INTEGRATED MOTOR CONTROLLER FOR ELECTRIC TWO WHEELER

FIELD OF INVENTION

[0001] The present disclosure generally relates to automobile industry, and specifically relates to integrate motor controller into a same physical enclosure and form factor as motor.

BACKGROUND

[0002] The subject matter discussed in the background section should not be assumed to be prior art merely as a result of its mention in the background section. Similarly, a problem mentioned in the background section or associated with the subject matter of the background section should not be assumed to have been previously recognized in the prior art. The subject matter in the background section merely represents different approaches, which in and of themselves may also correspond to implementations of the claimed technology.

[0003] Electric vehicles are becoming an increasingly popular segment of the automobile industry across the world, and electric two-wheeler contribute massively to the popularity of electric vehicles due to the many benefits and advantages provided. Some of the benefits accrued by users of electric two-wheeler vehicles include the low running cost, ease of maintenance, storage space, and low noise. In addition to the benefits provided to the users, electric vehicles are also environment-friendly as they do not contribute to carbon emission.

[0004] Due to the increasing popularity of two-wheeler electric vehicles, there is an increasing need to optimize the performance of such vehicles. One such aspect of electric two-wheeler vehicles that significantly impact its performance, and requires improvement is the use of separate motor and motor controller. Due to the use of separate motor and motor controller in the two-wheeler electric vehicle, there is a lot of space requirement and wiring complexity.

[0005] Hence, there is a need for developing a structural design for the motor and the motor controller for two-wheeler electric vehicles with reduction of space requirement and wiring complexity that provides improved performance and efficiency.

OBJECT OF THE INVENTION

[0006] An object of the invention is to reduce wiring complexity for two-wheeler electric vehicles by packing the motor and the motor controller in a physical enclosure.

[0007] Another objective of the invention is to improve reliability of two-wheeler electric vehicles by using fewer separate components.

[0008] Yet another objective of the invention is to redesign the existing motor and motor controller to enable integrated packaging without thermal or electromagnetic issues in the two-wheeler vehicle.

SUMMARY OF THE INVENTION

[0009] Before the present methods, systems, and hardware enablement are described, it is to be understood that this invention in not limited to the particular systems, and methodologies described, as there can be multiple possible embodiments of the present invention which are not expressly illustrated in the present disclosure. It is also to be understood that the terminology used in the description is for the purpose of describing the particular versions or embodiments only, and is not intended to limit the scope of the present invention which will be limited only by the appended claims.

[0010] The present invention provides an integrated electric system for an electric vehicle. The system includes a physical enclosure partitioned into a first section and a second section by a separating wall. The first section accommodates a motor controller, which comprises multiple controller modules arranged in a vertically stacked, three-dimensional configuration. The second section houses a motor, the motor positioned adjacent to the stacked controller modules. This vertical stacking of the controller modules, combined with the adjacent placement of the motor, results in a compact and lightweight design while improving thermal management and reducing electromagnetic interference.

[0011] In an aspect, the controller modules include a power electronics module, a control electronics module, and a sensing electronics module, each configured to perform specific functions for efficient operation and control of the motor. The power electronics module, control electronics module, and sensing electronics module are arranged in a vertically stacked

manner, wherein each module is positioned one above the other within the physical enclosure, forming a three-dimensional assembly that facilitates space optimization, enhances thermal management, and reduces electromagnetic interference.

[0012] In another aspect, the integrated electric system further comprising an integrated busbar to provide a direct electrical connection between the motor controller and the motor.

[0013] In another aspect, the motor controller is mounted on a printed circuit board (PCB) within the physical enclosure.

[0014] In another aspect, the power electronics module and the motor is thermally coupled to a heat sink for efficient heat dissipation.

[0015] In an aspect, the sensing electronics module is configured to monitor motor temperature, current, and rotational speed for real-time control.

[0016] In an aspect, the control electronics module is configured to execute software algorithms for regulating motor performance based on input from the sensing electronics.

[0017] In an aspect, the physical enclosure is made of a lightweight material selected from the group consisting of magnesium, aluminum, steel, or a composite material formed on a metal cylinder.

[0018] In one aspect, the electric vehicle may be selected from the group consisting of a two-wheeler electric vehicle, a light electric vehicle, or a micro-mobility electric vehicle.

[0019] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings constitute a part of the description and are used to provide further understanding of the present invention. The drawings illustrate exemplary

embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

[0021] **Fig. 1** illustrates a cross-sectional view of a physical enclosure integrating the motor and the motor controller, in accordance with an embodiment of the present invention.

[0022] **Fig. 2** illustrates an exploded view of the internal components of the integrated motor controller as an exemplary embodiment of the invention.

DESCRIPTION OF THE INVENTION

[0023] The description set forth below in connection with the appended drawings is intended as a description of various embodiments of the present invention and is not intended to represent the only embodiments in which the present invention may be practiced. Each embodiment described in this invention is provided merely as an example or illustration of the present invention, and should not necessarily be construed as preferred or advantageous over other embodiments. The description includes specific details for the purpose of providing a thorough understanding of the present invention. However, it will be apparent to those skilled in the art that the present invention may be practiced without these specific details.

[0024] Electric automobiles, especially two-wheeler vehicles have been growing in popularity and demand due to the several benefits and advantages offered by such vehicles. However, optimization of performance of two-wheeler vehicles have been a persistent issue due to the bulky size of such vehicles. Hence optimization of performance of such vehicles, especially with regard to the efficiency achieved by such vehicles, is possible with optimizing the size and wiring of the vehicles. The performance offered by an electric vehicle can be improved by improving the structural aspects and wiring complexity of the vehicle, so as to reduce the energy loss for powering the acceleration or propulsion of the vehicles.

[0025] Conventional two-wheeler electric vehicles utilize separate electric motor and motor controllers. Further, the two-wheeler electric vehicles commonly use either a hub motor built into the wheel or a mid-drive motor mounted centrally on the frame of the vehicles. The motor controller regulates power to the motor which may be enclosed in a separate enclosure with complex wiring running from the motor controller to the motor. Integrating the motor

controller into the same physical enclosure and form factor as the motor creates a consolidated integrated electric powertrain component for two-wheeler electrical vehicles. Hence, modification of structural aspects of such components are performed in the proposed invention to achieve reduced wiring complexity and increased performance of two-wheeler electric vehicles.

[0026] The present invention relates to the integrated motor and the motor controller in two-wheeler electric vehicles. The present invention comprises of a physical enclosure which is capable of housing the motor and the motor controller with same form factor in the two-wheeler electric vehicles. Additionally, the physical enclosure miniaturizes the powertrain system by eliminating separate motor and motor controller boxes effectively reducing the size of the two-wheeler electric vehicle. Further, all power regulation hardware and software are enclosed into the physical enclosure alongside the motor effectively reducing the wiring complexity of the two-wheeler electric vehicle.

[0027] Fig. 1 illustrates a cross-sectional view of a physical enclosure of an integrated electric system **100**. The integrated electric system **100** may comprise a physical enclosure **102**. The physical enclosure **102** is partitioned into a first section **102a** and a second section **102b** by a separating wall. In an embodiment, the physical enclosure **102** may be selected from a group consisting of a cabinet, rack, box, or case. In an embodiment, the physical enclosure **102** may be, but not limited to, made of magnesium, aluminum, steel, or press-forming a composite material on a metal cylinder.

[0028] The integrated electric system **100** may comprise a motor controller **104**. The motor controller **104** is housed within the first section of the physical enclosure **102**. The motor controller **104** may comprises multiple functional modules configured to collectively control the operation of a motor **106**. The motor controller **104** includes a power electronics module responsible for regulating the electrical power supplied to the motor **106**, a control electronics module configured to process control algorithms and generate appropriate control signals for motor operation, and a sensing electronics module adapted to monitor various motor parameters such as speed, position, and temperature. The power electronics module, the control electronics module, and the sensing electronics module are disposed in a vertically stacked three-dimensional arrangement. These modules operate in coordination to ensure efficient, precise, and safe control of the motor during operation.

[0029] The integrated electric system **100** may comprise the motor **106** housed within the second section and positioned adjacent to the vertically stacked controller modules. The three-dimensional stacking of the power electronics module, the control electronics module, and the sensing electronics module, along with the adjacent placement of the motor **106**, facilitates a compact and lightweight design while enhancing thermal performance and minimizing electromagnetic interference.

[0030] In an embodiment, the motor controller **104** may be selected from the group consisting of a DC motor controller, an AC motor controller, a stepper motor controller, a servo motor controller, and a field-oriented control (FOC) or vector controller configured for efficient and dynamic control of BLDC or AC motors.

[0031] In an embodiment, the integrated electric system **100** further comprises an integrated busbar configured to electrically connect the motor controller **104** to the motor **106**. The integrated busbar facilitates efficient power transfer, reduces wiring complexity, and contributes to the compact and lightweight design of the system.

[0032] In an embodiment, the motor controller **104** is mounted on a printed circuit board (PCB) housed within the physical enclosure **102** of the integrated electric system. The power electronics module and the motor **106** are thermally coupled to a heat sink to facilitate efficient heat dissipation during operation. The sensing electronics module is configured to monitor motor parameters, including temperature, current, and rotational speed, to enable real-time control of the motor. The control electronics module is adapted to execute software algorithms for regulating motor performance based on input received from the sensing electronics module, thereby ensuring optimized motor operation.

[0033] The physical enclosure **102** may be comprised within the chassis of the two-wheeler electric vehicle or within the rear wheel of the two-wheeler electric vehicle based on the type of a motor **106** utilized by the two-wheeler electric vehicle.

[0034] Hence the consolidated packaging of the motor **106** and the motor controller **104** in the physical enclosure **102** significantly reduce overall wires and connectors between the motor controller **104** and the motor **106.** Additionally, the integration includes cost savings and

improved reliability from fewer separate components of the motor controller **104** and the motor **106**.

[0035] Fig. 2 illustrates an exploded view of the internal components of the integrated motor controller, depicting various electronic and mechanical assemblies. The assembly comprises a protective logo cover, a high-voltage (HV) cable for conducting high voltage power, a current sensor for measuring motor current, an encoder for providing rotor position feedback, a power board assembly comprising power electronic components for controlling motor current, and a brainboard assembly comprising a microcontroller for processing encoder signals and executing control algorithms. Centrally positioned within the mid casing are the stator assembly and rotor assembly, with a wave spring washer for axial load distribution. These central components are enclosed by the front cover and sealed with an oil seal for preventing lubricant leakage. This integrated arrangement facilitates precise control and operation of the motor within a compact structure, resulting in reduced power loss and improved torque output.

Technical advantage of the invention

[0036] The integrated motor controller and the motor architecture proposed in the present invention helps in consolidating both functionalities of the motor and the motor controller into a physical enclosure reducing complex wiring and connectors. The innovation repackages the motor controller directly into the physical enclosure, significantly minimizing total package volume versus having distinct motor and motor controller. Additionally, the integration benefits result from fusing the corresponding components including enhanced reliability, installation simplification, lowered production costs, increased thermal dissipation efficiency, reduced system complexity with less failure points, and potential design improvements in drive optimization.

[0037] The foregoing descriptions of exemplary embodiments of the present disclosure have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the disclosure to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The exemplary embodiment was chosen and described in order to best explain the principles of the disclosure and its practical application, to thereby enable others skilled in the art to best utilize the

disclosure and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omissions, substitutions of equivalents are contemplated as circumstance may suggest or render expedient, but is intended to cover the application or implementation without departing from the spirit or scope of the claims of the present disclosure.

[0038] Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any component(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature or component of any or all the claims.

[0039] While specific language has been used to describe the disclosure, any limitations arising on account of the same are not intended. As would be apparent to a person in the art, various working modifications may be made to the apparatus in order to implement the inventive concept as taught herein.

[0040] In the above detailed description, reference is made to the accompanying drawings that form a part thereof, and illustrate the best mode presently contemplated for carrying out the invention. However, such description should not be considered as any limitation of scope of the present unit. The structure thus conceived in the present description is susceptible of numerous modifications and variations, all the details may furthermore be replaced with elements having technical equivalence.

We Claim:

1) An integrated electric system for an electric vehicle, comprising:
   a physical enclosure **102** partitioned into a first section **102a** and a second section **102b** by a separating wall;
   a motor controller **104** housed within the first section, the motor controller **104** comprising multiple modules stacked vertically in a three-dimensional arrangement;
   a motor **106** housed within the second section, positioned adjacent to the stacked controller modules; and
   an integrated busbar electrically connecting the motor controller **104** to the motor **106**.

2) The integrated electric system as claimed in claim 1, wherein the controller modules includes a power electronics module, a control electronics module, and a sensing electronics module configured to collectively control the operation of the motor **106**.

3) The integrated electric system as claimed in claim 1, wherein the power electronics module is thermally coupled to a heat sink for efficient heat dissipation.

4) The integrated electric system as claimed in claim 1, wherein the sensing electronics module is configured to monitor motor temperature, current, and rotational speed for real-time control.

5) The integrated electric system as claimed in claim 1, wherein the control electronics module is configured to execute software algorithms for regulating motor performance based on input from the sensing electronics.

6) The integrated electric system as claimed in claim 1, wherein the physical enclosure **102** is made of a lightweight material selected from the group consisting of magnesium, aluminum, steel, or a composite material formed on a metal cylinder.

7) The integrated electric system as claimed in claim 1, wherein the motor controller **104** is mounted on a printed circuit board (PCB) within the physical enclosure **102** to optimize space utilization and compactness.