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NON-CONTACT SMART SHIFTER

Abstract

A smart shifter is provided. The smart shifter includes a spiral magnet, a magneto-resistive sensor, and an outer housing. The spiral magnet and the magneto-resistive sensor are spaced apart within the outer housing such that there is no contact between the spiral magnet and the magneto-resistive sensor. The spiral magnet is configured to rotate with the outer housing. The magneto-resistive sensor is configured to determine a rotational position of the spiral magnet. A first function of the smart shifter is determined by the rotational position of the spiral magnet.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority pursuant to 35 U.S.C. 119(a) to Indian Application No. 202411010937, filed Feb. 16, 2024, which application is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] Various embodiments described herein relate generally to a shifter, and more particularly to a non-contact smart shifter.

BACKGROUND

[0003] Shifters are often desirable for use in vehicles to allow an end user to control some vehicle functionality such as movement, turn signals, headlights, washing, horns, and/or the like. Applicant has identified many technical challenges and difficulties associated with durability, weight, and ease of use with such shifters. Through applied effort, ingenuity, and innovation, many of these identified problems have been solved by developing solutions that are included in embodiments of the present disclosure, many examples of which are described in detail herein.

BRIEF SUMMARY

[0004] In one or more embodiments, a smart shifter is provided. In some embodiments, the smart shifter includes a spiral magnet. In some embodiments, the smart shifter includes a magneto-resistive sensor. In some embodiments, the smart shifter includes an outer housing. In some embodiments, the spiral magnet and the magneto-resistive sensor are spaced apart within the outer housing such that there is no contact between the spiral magnet and the magneto-resistive sensor. In some embodiments, the spiral magnet is configured to rotate with the outer housing. In some embodiments, the magneto-resistive sensor is configured to determine a rotational position of the spiral magnet. In some embodiments, a first function of the smart shifter is determined by the rotational position of the spiral magnet.

[0005] In one or more embodiments, the spiral magnet is fixed to the outer housing via one or more indexing plungers and an indexing plunger plate.

[0006] In one or more embodiments, the magneto-resistive sensor is part of a printed circuit board assembly configured to implement the first function of the smart shifter.

[0007] In one or more embodiments, the spiral magnet includes at least two magnetized pole layers arranged in a spiral pattern.

[0008] In one or more embodiments, the spiral magnet defines an opening at a center axis defined by the spiral magnet.

[0009] In one or more embodiments, the magneto-resistive sensor is positioned off-axis with respect to the center axis.

[0010] In one or more embodiments, the smart shifter includes a second magnet. In some embodiments, the smart shifter includes a three-dimensional integrated circuit. In some embodiments, the second magnet and the three-dimensional integrated circuit are spaced apart such that there is no contact between the second magnet and the three-dimensional integrated circuit. In some embodiments, the second magnet is configured to move across three dimensions. In some embodiments, the three-dimensional integrated circuit is configured to determine an absolute position of the second magnet. In some embodiments, the second function of the smart shifter is determined by the absolute position of the second magnet.

[0011] In one or more embodiments, the three-dimensional integrated circuit determines the absolute position of the second magnet based on a flux density.

[0012] In one or more embodiments, the second magnet is placed at a first end of a shaft, where a second end of the shaft is coupled to an assembly including the spiral magnet and the magneto-

resistive sensor.

[0013] In one or more embodiments, the smart shifter further includes a push switch, where the push switch allows movement of the shaft when engaged.

[0014] In one or more embodiments, the absolute position of the second magnet describes a linear displacement of the second magnet and a rotary position of the second magnet.

[0015] In one or more embodiments, the first function of the smart shifter or the second function of the smart shifter includes at least one of vehicle gear, vehicle speed, vehicle windshield wiper function, headlight function, or turn indicator function.

[0016] In one or more embodiments, a method is provided. In some embodiments, the method includes determining, by a magneto-resistive sensor, a rotational position of a spiral magnet, where the spiral magnet and the magneto-resistive sensor are spaced apart within an outer housing such that there is no contact between the spiral magnet and the magneto-resistive sensor, and where the spiral magnet is configured to rotate with the outer housing. In some embodiments, the method includes determining a first function of a smart shifter based on the rotational position of the spiral magnet. In some embodiments, the method includes implementing the first function of the smart shifter.

[0017] In one or more embodiments, the spiral magnet is fixed to the outer housing via one or more indexing plungers and an indexing plunger plate.

[0018] In one or more embodiments, the magneto-resistive sensor is part of a printed circuit board assembly configured to implement the first function of the smart shifter.

[0019] In one or more embodiments, the spiral magnet includes at least two magnetized pole layers arranged in a spiral pattern.

[0020] In one or more embodiments, the spiral magnet defines an opening at a center axis defined by the spiral magnet.

[0021] In one or more embodiments, the magneto-resistive sensor is positioned off-axis with respect to the center axis.

[0022] In one or more embodiments, the method further includes determining, by a three-dimensional integrated circuit, an absolute position of a second magnet, where the second magnet and the three-dimensional integrated circuit are spaced apart such that there is no contact between the second magnet and the three-dimensional integrated circuit, and where the second magnet is configured to move across three dimensions. In some embodiments, the method further includes determining a second function of the smart shifter based on the absolute position of the second magnet. In some embodiments, the method includes implementing the second function of the smart shifter.

[0023] In one or more embodiments, the three-dimensional integrated circuit determines the absolute position of the second magnet based on a flux density.

[0024] In one or more embodiments, the second magnet is placed at a first end of a shaft, where a second end of the shaft is coupled to an assembly including the spiral magnet and the magneto-resistive sensor.

[0025] In one or more embodiments, the smart shifter further includes a push switch, where the push switch allows movement of the shaft when engaged.

[0026] In one or more embodiments, the absolute position of the second magnet describes a linear displacement of the second magnet and a rotary position of the second magnet.

[0027] In one or more embodiments, the first function of the smart shifter or the second function of the smart shifter includes at least one of vehicle gear, vehicle speed, vehicle windshield wiper function, headlight function, or turn indicator function.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0029] FIG. 1 is a smart shifter including a rotatable component and multi-axis component in accordance with various embodiments of the present disclosure;

[0030] FIG. 2A depicts a perspective view of a rotatable component of a smart shifter in accordance with various embodiments of the present disclosure;

[0031] FIG. 2B depicts a perspective view of a portion of a rotatable component including a spiral magnet and a magneto-resistive sensor in accordance with various embodiments of the present disclosure;

[0032] FIGS. 3A-3B depict a magneto-resistive sensor in accordance with various embodiments of the present disclosure;

[0033] FIGS. 3C-3D depict a magneto-resistive sensor interacting with a spiral magnet in accordance with various embodiments of the present disclosure;

[0034] FIG. 3E depicts input and output of a magneto-resistive sensor in accordance with various embodiments of the present disclosure;

[0035] FIG. 4A depicts a north pole and a south pole of a spiral magnet in accordance with various embodiments of the present disclosure;

[0036] FIG. 4B depicts varying sizes and numbers of poles in spiral magnets in accordance with various embodiments of the present disclosure;

[0037] FIGS. 5A-5B depict output of a magneto-resistive sensor in accordance with various embodiments of the present disclosure;

[0038] FIG. 6A depicts a perspective view of a multi-axis component in accordance with various embodiments of the present disclosure;

[0039] FIG. 6B depicts a side view of a multi-axis component in accordance with various embodiments of the present disclosure; and,

[0040] FIGS. 7A-7B depict a magnet moving relative to a three-dimensional integrated circuit in accordance with various embodiments of the present disclosure.

DETAILED DESCRIPTION

[0041] The present disclosure more fully describes various embodiments with reference to the accompanying drawings. It should be understood that some, but not all embodiments are shown and described herein. Indeed, the embodiments may take many different forms, and accordingly this disclosure should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

[0042] It should be understood at the outset that although illustrative implementations of one or more aspects are illustrated below, the disclosed systems, and methods may be implemented using any number of techniques, whether currently known or not yet in existence. The disclosure should in no way be limited to the illustrative implementations, drawings, and techniques illustrated below, but may be modified within the scope of the appended claims along with their full scope of equivalents. While values for dimensions of various elements are disclosed, the drawings may not be to scale.

[0043] The words “example,” or “exemplary,” when used herein, are intended to mean “serving as an example, instance, or illustration.” Any implementation described herein as an “example” or “exemplary embodiment” is not necessarily preferred or advantageous over other implementations.

[0044] As used herein, the term “or” is intended to mean an inclusive “or” rather than an exclusive “or”. That is, unless specified otherwise, or clear from context, “X employs A or B” is intended to mean any of the natural inclusive permutations. That is, if X employs A; X employs B; or X employs both A and B, then “X employs A or B” is satisfied under any of the foregoing instances.

In addition, the articles “a” and “an” as used in this application and the appended claims should generally be construed to mean “one or more” unless specified otherwise or clear from context to be directed to a singular form.

[0045] As used herein, the terms “coupled,” “fixed,” “attached to,” and the like refer to both direct coupling, fixing, or attaching, as well as indirect coupling, fixing, or attaching through one or more intermediate components or features, unless otherwise specified herein.

[0046] As used herein, the term “positioned directly on” refers to a first component being positioned on a second component such that they make contact. Similarly, as used herein, the term “positioned directly between” refers to a first component being positioned between a second component and a third component such that the first component makes contact with both the second component and the third component. In contrast, a first component that is “positioned between” a second component and a third component may or may not have contact with the second component and the third component. Additionally, a first component that is “positioned between” a second component and a third component is positioned such that there may be other intervening components between the second component and the third component other than the first component.

[0047] It is desirable, in some examples, to reduce the amount of contact between parts of a shifter. Embodiments of the present disclosure include, but are not limited to, a non-contact smart shifter that is lightweight, durable, and configurable to implement multiple functions of, for example, a vehicle (e.g., a car).

[0048] Turning now to FIG. 1, an example smart shifter **100** is depicted. In some embodiments, the smart shifter includes a rotatable component **110** and a multi-axis component **130**. The rotatable component **110** may be configured to implement different functionality than the multi-axis component **130**. For example, the rotatable component **110** may control windshield wiper functionality (e.g., wiper speed and washing), speed control functionality, horn function, and/or headlight functionality and the multi-axis component **130** may be control speed and/or gear of a vehicle.

[0049] In one or more embodiments, rotatable component **110** is cylindrical in shape. For example, rotatable component may be shaped in such a way to be gripped by a hand of an end user. The cylindrical rotatable component **110** may have a length similar to the width of a human hand and a diameter that allows the human hand to comfortably grip the rotatable component **110**.

[0050] In one or more embodiments, rotatable component **110** includes an outer housing **120**. For example, the outer housing **120** may be a shell or casing surrounding internal components of the rotatable component **120**. In some examples, the outer housing **120** fully encapsulates the internal components of rotatable component **120**. Outer housing **120** may be made from, for example, a plastic or rubber material to ensure end user comfort when gripping the outer housing **120**. A user turning the outer housing **120** may initiate functionality such as windshield wiper functionality, turn indicator functionality, headlight functionality, and/or the like.

[0051] In one or more embodiments, multi-axis component **130** is connected to rotatable component **110** by a shaft **150**. In some examples, shaft **150** extends within a fixed housing **140** of multi-axis component **130**. The shaft **150** may be manipulated by a user gripping the rotatable component **110** such that the shaft **150** is moved in a number of directions within fixed housing **140**. For example, the shaft **150** may be manipulated up, down, left, right, or rotated by an end user.

[0052] In one or more embodiments, fixed housing **140** is fixed and not movable by an end user. This may result from the fixed housing **140** being secured to an interior of a vehicle by, for example, bolts or screws. The fixed housing may be made out of durable material such as plastic or metal (e.g., aluminum).

[0053] In some examples, shaft **150** may extend through flexible shell **160** adjacent to fixed housing **140**. Flexible shell **160** may be made of flexible material such as rubber or a loose cloth material. In some examples, flexible shell **160** allows shaft **150** to be manipulated and move within

it while protecting an opening in fixed housing **140**.

[0054] Turning now to FIG. 2A, an example perspective view of a rotatable component **110** is provided. In the depicted example, outer housing **120** surrounds spiral magnet **110**, printed circuit board assembly **220**, magneto-resistive sensor **260**, index plungers **230**, and indexing plunger plate **240**. In some examples, rotatable component further includes push switch **250**.

[0055] In one or more embodiments, index plunger plate **240** is fixed to outer housing **120**. For example, index plunger plate **240** may be cylindrical or disc shapes such that its sides are fixed to outer housing **120**. In some examples, when a user rotates outer housing **120**, indexing plunger plate **240** may rotate with the outer housing **120**.

[0056] In one or more embodiments, indexing plunger plate **240** may be connected to one or more indexing plungers **230**. For example, in the depicted embodiment, indexing plungers **230** are placed on opposite sides of indexing plunger plate **240**. Indexing plungers **230** may extend from indexing plunger plate **240** along the length of cylindrical component **110**. For example, indexing plungers **230** may extend along the outer housing **120**. In some examples, the indexing plungers **230** may be coupled to a spiral magnet **210**.

[0057] In one or more embodiments, spiral magnet **210** is placed within outer housing **120** and fixed to indexing plungers **230**. Spiral magnet **210** may have at least two magnetized pole layers arranged in a spiral pattern. For example, the spiral magnet **210** may have at least one north pole and at least one south pole arranged in the spiral formation. In some examples, when a user rotates outer housing **120**, the indexing plungers **230** rotate the spiral magnet **210** with the outer housing **120**. Rotation of spiral magnet **210** then may cause a change in a magnetic field (e.g., a flux density). In some examples, the spiral magnet **210** defines an opening at a center axis defined by the spiral magnet **210**. The center axis may also be defined by the rotatable component **110**, indexing plunger plate **240**, printed circuit board assembly **220**, and/or push switch **250**.

[0058] In one or more embodiments, printed circuit board assembly **220** is spaced apart from the spiral magnet **210** such that there is no contact between printed circuit board assembly **220** and spiral magnet **210**. For example, printed circuit board assembly **220** may be spaced 1-3 millimeters apart from spiral magnet **210** such that a rotational position of spiral magnet **210** may be determined by printed circuit board assembly **220**. In some examples, the printed circuit board assembly **220** is a cylindrical or disc shape. The printed circuit board assembly **220** may define an opening at the center axis defined by spiral magnet **220**. The printed circuit board assembly **220** may be fixed to a non-rotatable end of the rotatable component **110**. For example, the printed circuit board assembly **220** will remain fixed during rotation of spiral magnet **210**.

[0059] In one or more embodiments, push switch **250** is placed at an end of rotatable component **110**. Push switch **250** may be a circular button that may be engaged by an end user. In some examples, end user engagement with push switch **250** may allow the end user to manipulate shaft **150**. For example, the end user may move shaft **150** up, down, left, or right while engaging push switch **250**. In some examples, this causes the rotatable component **110** to lean at an angle compared to its position prior to the movement of shaft **150**.

[0060] Turning now to FIG. 2B, an example closeup view of an area between spiral magnet **210** and printed circuit board assembly **220**. In one or more embodiments, a printed circuit board assembly including a magneto-resistive sensor **260** is placed on the printed circuit board assembly **220** and is not in contact with spiral magnet **210**. The magneto-resistive sensor **260** may stay fixed while the spiral magnet **210** rotates. In some examples, spiral magnet **210** is off-axis from magneto-resistive sensor **260**. For example, magneto-resistive sensor **260** may be an angular position sensor for off axis applications. In some examples, the magneto-resistive sensor **260** detects a rotational position of spiral magnet **210**. In some examples, magneto-resistive sensor **260** is configured to detect the rotational position of spiral magnet **210** within 0.1 degrees. The magneto-resistive sensor **260** may be able to detect the rotational position of the spiral magnet **210** based on a flux density caused by the spiral magnet or change in a magnetic field.

[0061] In some examples, allowing the magneto-resistive sensor **260** to determine the position of the spiral magnet **210** without contact increases the life span of smart shifter **100**. In addition, weight of the shifter is reduced by removing excess components. Furthermore, the accuracy of the magneto-resistive sensor's **260** detection of rotational position of spiral magnet **210** allows for high reliability. As a further advantage, self-calibration is possible and different positions may be configured to correspond to different functions.

[0062] Turning now to FIG. 3A, an example magneto-resistive sensor **260** is provided. In some examples, the magneto-resistive sensor **260** and printed circuit board assembly **220** are contained in a cylinder with an outside diameter **310** of 10 mm. In some examples, the cylinder has a length **320** of 10 mm. These measurements for the cylinder provide example benefits such as allowing a lighter weight smart shifter with reduced material costs. In some examples, the printed circuit board assembly **220** is connected to a circuitry array **330** which allows functionality to be implemented based on the position of the spiral magnet **210**.

[0063] Turning now to FIG. 3B, an example cross-section view of magneto-resistive sensor **260** and printed circuit board assembly **220** is illustrated. In some examples, the circuitry array **330** and magneto-resistive sensor **260** are coupled to the printed circuit board assembly **240**. The magneto-resistive sensor **260** may be, for example, a TAD2134. In some examples, the magneto-resistive sensor **260** has an accuracy of 0.1 degrees.

[0064] Turning now to FIG. 3C, an example perspective view of the magneto-resistive sensor **260** reading the magnetic field of the spiral magnet **210** is illustrated. In one or more embodiments, the magneto-resistive sensor **260** and printed circuit board assembly **220** remains fixed while the spiral magnet **210** is configured to spin or rotate. In some examples, an integrated circuit may be deployed in place of printed circuit board assembly **220**. In some examples, the spin or rotation of spiral magnet **210** creates a change in magnetic field or flux density, which is sensed by the magneto-resistive sensor **260**. In some examples, the magneto-resistive sensor **260** implements functionality based on the position of the spiral magnet **210** via the circuit array **330**.

[0065] Turning now to FIG. 3D, an illustration of the magneto-resistive sensor placed above a spiral magnet **210** is illustrated. As shown in FIG. 3D, the printed circuit board assembly **220** may be wider than the distance between the edge of spiral magnet **210** and the opening defined by spiral magnet **210**. In some examples, the printed circuit board assembly **220** may be perpendicular to the spiral magnet **210**. At this example orientation, magneto-resistive sensor **260** remains fixed as the spiral magnet **210** rotates.

[0066] Turning now to FIG. 3E, an example input and output of magneto-resistive sensor **260** is illustrated. For example, input and outputs may be communicated via circuitry array **220** and printed circuit board assembly **220**.

[0067] In one or more embodiments, the magneto-resistive sensor **260** is powered by a battery **350**. In some embodiments, the battery **350** applies direct current to the magneto-resistive sensor **260**. For example, the battery **350** may apply between 8 volts and 32 volts of direct current to the magneto-resistive sensor **260** in order to provide the correct power for detecting rotational position of spiral magnet **210**.

[0068] In one or more embodiments, the magneto-resistive sensor **260** outputs to an electronic control unit **360**. The electronic control unit **360** may control one or more electrical systems or subsystems in a vehicle, such as a car, truck, boat, plane, train, motorcycle, and/or the like. For example, the electronic control unit **360** may control function of windshield wipers, turn indicators, headlights, gears, and/or the like. In some examples, a sine/cosine output from the magneto-resistive sensor **260** is fed to the electronic control unit **360**. The output from the magneto-resistive sensor **360** may be single-ended or differential.

[0069] FIG. 4A depicts an example spiral magnet **210** having four poles including a north pole **410** and a south pole **420**. In this example spiral magnet **210**, there are two north poles **510** and two south poles **420**. The north poles **410** and south poles **420** are arranged in a spiral formation. In this

example, each pole has an equal width and is tapered off into an infinitesimal slice as it moves along the spiral magnet **210**.

[0070] In some examples, the magneto-resistive sensor **260** is placed along a center track **430** of the spiral magnet **210**. Each of the example north poles **410** and south poles **420** pass through the center track **430**. For example, a magneto-resistive sensor **260** may determine the change in magnetic field based on its position along the center track **430**. In other embodiments, the magneto-resistive sensor **260** may be placed inside or outside the center track **430**.

[0071] FIG. **4B** depicts example spiral magnet having different pole counts. For example, spiral magnet **440a** having two poles (e.g., “two pole” spiral magnet). The spiral magnet **440a** has a diameter of 25 mm and is formed of adjacent tilted and alternating magnetized north and south poles having the same width being tapered off into infinitesimal slices moving along the spiral magnet **440a**. An example spiral magnet **440b** is depicted having four poles (e.g., “four pole” spiral magnet). The spiral magnet **440b** is formed of adjacent tilted and alternating magnetized north and south poles having the same width being tapered off into infinitesimal slices moving along the spiral magnet **440b**. An example spiral magnet **440c** is provided having six poles (e.g., “six pole” spiral magnet). The spiral magnet **440c** is formed of adjacent tilted and alternating magnetized north and south poles having the same width being tapered off into infinitesimal slices moving along the spiral magnet **440c**. An example spiral magnet **440d** is depicted having eight poles (e.g., “eight pole” spiral magnet). The spiral magnet **440d** is formed of adjacent tilted and alternating magnetized north and south poles having the same width being tapered off into infinitesimal slices moving along the spiral magnet **440d**. A spiral magnet **440e** is depicted having ten poles (e.g., “ten pole” spiral magnet). The spiral magnet **440e** is formed of adjacent tilted and alternating magnetized north and south poles having the same width being tapered off into infinitesimal slices moving along the spiral magnet **440e**. An example spiral magnet **440f** having twenty-four poles (e.g., “twenty-four pole” spiral magnet). The spiral magnet **440f** has a diameter of 140 mm and is formed of adjacent tilted and alternating magnetized north and south poles having the same width being tapered off into infinitesimal slices moving along the spiral magnet **440f**.

[0072] It should be understood that a spiral magnet as described herein is not limited to the pole count configurations of the examples provided in FIGS. **4A-4B**. In various embodiments, a spiral magnet may have a pole count that is different from the examples of FIGS. **4A-4B**. For example, an example spiral magnet may comprise 7 poles, 9 poles, or the like in some embodiments. As depicted in FIG. **4B**, diameters of spiral magnets may vary in size, but may be different sizes from those depicted in other embodiments.

[0073] In various embodiments, a spiral magnet may have a spiral in a number of poles (e.g., 2, 6, 8, 24, 36 or the like) for the required angle. In various embodiments, the pole count of a spiral magnet may be based at least in part on the tilt angle of the north and south poles and/or the width of the north and south poles. Additionally and/or alternatively, in various embodiments, the pole count of the spiral magnet may be based at least in part on one or more other parameters (e.g., outer diameter, inner diameter, radial thickness, axial thickness, and/or the like) of the spiral magnet. In various embodiments, the pole pattern is an Archimedean spiral that is generally defined as $r=a+b\cdot\theta^{1/c}$, where r is the radius at a given angle θ (e.g., amount of rotation of the radius), a is the starting location of the spiral at the inner diameter, b is the tilt angle, and c describes the growth rate/shape of the radius.

[0074] FIG. **5A** shows an example graph **510** of sine **520** and cosine **530** output signals corresponding to an output of a magneto-resistive sensor **260** detecting movement of a spiral magnet **210**, while FIG. **5B** shows an example graph **540** of processed output signal generated **550**, utilizing an arctangent function, based at least in part on the sine **520** and cosine **530** output signals of FIG. **5A**.

[0075] Turning now to FIG. **6A-6B**, a multi-axis component **130** of a smart shifter **100** is provided. In one or more embodiments, the fixed housing **140** of the multi-axis component **130** includes shaft

150, second magnet **610**, three-dimensional integrated circuit **630**, and second printed circuit board assembly **610**.

[0076] In one or more embodiments, a second magnet **610** is coupled to a first end of shaft **150**, wherein the second end of shaft **150** is coupled to an assembly comprising the rotatable component **110**. In some examples, the second magnet **610** includes a north pole and a south pole. The second magnet **610** may move with the shaft **150** when the shaft **150** is manipulated by an end user. For example, the second magnet **610** may be rotated or moved up, down, left, or right based on manipulation of shaft **150** by an end user.

[0077] In one or more embodiments, a second printed circuit board assembly **620** is secured inside the fixed housing **140** of multi-axis component **130**. The example second printed circuit board assembly is placed such that there is a gap between the printed circuit board assembly and the second magnet **610**.

[0078] In one or more embodiments, a three-dimensional integrated circuit **630** is coupled to the second printed circuit board assembly **620**. The example three-dimensional integrated circuit **630** is spaced apart from the second magnet **610** due to being fixed on second printed circuit board assembly **620**. Three-dimensional integrated circuit **630** may be automotive grade (e.g., AEC-Q100). In some examples, three-dimensional integrated circuit **630** may be micro-powered with a programmable duty cycle. Some example three-dimensional integrated circuits **630** may have selectable digital output. Three-dimensional integrated circuit **630** may be, for example, 16-bit magnetic, 16-bit supply voltage, or 14-bit temperature. Some example three-dimensional integrated circuits **630** may operate at runtime programmable modes, single measurement, burst mode up to 2 kHz, or wake-up on change mode. An example three-dimensional integrated circuit **630** may have a programmable measurement range and/or an extended magnetic sensing range option. In some examples, the three-dimensional integrated circuit **630** may use on-chip magnetic calibration data allowing an off-chip digital signal processor to achieve maximum accuracy.

[0079] In some examples, as the shaft **150** changes angle and direction due to user manipulation, second magnet **610** is moved relative to three-dimensional integrated circuit **630**. The example three-dimensional integrated circuit **630** is configured to decode an absolute position of the second magnet **610**. In some examples, the three-dimensional integrated circuit **630** then sends signals to a processor to activate an intended function based on the absolute position of second magnet **610**.

[0080] Turning now to FIGS. 7A-7B, example depictions of second magnet **610** moving with respect to three-dimensional integrated circuit **630** are provided. For example, second magnet **610** may move up, down, left, or right (e.g., in x or y directions) with shaft **150**. As second magnet **610** moves in these directions, it may additionally move in the z direction and be angled with respect to three-dimensional integrated circuit **630**, as shown in FIG. 7B. In further examples, second magnet **610** may rotate with respect to three-dimensional integrated circuit **630**.

[0081] In some examples, the three-dimensional integrated circuit decodes the absolute position of second magnet **610** based on flux density (e.g., BX, BY, and BZ components of flux density). In some examples, the three-dimensional integrated circuit determines a linear displacement and a rotary position (e.g., between 0 and 360 degrees). Application software may be selected for an external microcontroller such that different positions of second magnet **610** result in different functionality. For example, different positions of second magnet **610** may implement vehicle gear change, vehicle speed change, turn indicator functionality, windshield wiper functionality, headlight functionality, and/or the like.

[0082] By sensing a position of the second magnet **610** without contact, the weight of an example smart shifter **100** is reduced and the durability is increased. In addition, example functionality indicated by different magnet placements can be easily reconfigured. Wear and tear of the example smart shifter **100** is reduced and reliability is increased.

Conclusion

[0083] The above descriptions of various embodiments of the subject disclosure and corresponding

figures and what is described in the Abstract, are described herein for illustrative purposes, and are not intended to be exhaustive or to limit the disclosed embodiments to the precise forms disclosed. It is to be understood that one of ordinary skill in the art may recognize that other embodiments having modifications, permutations, combinations, and additions can be implemented for performing the same, similar, alternative, or substitute functions of the disclosed subject matter, and are therefore considered within the scope of this disclosure. Therefore, the disclosed subject matter should not be limited to any single embodiment described herein, but rather should be construed in breadth and scope in accordance with the appended claims below. Moreover, although the foregoing descriptions and the associated drawings describe example embodiments in the context of certain example combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. A smart shifter, comprising: a spiral magnet; a magneto-resistive sensor; and an outer housing, wherein the spiral magnet and the magneto-resistive sensor are spaced apart within the outer housing such that there is no contact between the spiral magnet and the magneto-resistive sensor, wherein the spiral magnet is configured to rotate with the outer housing, wherein the magneto-resistive sensor is configured to determine a rotational position of the spiral magnet, and wherein a first function of the smart shifter is determined by the rotational position of the spiral magnet.
2. The smart shifter of claim 1, wherein the spiral magnet is fixed to the outer housing via one or more indexing plungers and an indexing plunger plate.
3. The smart shifter of claim 1, wherein the magneto-resistive sensor is part of a printed circuit board assembly configured to implement the first function of the smart shifter.
4. The smart shifter of claim 1, wherein the spiral magnet comprises two magnetized pole layers arranged in a spiral pattern.
5. The smart shifter of claim 4, wherein the spiral magnet defines an opening at a center axis defined by the spiral magnet.
6. The smart shifter of claim 5, wherein the magneto-resistive sensor is positioned off-axis with respect to the center axis.
7. The smart shifter of claim 1, further comprising: a second magnet; and a three-dimensional integrated circuit, wherein the second magnet and the three-dimensional integrated circuit are spaced apart such that there is no contact between the second magnet and the three-dimensional integrated circuit, wherein the second magnet is configured to move across three dimensions, wherein the three-dimensional integrated circuit is configured to determine an absolute position of the second magnet, and wherein a second function of the smart shifter is determined by the absolute position of the second magnet.
8. The smart shifter of claim 7, wherein the three-dimensional integrated circuit determines the absolute position of the second magnet based on a flux density.
9. The smart shifter of claim 7, wherein the second magnet is placed at a first end of a shaft, wherein a second end of the shaft is coupled to an assembly comprising the spiral magnet and the magneto-resistive sensor.
10. The smart shifter of claim 9, further comprising a push switch, wherein the push switch allows movement of the shaft when engaged.
11. The smart shifter of claim 7, wherein the absolute position of the second magnet describes a

linear displacement of the second magnet and a rotary position of the second magnet.

12. The smart shifter of claim 7, wherein the first function of the smart shifter or the second function of the smart shifter comprises at least one of vehicle gear, vehicle speed, vehicle windshield wiper function, headlight function, or turn indicator function.

13. A method, comprising: determining, by a magneto-resistive sensor, a rotational position of a spiral magnet, wherein the spiral magnet and the magneto-resistive sensor are spaced apart within an outer housing such that there is no contact between the spiral magnet and the magneto-resistive sensor, and wherein the spiral magnet is configured to rotate with the outer housing; determining a first function of a smart shifter based on the rotational position of the spiral magnet; and implementing the first function of the smart shifter.

14. The method of claim 13, wherein the spiral magnet is fixed to the outer housing via one or more indexing plungers and an indexing plunger plate.

15. The method of claim 13, wherein the magneto-resistive sensor is positioned on a printed circuit board assembly configured to implement the first function of the smart shifter.

16. The method of claim 13, wherein the spiral magnet comprises at least two magnetized pole layers arranged in a spiral pattern.

17. The method of claim 16, wherein the spiral magnet defines an opening at a center axis defined by the spiral magnet.

18. The method of claim 17, wherein the magneto-resistive sensor is positioned off-axis with respect to the center axis.

19. The method of claim 13, further comprising: determining, by a three-dimensional integrated circuit, an absolute position of a second magnet, wherein the second magnet and the three-dimensional integrated circuit are spaced apart such that there is no contact between the second magnet and the three-dimensional integrated circuit, and wherein the second magnet is configured to move across three dimensions; determining a second function of the smart shifter based on the absolute position of the second magnet; and implementing the second function of the smart shifter.

20. The method of claim 19, wherein the three-dimensional integrated circuit determines the absolute position of the second magnet based on a flux density.
