the idler wheel position relative to the centerline extending between the axles of the motor and the wheel controls the belt tension. However, any other suitable tensioning mechanism can be used.
The motor 500 can additionally include a motor controller 520 that controls one or more operation parameters of the motor 500. The motor controller 520 is preferably mounted to the same truck 300 as the motor 500, but can alternatively be mounted to the support surface 200 adjacent the motor 500, mounted to the motor 500 itself (e.g. to a motor end or to a curved motor surface), or mounted to any suitable vehicle component. The motor controller 520 is preferably connected to an encoder within the motor 500 that determines the angular position of the motor 500 shaft or rotor, such that the motor controller 520 can determine the frequency of motor 500 rotation. The motor controller 520 preferably additionally controls the magnitude and direction of the current provided to the motor 500. The motor controller 520 is preferably a pulse modulated speed controller, but can alternatively be any suitable motor controller 520.

The processor 600 of the drive train 110 functions to control motor operation based on a signal 802 received from a control input 800. The processor 600 is preferably a CPU, but can alternatively be any suitable processor 600. The processor 600 is preferably electrically connected by a flexible connection to the motor 500, more preferably directly connected to the motor controller 520, and can additionally be electrically connected to the energy storage device 700 by a flexible connection. The processor 600 is preferably coupled to the vehicle 100 proximal the motor 500, but can alternatively/ additionally be coupled to the vehicle 100 proximal the energy storage device 700 or be coupled to the vehicle 100 distal from the energy storage device 700 and the motor 500. The processor 600 is preferably mounted to a truck 300, but can alternatively be mounted to the support surface 200 (preferably the bottom surface 204 but alternatively the riding surface 202) adjacent a truck 300, to the energy storage device 700, to the motor 500, or to any other suitable vehicle component.

The processor 600 preferably includes a receiver that receives the signal 802 from the control input 800. The receiver can be a wireless receiver, wherein the control input 800 is a remote control 820, be a wired receiver, wherein the control input 800 is electrically connected to the processor 600, or be a mechanical receiver, wherein the control input 800 is mechanically connected to the processor 600 (e.g. by a cable). The signal 802 received by the processor 600 is preferably indicative of desired acceleration, deceleration, or cruising. The processor 600 preferably adjusts the motor operation based on the indicated action.

The processor 600 preferably adjusts motor operation between an acceleration state and a deceleration state. The processor 600 can additionally adjust motor operation to achieve a cruising state. In adjusting the motor operation to the acceleration state, the processor 600 preferably induces the motor 500 to output an acceleration torque that increases the velocity of the vehicle 100, wherein the acceleration torque is preferably higher than the instantaneous torque output and is preferably in the same direction as the instantaneous torque output. The processor 600 can further control the motor torque output such that the change in acceleration is below a predetermined threshold. In adjusting the motor operation to the deceleration state, the processor 600 preferably induces the motor 500 to output a deceleration torque that decreases the velocity of the vehicle 100, wherein the deceleration torque is preferably lower than the instantaneous torque output. The deceleration torque can be a lower magnitude torque in the same direction as the instantaneous torque output, be a torque having a direction reversed from that of the instantaneous torque output, be no torque, wherein the deceleration threshold. In adjusting the motor operation to the deceleration state, the processor 600 preferably induces the motor 500 to output a deceleration torque that substantially maintains the velocity of the vehicle 100, wherein the cruising torque is preferably substantially the same as the instantaneous torque output. The torque output from the motor 500 is preferably rate limited and checked for saturation to protect the hardware and to prevent abrupt acceleration or braking. However, the torque output can alternatively not be rate limited.
input mechanism 822 is at the rest position, but can alternatively be sent when the input mechanism 822 is depressed, rotated, deflected (e.g. along an axis separate from acceleration or deceleration), or otherwise actuated. A lack of a signal 802 can alternatively be interpreted by the processor 600 as a cruising signal, wherein the control input 800 could not send a signal 802 in the rest position.

[0045] In a second variation of the vehicle 100, the control input 800 includes a force sensor 840 coupled to the support surface 200, as shown in FIG. 8. The force sensor 840 preferably includes a direct electrical connection to the processor 600, but can be wirelessly connected to the processor 600 or otherwise connected to the processor 600. The force sensor 840 preferably covers substantially the entirety of the riding surface 202, but can alternatively cover a portion of the riding surface 202, cover a portion of the bottom surface 204, or couple to the support surface 200 at any suitable location. The force sensor 840 is preferably integrated into the grip tape that is applied to the riding surface 202, but can alternatively be adhered onto the riding surface 202 by the grip tape, adhered to the riding surface 202 then covered by the grip tape, or otherwise coupled to the riding surface 202. The force sensor 840 is preferably an array of pressure sensor strips, but can alternatively include a grid of pressure sensors 860, a series of pressure sensor sections, or have any other suitable configuration. As shown in FIG. 8, the vehicle 100 preferably includes multiple pressure sensor strips aligned perpendicular to the longitudinal axis of the support surface 200, but can alternatively include a single pressure sensor 860 strip extending along the longitudinal axis of the support surface 200, a grid of pressure sensors 860, a first, second, and third pressure sensor 860 located at the first end, middle, and second end of the support surface 200, respectively, or any other suitable pressure sensor configuration.

[0046] As shown in FIG. 9, each pressure sensor 860 is preferably a capacitive sensor, and includes an upper shield top layer 861, upper shield bottom layer 862, upper dielectric layer 863, sensing plate 864, a lower dielectric layer 865 and a lower shield layer 866. The upper and lower shield layers are preferably grounded, as shown in FIG. 10. The upper dielectric layer 863, sensing plate 864, and lower dielectric layer 865 preferably form the sensing circuit, wherein the sensing circuit is preferably electrically connected by a flexible connection to the processor 600. Alternatively, the pressure sensor 860 can be a resistive sensor, including two flexible sheets coated with resistive material or patterned with a resistive grid and separated by microdots. However, the pressure sensor 860 can be any other suitable capacitive sensor, resistive sensor, strain gauge, force sensing resistor, or any other suitable sensor capable of measuring an applied force.

[0047] Each pressure sensor 860 of the force sensor 840 preferably sends the processor 600 a measurement of the applied force (pressure signal 802) received by said pressure sensor 860. More preferably, a plurality of location-mapped pressure sensors 860 each sends the processor 600 a pressure signal 802. The signals 802 are preferably received by the processor 600 at a predetermined frequency, but can alternatively be received whenever the applied force changes or in response to any other suitable condition. The processor 600 preferably processes the pressure signals 802 to determine whether the signals 802 constitute a drive command or a halt command. The processor 600 preferably compares the total measured force to a force threshold, wherein a drive command is determined when the total measured force exceeds the force threshold (e.g. indicating a user 10 on the support surface 200), and a halt command is determined when the total measured force falls below the force threshold (e.g. indicating that the user 10 is off of the support surface 200). When a halt command is determined, the processor 600 adjusts the motor 500 to output no torque or a torque substantially opposing the instantaneous torque. When a drive command is determined, the processor 600 preferably processes the pressure signals 802 to determine whether the measurements constitute an acceleration signal, a deceleration signal, or a cruising signal. The processor 600 preferably determines whether the pressure signals 802 constitute an acceleration, deceleration, or cruising signal based on the measured location of the applied force (e.g. determined by which pressure sensor 860 sends a pressure signal 802 over a baseline threshold, or by the location as indicated by a pressure sensor 860), the measured magnitude of the applied force, and/or any other suitable parameter of the applied force. For example, as shown in FIGS. 11A to 11C, the determined signal 802 can be dependent on the force distribution between a first segment 842 and a second segment 844, wherein the first segment 842 is forward of a neutral position 846 on the support surface 200 and the second segment 844 is rearward of the neutral position 846 on support surface 200. The neutral position 846 is preferably calculated as the point on the support surface 200 midway between the first segment 842 and the second segment 844, but can be calculated as a point on the support surface 200 midway between the centroids of the first and second segments, or any other suitable position. In this example, the measurements can constitute an acceleration signal when the force measured at the first segment 842 exceeds the force measured at the second segment 844; as a deceleration signal when the force measured at the second segment 844 exceeds that measured at the first segment 842; and as a cruising signal when the force applied to the first and the second segments are substantially similar. Alternatively, the sent signal 802 can be dependent on the average position of pressure application (pressure center 848) relative to the neutral position 846, wherein the pressure signals 802 constitute an acceleration signal if the pressure center 848 is forward of the neutral position 846, a deceleration signal if the pressure center 848 is rearward of the neutral position 846, and a cruising signal if the pressure center 848 substantially coincides with the neutral position 846. The rate of change in the signaled amount of acceleration or deceleration can additionally be dependent on the rate of change of force application to the first or second segments, respectively. Alternatively, any suitable signal 802 can be sent in response to any suitable parameter derived from the measured forces.

[0048] However, any other suitable input device, such as a touchscreen slider, one or more stomping pads, or pressure-sensitive apparel (e.g. gloves) can be used as the control input 800.

Variations of the Vehicle Configuration.

[0049] In a first variation of the vehicle, as shown in FIG. 13, the vehicle 100 includes a deck 200, a first and a second truck 300 mounted to the deck 200, an electric motor 500 adjustably mounted to the first truck 300, a wheel 420 or wheel bearing 400 driveably connected to the electric motor 500 by a positive drive mechanism, a battery 702 that is electrically connected to the electric motor 500 with a wire fastened along the wire length to the bottom surface 204 and is mounted on the second truck 300 or on the deck 200.
adjacent the second truck 300, a motor controller 520 that controls electric motor operation and is mounted adjacent to or mounted on the first truck 300, and a processor 600 that receives a signal 802 from a control input 800 and determines a target operation parameter for the motor controller 520 based on the signal 802, wherein the processor 600 is mounted adjacent to or mounted on the first truck 300.

[0050] In a second variation of the vehicle, as shown in FIG. 14, the vehicle 100 includes a deck 200, a first and a second truck 300 mounted to the deck 200, an electric motor 500 adjustable mounted to the first truck 300, a wheel 420 or wheel bearing 400 driveably connected to the electric motor 500 by a positive drive mechanism, a battery 702 mounted on the first truck 300 or on the deck 200 adjacent the first truck 300 and electrically connected to the electric motor 500 with a wire, a motor controller 520 that controls electric motor operation and is mounted adjacent to or mounted on the first truck 300, and a processor 600 that receives a signal 802 from a control input 800 and determines a target operation parameter for the motor controller 520 based on the signal 802, wherein the processor 600 is mounted adjacent to or mounted on the first truck 300.

[0051] In a third variation of the vehicle, as shown in FIG. 1, the vehicle 100 includes a deck 200, a first and a second truck 300 mounted to the deck 200, first electric motor 500 adjustable mounted to the first truck 300, a second electric motor 500 adjustable mounted to the first truck 300 adjacent to the first electric motor 500, a first and second wheel 420 or wheel bearing 400 driveably connected to the first and second electric motor 500 by a first and second positive drive mechanism, respectively, a battery 702 mounted on the second truck 300 or on the deck 200 adjacent the second truck 300 and electrically connected to the first and second electric motor 500 by a first and second wire fastened along the wire lengths to the bottom surface 204 of the deck 200, a first and second motor controller 520 that controls first and second electric motor operation, respectively, wherein the first and second motor controllers 520 are mounted adjacent to or mounted on the first truck 300 adjacent the respective motor 500, and a processor 600 that receives a signal 802 from a control input 800 and determines a target operation parameter for the first and second motor controller 520 based on the signal 802, wherein the processor 600 is mounted adjacent to or mounted on the first truck 300. In operation, the processor 600 can additionally determine a steering input (e.g., from a pressure differential between the two lateral sides of the deck 200, from a steering wheel 420, etc.) and independently drive the wheels 420 to achieve the desired steering (e.g., increase the torque output of the right electric motor 500 while maintaining or decreasing the torque output of the left electric motor 500 to achieve a left turn).

[0052] In a fourth variation of the vehicle, as shown in FIG. 15, the vehicle 100 includes a deck 200, a first and a second truck 300 mounted to the deck 200, a first and a second electric motor 500 adjustable mounted to the first truck 300 in an adjacent configuration, a first and second wheel 420 or wheel bearing 400 driveably connected to the first and second electric motor 500 by a first and second positive drive mechanism, respectively, a battery 702 mounted on the first truck 300 or on the deck 200 adjacent the first truck 300 and electrically connected to the first and second electric motors 500 by a first and second wire, a first and second motor controller 520 that controls first and second electric motor operation, respectively, wherein the first and second motor controller 520 are mounted adjacent to or mounted on the first truck 300 adjacent the respective motor 500, and a processor 600 that receives a signal 802 from a control input 800 and determines a target operation parameter for the first and second motor controller 520 based on the signal 802, wherein the processor 600 is mounted adjacent to or mounted on the first truck 300.

[0053] In a fifth variation of the vehicle, as shown in FIG. 16, the vehicle 100 includes a deck 200 mounted to two drive trains 100 each drive train 110 including a truck 300, an electric motor 500 adjustable mounted to the truck 300, a wheel 420 or wheel bearing 400 driveably connected to the electric motor 500 by a positive drive mechanism, and a motor controller 520 that controls electric motor operation. The drive trains 110 are preferably mounted to opposing ends of the deck 200, wherein the driven wheels 420 can be arranged on opposing sides of the deck 200 or on the same side of the deck 200. A processor 600 preferably controls both drive trains 110 based on a signal 802 received from a control input 800, but the drive trains 110 can alternatively be controlled by multiple processors 600. The processor 600 can be mounted to the deck 200 adjacent the first truck 300, mounted to the deck 200 adjacent the second truck 300, mounted to the first truck 300, or mounted to the second truck 300. A battery 702 preferably powers both electric motors 500, and is preferably connected to both electric motors 500 by two wires fastened to the bottom surface 204 along the wire lengths. The battery 702 is preferably mounted adjacent to or mounted on the first or second truck 300. Alternatively, the vehicle 100 includes a first and a second battery 702 that power and are mounted adjacent to or mounted on the first and second drive trains 110, respectively.

[0054] In a sixth variation of the vehicle, as shown in FIG. 17, the vehicle 100 includes a deck 200 mounted to two drive trains 110, each drive train 110 including a truck 300, a first and second electric motor 500 mounted to the truck 300, a first and second wheel 420 or wheel bearing 400 driveably connected to the first and second electric motors 500, respectively, and a first and second motor controller 520 that controls first and second electric motor operation, respectively. Thus, the vehicle 100 has four independently driven wheels 420, supported by two trucks 300. The drive trains 110 are preferably mounted to opposing ends of the deck 200. A processor 600 preferably controls both drive trains 110 based on a signal 802 received from a control input 800, but the drive trains 110 can alternatively be controlled by multiple processors 600. The processor 600 can be mounted to the deck 200 adjacent the first truck 300, mounted to the deck 200 adjacent the second truck 300, mounted to the first truck 300, or mounted to the second truck 300. A battery 702 preferably powers all four electric motors 500, and is preferably connected to all electric motors 500 by wires fastened to the bottom surface 204 along the wire lengths. The battery 702 is preferably mounted adjacent to or mounted on the first or second truck 300. Alternatively, the vehicle 100 includes a first and a second battery 702 that power and are mounted adjacent to or mounted on the first and second drive trains 110, respectively.

[0055] However, the vehicle configuration can include any suitable combination of the aforementioned elements.

[0056] As a person skilled in the art will recognize from the previous detailed description and from the figures and claims, modifications and changes can be made to the preferred embodiments of the invention without departing from the scope of this invention defined in the following claims.
We claim:

1. An electric skateboard comprising:
   a deck;
   a skateboard truck mounted to the deck;
   a wheel rotatably fixed to the truck;
   an electric motor mounted to the truck, the electric motor configured to drive the wheel;
   an energy storage device, movably coupled to the deck, that powers the electric motor; and
   a processor that controls operation of the electric motor based on a signal received from a control input.

2. The electric skateboard of claim 1, wherein the energy storage device is movably coupled to the support surface by a suspension mechanism that substantially reduces shear force between the energy storage device and the support surface.

3. The electric skateboard of claim 2, wherein the suspension mechanism includes a flexible casing.

4. The electric skateboard of claim 1, wherein the energy storage device is movably coupled to the support surface by a power truck, wherein the energy storage device is mounted to the power truck.

5. The electric skateboard of claim 4, wherein the power truck is a separate truck from the first truck, wherein the first truck is mounted to a first end of the deck and the power truck is mounted to a second, opposing end of the deck.

6. The electric skateboard of claim 1, wherein the electric motor drives the wheel through a positive drive mechanism.

7. The electric skateboard of claim 6, further comprising a belt tensioning mechanism.

8. The electric skateboard of claim 7, wherein the belt tensioning mechanism comprises an adjustable mounting system that adjustably mounts the electric motor to the truck, wherein adjustment of a position of the electric motor shaft relative to the wheel axis adjusts a belt tension of the positive drive mechanism.

9. The electric skateboard of claim 1, wherein the processor controls the electric motor to output an acceleration torque in a first direction, output a deceleration torque in a second direction opposing the first direction, and output a cruising torque substantially equivalent to an instantaneous torque during electric motor operation.

10. The electric skateboard of claim 1, wherein the control input comprises a pressure sensor mounted to the support surface and connected to the controller, wherein the signal received from the control input is indicative of an applied force received by the pressure sensor.

11. The electric skateboard of claim 9, wherein the signal is indicative of a position of the applied force along a length of the support surface, wherein the processor adjusts the output torque based on the indicated position of the applied force.

12. The electric skateboard of claim 11, wherein the signal is indicative of a magnitude of the applied force, wherein the processor adjusts the output torque based on the indicated magnitude of the applied force.

13. The electric skateboard of claim 12, wherein the control input comprises a remote control unit that sends an acceleration signal based on a position of an input mechanism.

14. The electric skateboard of claim 1, further comprising a second wheel rotatably fixed to the truck and a second electric motor mounted to the truck that drives the second wheel.

15. A drive train for an electric skateboard, the skateboard including a support surface, the drive train comprising:
   a skateboard truck configured to mount to the support surface;
   a bearing rotatably supported by the truck;
   an electric motor mounted to the truck, the electric motor configured to drive the bearing;
   an energy storage device configured to movably couple to the support surface and to power the electric motor; and
   a processor that controls operation of the electric motor based on a signal received from a control input.

16. The drive train of claim 15, wherein the energy storage device is movably coupled to the support surface by a suspension mechanism that substantially decouples the energy storage device from the support surface in shear force.

17. The drive train of claim 16, wherein the suspension mechanism includes a flexible casing.

18. The drive train of claim 15, wherein the electric motor drives the bearing through a positive drive mechanism.

19. The drive train of claim 18, wherein the positive drive mechanism comprises a toothed belt passing around a first toothed pulley connected to the electric motor and around a second toothed pulley connected to the bearing.

20. The drive train of claim 19, further comprising a belt tensioning mechanism.

21. The drive train of claim 20, wherein the belt tensioning mechanism comprises an adjustable mounting system that adjustably mounts the electric motor to the truck, wherein adjustment of a position of the electric motor shaft relative to the bearing adjusts the belt tension.

22. The drive train of claim 15, wherein the processor controls the electric motor to output a cruising torque that substantially maintains the instantaneous speed of the skateboard during operation.

23. An electric skateboard, comprising:
   a support surface;
   a heat conducting skateboard truck mounted to the support surface;
   a wheel rotatably fixed to the truck;
   an electric motor configured to drive the wheel, the electric motor mounted to the truck, wherein the truck is thermally connected to the motor controller;
   a motor controller configured to control the electric motor, the motor controller mounted to the truck, wherein the truck is thermally connected to the motor controller;
   an energy storage device, movably coupled to the second end of the deck, that powers the electric motor; and
   a processor that adjusts an output torque of the electric motor based on a signal received from a control input.