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(54) **CAMERA MODULE**

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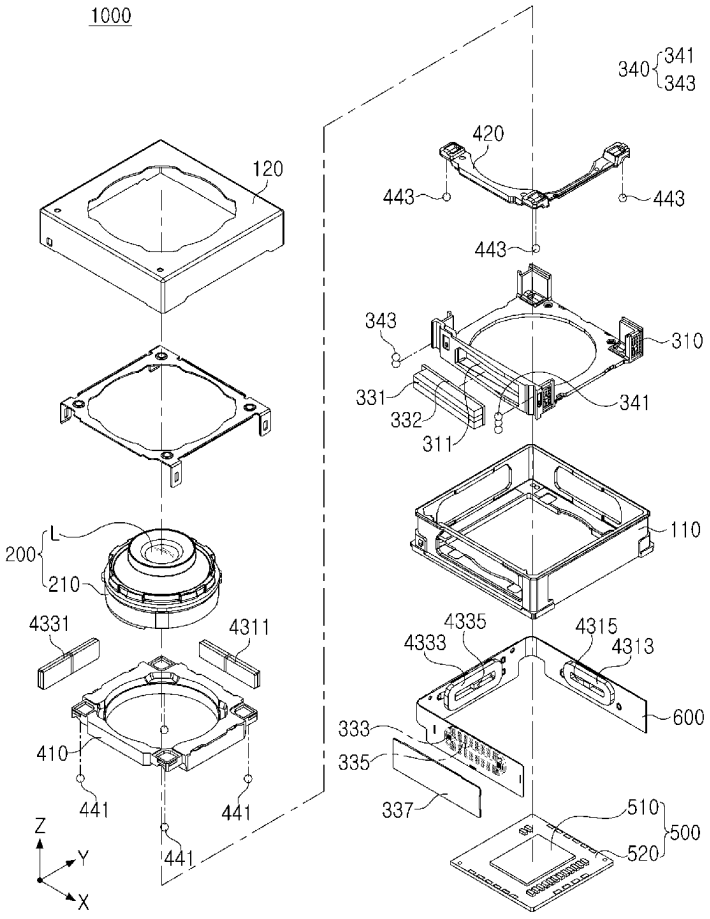
(57) **ABSTRACT**

A camera module is provided. The camera module includes a lens module including at least one lens, a carrier that accommodates the lens module and is configured to move in an optical axis direction, a housing that accommodates the carrier, a focus adjustment driving unit including a focus adjustment magnet disposed on the carrier and a focus adjustment coil disposed on the housing to face the focus adjustment magnet and configured to generate a driving force to move the carrier in the optical axis direction, and a first ball group disposed between the carrier and the housing to guide movement of the carrier in the optical axis direction, wherein a gap between the focus adjustment magnet and the focus adjustment coil increases or decreases in a longitudinal direction of the focus adjustment magnet.



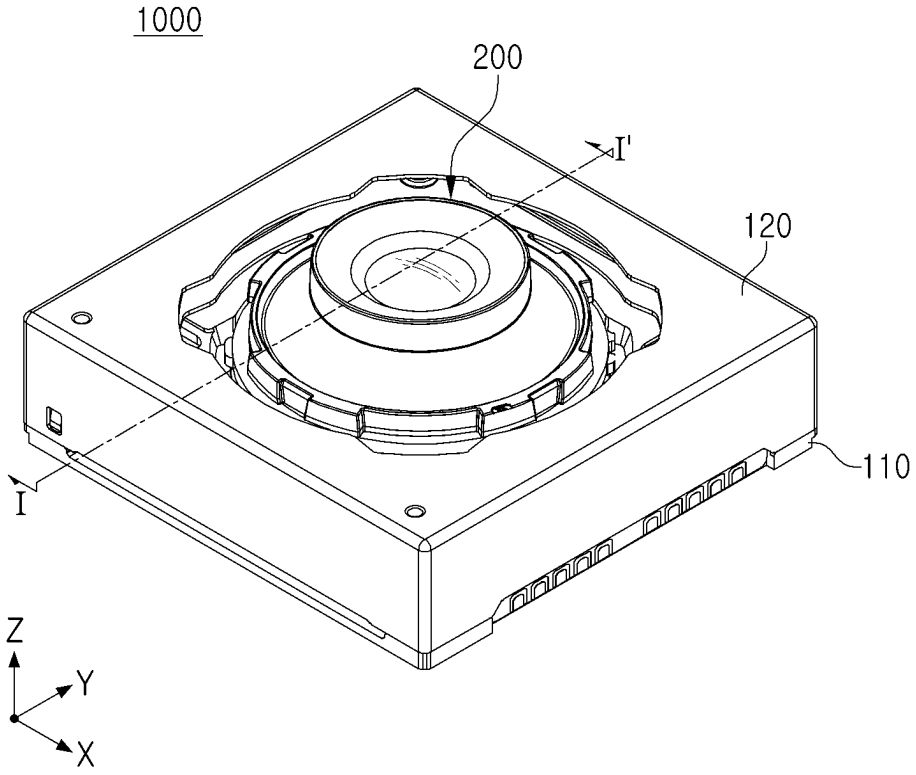
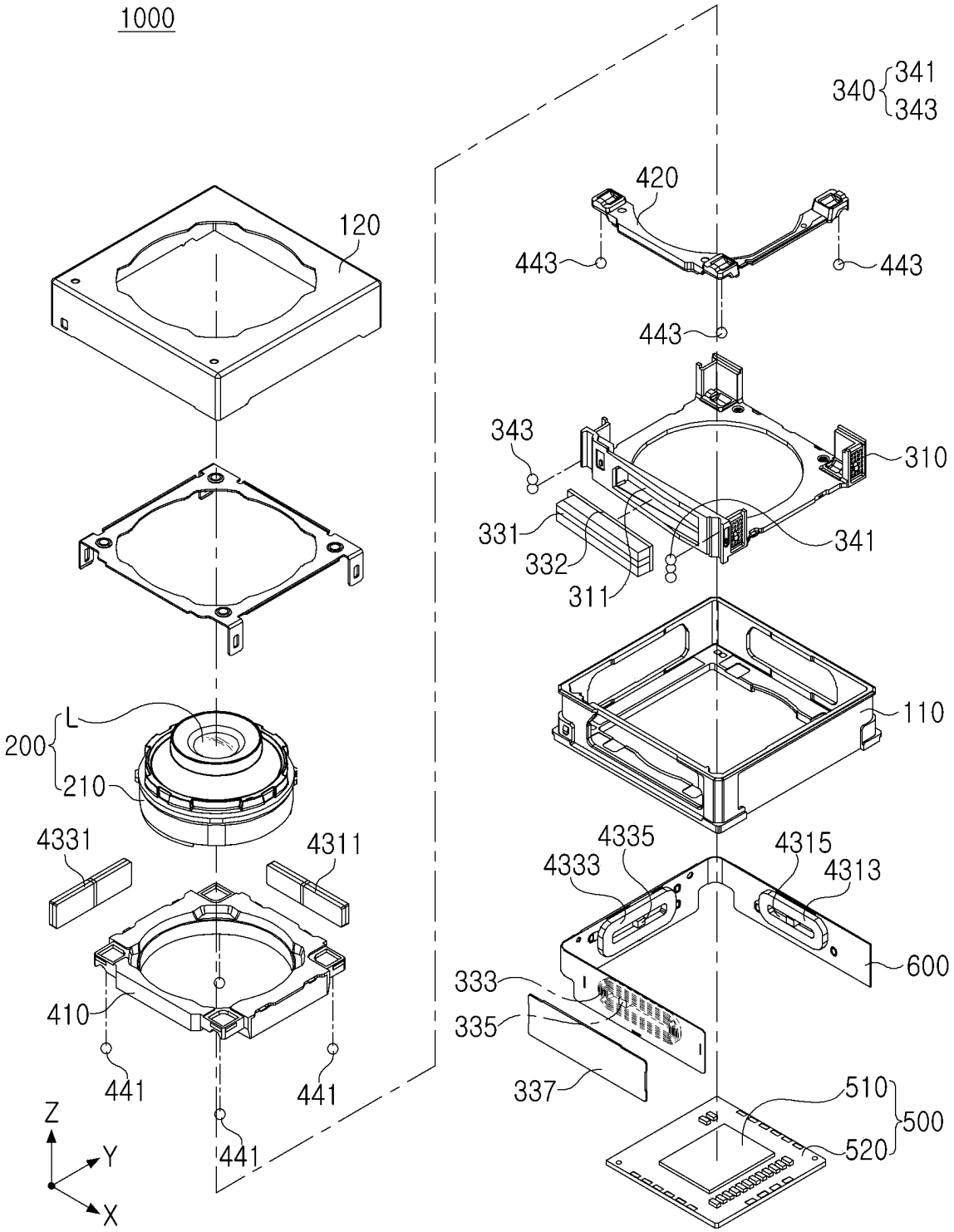


FIG. 1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337
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500
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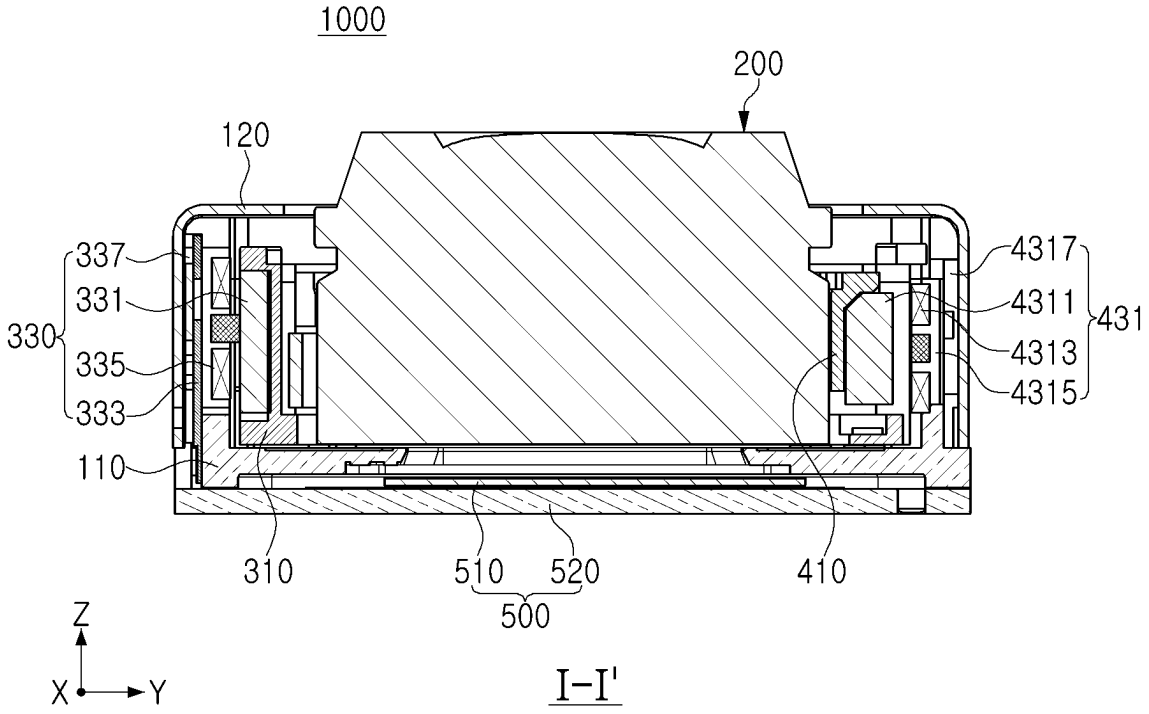
FIG. 2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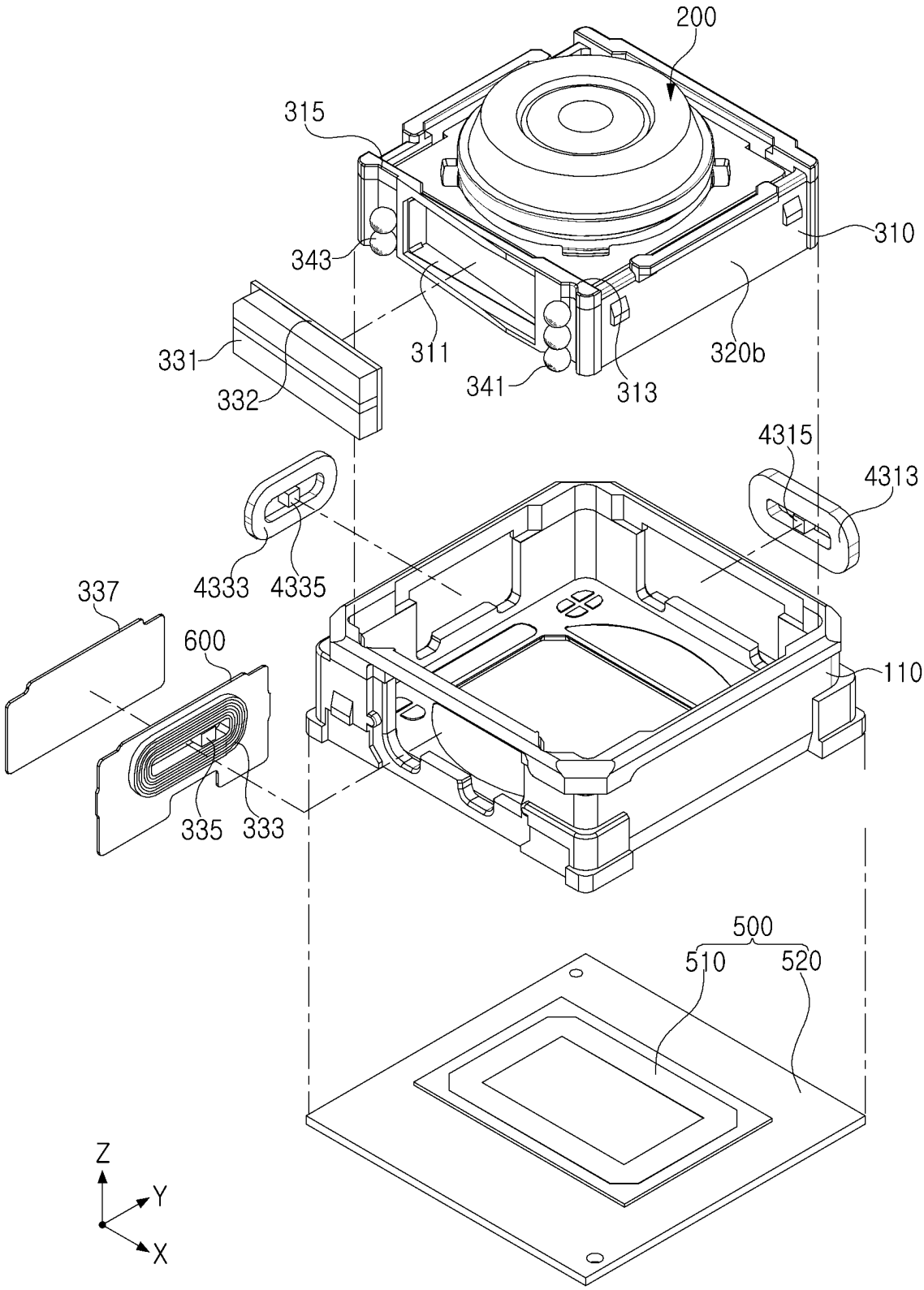
I-I'

FIG. 3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343
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320b
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332
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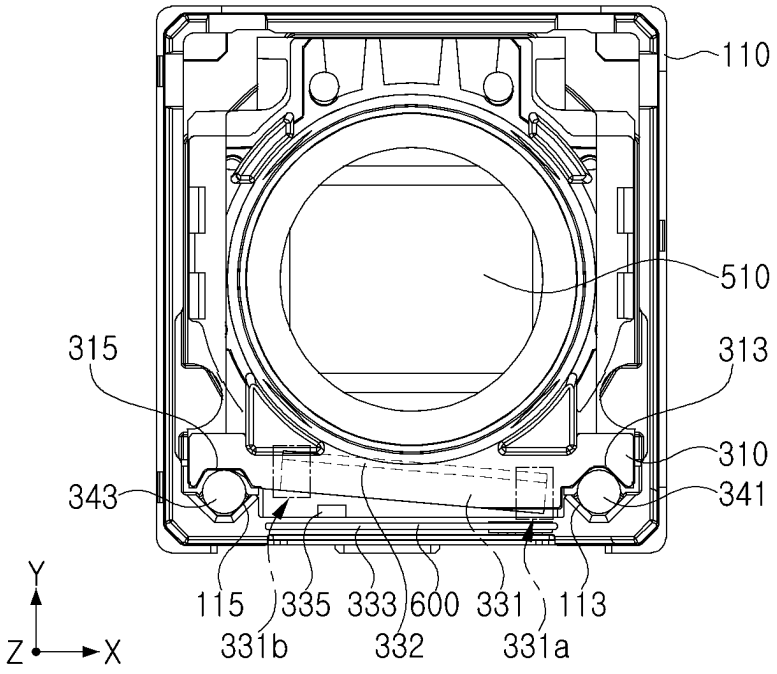
Y
X

FIG. 4


110
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113
331b
332
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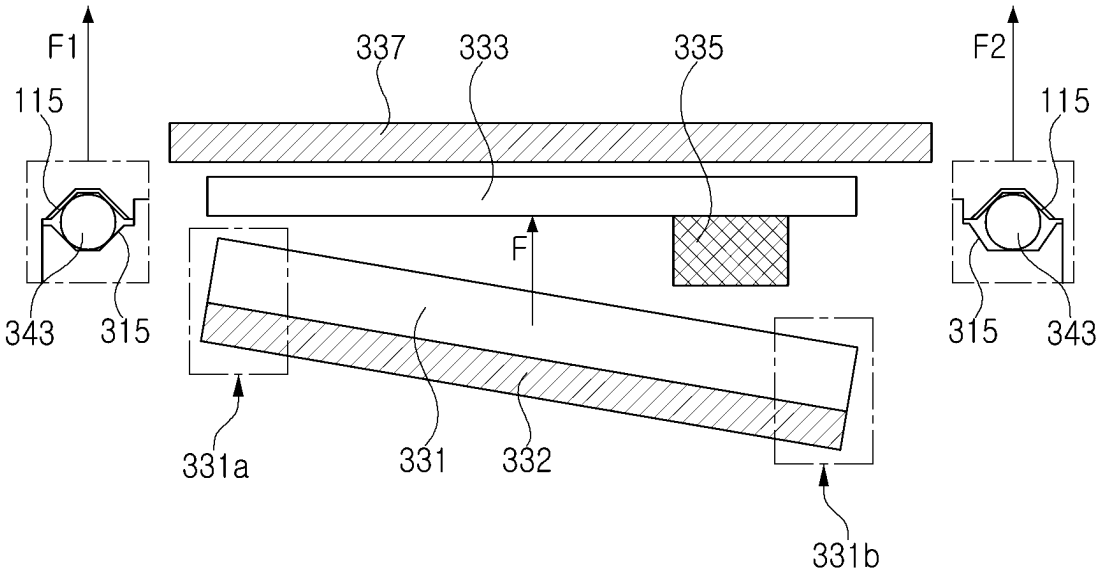
FIG. 5


F1
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331a
331
332
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FIG. 6

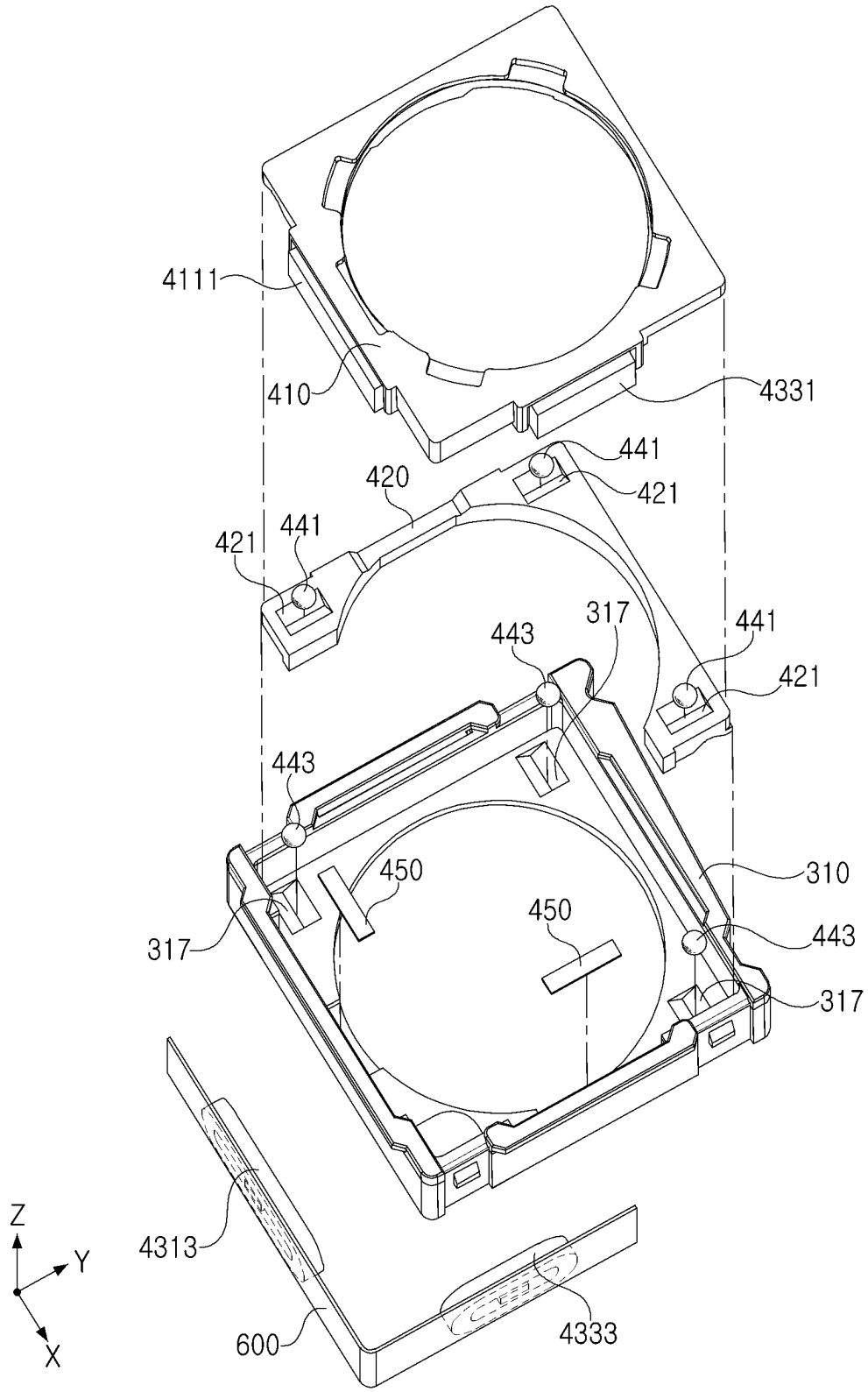
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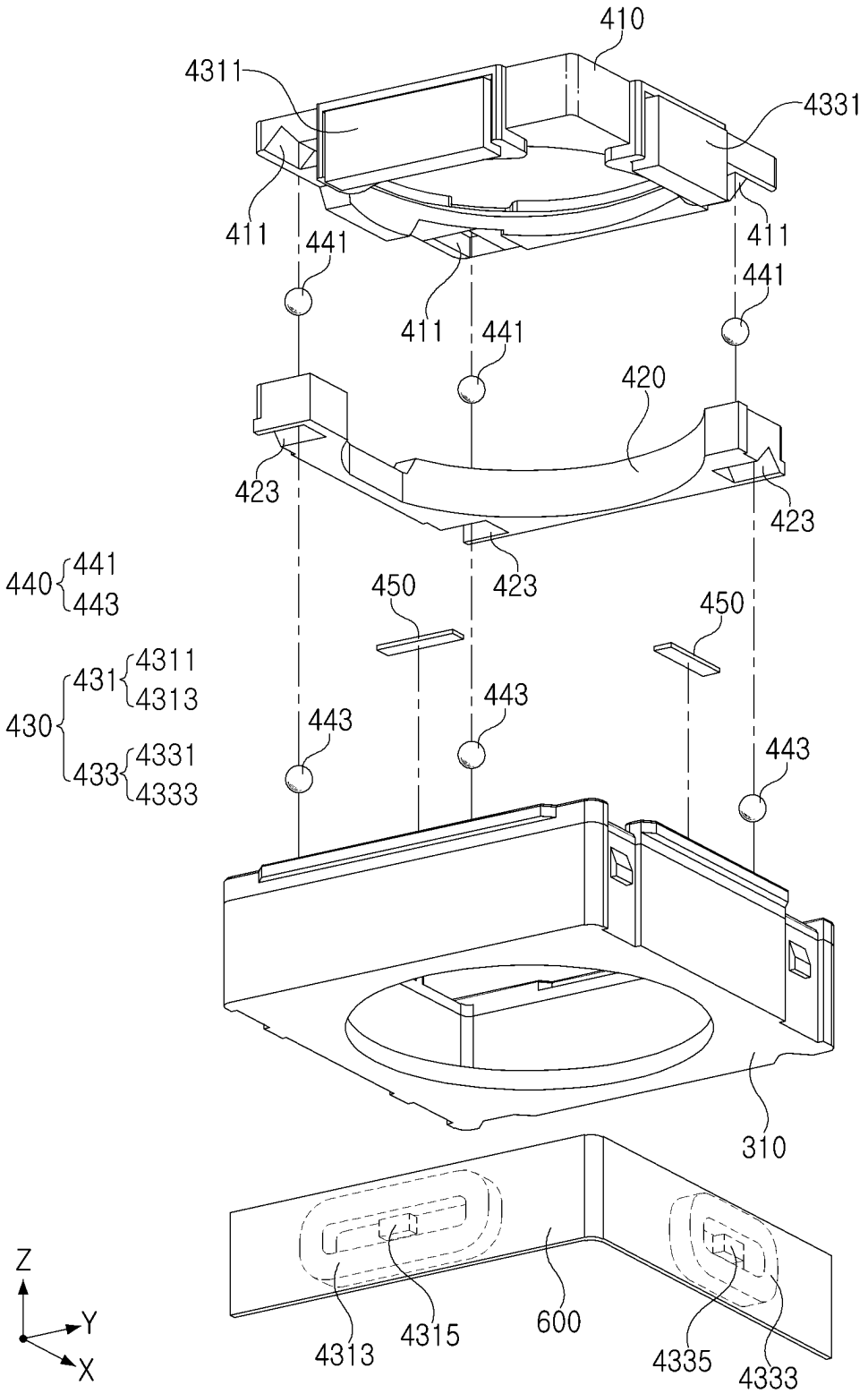
FIG. 7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4311
4313
430
433
4331
4333
443
443
443
310
Z
Y
X
4313
4315
600
4335
4333

FIG. 8

CAMERA MODULE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under 35 USC § 119 (a) of Korean Patent Application No. 10-2024-0023683 filed on Feb. 19, 2024, in the Korean Intellectual Property Office, the entire disclosure of which is incorporated herein by reference for all purposes.

BACKGROUND

1. Field

[0002] The following description relates to a camera module.

2. Description of Related Art

[0003] Camera modules are implemented in portable electronic devices, such as, but not limited to, smartphones, tablet personal computers (PCs), and laptops.

[0004] Most camera modules implemented in portable electronic devices have an autofocusing (AF) operation and an optical imaging stabilization (OIS) operation, and a zoom operation may be added thereto.

[0005] Among the above camera module operations, it is important to ensure linearity of movement in the autofocusing operation to prevent tilt.

SUMMARY

[0006] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[0007] In a general aspect, a camera module includes a lens module comprising at least one lens; a carrier, that accommodates the lens module, and is configured to move in an optical axis direction; a housing that accommodates the carrier; a focus adjustment driving unit comprising a focus adjustment magnet disposed on the carrier and a focus adjustment coil disposed on the housing to face the focus adjustment magnet, and configured to generate a driving force to move the carrier in the optical axis direction; and a first ball group disposed between the carrier and the housing to guide movement of the carrier in the optical axis direction, wherein a gap between the focus adjustment magnet and the focus adjustment coil increases or decreases in a longitudinal direction of the focus adjustment magnet.

[0008] The camera module may include a substrate on which the focus adjustment coil is disposed, wherein the focus adjustment coil is patterned and formed on one surface of the substrate.

[0009] The camera module may include a position sensor disposed on one surface of the substrate, wherein the position sensor protrudes further from one surface of the substrate toward the focus adjustment magnet than the focus adjustment coil.

[0010] The gap between the focus adjustment magnet and the focus adjustment coil may increase from a first side of the focus adjustment magnet to a second side of the focus adjustment magnet in the longitudinal direction, and the position sensor may be disposed to face the second side of the focus adjustment magnet.

[0011] The camera module may include a first yoke disposed to face the focus adjustment magnet with the focus adjustment coil interposed therebetween, wherein the first yoke may be provided as a magnetic material to generate an attractive force with the focus adjustment magnet.

[0012] The gap between the focus adjustment magnet and the focus adjustment coil may increase from a first side of the focus adjustment magnet to a second side of the focus adjustment magnet in the longitudinal direction, and the first ball group may include a first ball member disposed to be close to the first side of the focus adjustment magnet in the longitudinal direction; and a second ball member disposed to be close to the second side of the focus adjustment magnet in the longitudinal direction.

[0013] A number of contact points at which the first ball member contacts the carrier and the housing may be greater than a number of contact points at which the second ball member contacts the carrier and the housing.

[0014] The carrier may include a seating recess comprising an inclined surface that is disposed obliquely with respect to the focus adjustment coil, and in which the focus adjustment magnet is disposed.

[0015] The camera module may include a back yoke disposed between the carrier and the focus adjustment magnet, wherein the back yoke is arranged parallel to the focus adjustment magnet.

[0016] The camera module may further include a first frame and a second frame that accommodate the lens module, and are configured to move in a direction, perpendicular to the optical axis direction.

[0017] In a general aspect, a camera module includes a housing that accommodates a lens module; a carrier, configured to move in an optical axis direction with respect to the housing; a first ball member and a second ball member disposed between the housing and the carrier, spaced apart from each other in a first axis direction, perpendicular to the optical axis direction, and respectively including one or more balls; a driving unit comprising a focus adjustment magnet disposed on the carrier; and a yoke facing the focus adjustment magnet in a second axis direction, perpendicular to the optical axis direction and the first axis direction, wherein a number of balls included in the first ball member is greater than a number of balls included in the second ball member, and a gap between the yoke and the focus adjustment magnet decreases at a position closer to the first ball member than the second ball member.

[0018] The focus adjustment magnet may be disposed between the first ball member and the second ball member, the yoke is disposed on the housing, and the focus adjustment magnet may be disposed obliquely with respect to the yoke.

[0019] A focus adjustment coil, facing the focus adjustment magnet in the second axis direction, may be disposed on the housing, and the focus adjustment magnet may be disposed obliquely with respect to the focus adjustment coil.

[0020] The camera module may further include a substrate on which the focus adjustment coil is disposed, wherein the focus adjustment coil may be patterned and formed on a first surface of the substrate.

[0021] The camera module may include a position sensor disposed on the first surface of the substrate, wherein the

position sensor protrudes further from the first surface of the substrate toward the focus adjustment magnet than the focus adjustment coil.

[0022] A gap between the focus adjustment magnet and the focus adjustment coil may increase from a first side of the focus adjustment magnet to a second side of the focus adjustment magnet in the longitudinal direction, and the position sensor may be disposed to face the second side of the focus adjustment magnet.

[0023] Other features and aspects will be apparent from the following detailed description, the drawings, and the claims.

BRIEF DESCRIPTION OF DRAWINGS

[0024] FIG. **1** illustrates a perspective view of an example camera module, in accordance with one or more embodiments.

[0025] FIG. **2** illustrates a schematic exploded perspective view of an example camera module, in accordance with one or more embodiments.

[0026] FIG. **3** illustrates a cross-sectional view taken along line I-I' of FIG. **1**.

[0027] FIG. **4** illustrates an exploded perspective view of a focus adjustment unit, in accordance with one or more embodiments.

[0028] FIG. **5** illustrates a plan view of a focus adjustment unit, in accordance with one or more embodiments.

[0029] FIG. **6** illustrates a conceptual diagram of a focus adjustment unit, in accordance with one or more embodiments.

[0030] FIG. **7** and FIG. **8** are exploded perspective views of a shake correction unit, in accordance with one or more embodiments.

[0031] Throughout the drawings and the detailed description, unless otherwise described, the same reference numerals refer to the same elements. The drawings may not be to scale, and the relative size, proportions, and depiction of elements in the drawings may be exaggerated for clarity, illustration, and convenience.

DETAILED DESCRIPTION

[0032] The following detailed description is provided to assist the reader in gaining a comprehensive understanding of the methods, apparatuses, and/or systems described herein. However, various changes, modifications, and equivalents of the methods, apparatuses, and/or systems described herein will be apparent after an understanding of the disclosure of this application. For example, the sequences within and/or of operations described herein are merely examples, and are not limited to those set forth herein, but may be changed as will be apparent after an understanding of the disclosure of this application, except for sequences within and/or of operations necessarily occurring in a certain order. As another example, the sequences of and/or within operations may be performed in parallel, except for at least a portion of sequences of and/or within operations necessarily occurring in an order, e.g., a certain order. Also, descriptions of features that are known after an understanding of the disclosure of this application may be omitted for increased clarity and conciseness.

[0033] Although terms such as "first," "second," and "third", or A, B, (a), (b), and the like may be used herein to describe various members, components, regions, layers, or sections, these members, components, regions, layers, or sections are not to be limited by these terms. Each of these terminologies is not used to define an essence, order, or sequence of corresponding members, components, regions, layers, or sections, for example, but used merely to distinguish the corresponding members, components, regions, layers, or sections from other members, components, regions, layers, or sections. Thus, a first member, component, region, layer, or section referred to in the examples described herein may also be referred to as a second member, component, region, layer, or section without departing from the teachings of the examples.

[0034] Throughout the specification, when a component or element is described as "on," "connected to," "coupled to," or "joined to" another component, element, or layer, it may be directly (e.g., in contact with the other component, element, or layer) "on," "connected to," "coupled to," or "joined to" the other component element, or layer, or there may reasonably be one or more other components elements, or layers intervening therebetween. When a component or element is described as "directly on", "directly connected to," "directly coupled to," or "directly joined to" another component element, or layer, there can be no other components, elements, or layers intervening therebetween. Likewise, expressions, for example, "between" and "immediately between" and "adjacent to" and "immediately adjacent to" may also be construed as described in the foregoing.

[0035] The terminology used herein is for describing various examples only and is not to be used to limit the disclosure. The articles "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. As non-limiting examples, terms "comprise" or "comprises," "include" or "includes," and "have" or "has" specify the presence of stated features, numbers, operations, members, elements, and/or combinations thereof, but do not preclude the presence or addition of one or more other features, numbers, operations, members, elements, and/or combinations thereof, or the alternate presence of an alternative stated features, numbers, operations, members, elements, and/or combinations thereof. Additionally, while one embodiment may set forth such terms "comprise" or "comprises," "include" or "includes," and "have" or "has" specify the presence of stated features, numbers, operations, members, elements, and/or combinations thereof, other embodiments may exist where one or more of the stated features, numbers, operations, members, elements, and/or combinations thereof are not present.

[0036] As used herein, the term "and/or" includes any one and any combination of any two or more of the associated listed items. The phrases "at least one of A, B, and C", "at least one of A, B, or C", and the like are intended to have disjunctive meanings, and these phrases "at least one of A, B, and C", "at least one of A, B, or C", and the like also include examples where there may be one or more of each of A, B, and/or C (e.g., any combination of one or more of each of A, B, and C), unless the corresponding description and embodiment necessitates such listings (e.g., "at least one of A, B, and C") to be interpreted to have a conjunctive meaning.

[0037] The features described herein may be embodied in different forms, and are not to be construed as being limited to the examples described herein. Rather, the examples described herein have been provided merely to illustrate some of the many possible ways of implementing the

methods, apparatuses, and/or systems described herein that will be apparent after an understanding of the disclosure of this application. The use of the term "may" herein with respect to an example or embodiment (e.g., as to what an example or embodiment may include or implement) means that at least one example or embodiment exists where such a feature is included or implemented, while all examples are not limited thereto. The use of the terms "example" or "embodiment" herein have a same meaning (e.g., the phrasing "in one example" has a same meaning as "in one embodiment", and "one or more examples" has a same meaning as "in one or more embodiments").

[0038] One or more operations may provide a camera module which has improved focusing performance, while having a reduced number of parts and a reduced price.

[0039] The following description relates to a camera module **1000**, which may be applied to, or implemented in, portable electronic devices, such as, but not limited to, smartphones, and used to capture an image or a video of an external subject.

[0040] FIG. **1** illustrates a perspective view of an example camera module, in accordance with one or more embodiments, and FIG. **2** illustrates a schematic exploded perspective view of an example camera module, in accordance with one or more embodiments.

[0041] Referring to FIGS. **1** and **2**, the example camera module **1000**, in accordance with one or more embodiments, may include a lens module **200** a focus adjustment unit that moves the lens module **200** in an optical axis direction (the Z-axis direction), a shake correction unit that moves the lens module **200** in a direction (X-and Y-axis directions), perpendicular to the optical axis (Z-axis), an image sensor module **500** that converts light incident on the lens module **200** into an electrical signal, and a housing **110** and a case **120** that accommodates the components listed above.

[0042] The housing **110** may have a rectangular box shape with an internal space. For example, the housing **110** may have a top and bottom and at least three sides that are open. The lens module **200**, the focus adjustment unit, and the shake correction unit may be accommodated in the internal space of the housing **110**, and the image sensor module **500** may be disposed below the housing **110**. In an example, a substrate **600** on which portions of the focus adjustment unit and the shake correction unit are mounted may be disposed on the sides of the housing **110**.

[0043] The case **120** may be coupled to the housing **110** with the components listed above accommodated and disposed in the housing **110**. In an example, the case **120** may cover the internal space, while surrounding the four sides of the housing **110**.

[0044] The case **120** may be coupled to the housing **110** and may have an operation of protecting components accommodated and disposed in the housing **110**.

[0045] Additionally, the case **120** may perform the operation of shielding components within the housing from electromagnetic waves. Therefore, electromagnetic waves generated by the camera module **1000** may not affect other electronic components within a portable electronic device, or conversely, electromagnetic waves generated by other electronic components within a portable electronic device may not affect the camera module **1000**.

[0046] Accordingly, the case **120** may be formed of a metal material, and may be grounded to a ground pad of a printed circuit board (hereinafter, referred to as a sensor board **520**) of the image sensor module **500** disposed below the housing **110**.

[0047] The image sensor module **500** may include an image sensor **510** and the sensor substrate **520** on which the image sensor **510** is mounted.

[0048] The image sensor **510** may convert light incident through the lens module **200** into an electrical signal. In an example, the image sensor **510** may be a charge coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS), as examples. The electrical signal converted by the image sensor **510** may be output as an image or a video through a display device of a portable electronic device.

[0049] The image sensor **510** may be electrically connected to the sensor substrate **520** through, as an example, wire bonding, etc.

[0050] Although not illustrated in the drawing, the image sensor module **500** may further include an infrared (IR) cut filter. The IR cut filter may be disposed above the image sensor **510** to block light in an infrared region, in light incident through the lens module **200**, from entering the image sensor **510**.

[0051] The lens module **200** may include a lens barrel **210** in which at least one lens L is accommodated. in an example, the lens barrel **210** may have a hollow cylindrical shape, and the at least one lens L may be mounted in the lens barrel **210** in the optical axis direction (the Z-axis direction).

[0052] The lens module **200** may be configured to move in the optical axis direction (the Z-axis direction) and in directions (the X-axis and Y-axis directions), perpendicular to the optical axis. For example, the lens module **200** may be moved in the optical axis direction (the Z-axis direction) by the focus adjustment unit during focus adjustment, and may be moved in the directions (the X-axis and Y-axis directions), perpendicular to the optical axis, by the shake correction unit **400** during shake correction.

[0053] Referring to FIG. **3**, the lens module **200**, the focus adjustment unit, and the shake correction unit **400** may be movable portions accommodated in the internal space of the housing **110** and may be moved relative to the housing **110** and the case **120**, and the housing **110** and case **120** may be fixed portions. In an example, portions of the focus adjustment unit and the shake correction unit **400** may be disposed on the housing **110**, which may be fixed portions not moved in the optical axis direction (the Z-axis direction) and/or in the directions (the X-axis and Y-axis directions), perpendicular to the optical axis.

[0054] Hereinafter, the focus adjustment unit, in accordance with one or more embodiments, is described with reference to FIGS. **3** to **6**.

[0055] FIG. **3** is a cross-sectional view taken along line I-I' of FIG. **1**, FIG. **4** is an exploded perspective view of the focus adjustment unit, in accordance with one or more embodiments, FIG. **5** is a plan view of the focus adjustment unit, in accordance with one or more embodiments, and FIG. **6** is a conceptual diagram of a focus adjustment unit, in accordance with one or more embodiments.

[0056] The focus adjustment unit may be a portion adjusting focus so that the subject is in focus. Specifically, the focus adjustment unit may adjust focus by moving the lens module **200** in the optical axis direction (the Z-axis direction).

[0057] The focus adjustment unit may include a carrier **310** that guides a movement of the lens module **200** in the

optical axis direction (the Z-axis direction) and a focus adjustment driving unit **330** that generates a driving force in the optical axis direction (the Z-axis direction).

[0058] The carrier **310** may be provided with a space into which the lens barrel **210** may be inserted. The lens barrel **210** may be arranged to penetrate through the carrier **310** in the optical axis direction (the Z-axis direction).

[0059] The carrier **310** may be moved relative to the housing **110** in the optical axis direction (the Z-axis direction), while accommodated in the housing **110**. The lens barrel **210** may be moved in the optical axis direction (the Z-axis direction) together with the carrier **310**, while accommodated in the carrier **310**.

[0060] The focus adjustment driving unit **330** may generate a driving force to move the carrier **310** in the optical axis direction (the Z-axis direction).

[0061] The focus adjustment driving unit **330** may include a focus adjustment magnet **331** and a focus adjustment coil **333** arranged to face each other. In an example, the focus adjustment magnet **331** may be disposed on one side of the carrier **310**, and the focus adjustment coil **333** may be disposed on one side of the housing **110** to face the focus adjustment magnet **331**. Accordingly, the focus adjustment magnet **331** may be a moving member that moves in the optical axis direction (the Z-axis direction) together with the carrier **310**, and the focus adjustment coil **333** may be a fixed member that is fixed to the housing **110**. However, positions of the focus adjustment magnet **331** and the focus adjustment coil **333** may be interchanged.

[0062] The focus adjustment coil **333** may be mounted on the housing **110** via a printed circuit board (hereinafter referred to as a substrate) **600**. According to one or more embodiments, the focus adjustment coil **333** may be a fine pattern coil (FP coil) that is formed by patterning a metal layer on an insulating layer of the substrate **600**. In the example of fine pattern coils, a driving force may increase as a gap between patterns decreases.

[0063] When the focus adjustment coil **333** is provided as a fine pattern coil, a separate process for electrically connecting the focus adjustment coil **333** to the substrate **600** may not be needed, so the manufacturing process may be simplified. Additionally, since the fine pattern coil may be thinner than a winding coil, a gap between the focus adjustment magnet **331** and the focus adjustment coil **333** may decrease, which may be advantageous in miniaturizing the camera module **1000**.

[0064] According to one or more embodiments, the focus adjustment magnet **331** may be disposed obliquely with respect to the focus adjustment coil **333**. Since the focus adjustment magnet **331** is disposed obliquely with respect to the focus adjustment coil **333**, a gap between one side **331***a* of the focus adjustment magnet and the focus adjustment coil **333** may be less than a gap between the other side **331***b* of the focus adjustment magnet and the focus adjustment coil **333**.

[0065] The focus adjustment magnet **331** may be disposed in a seating recess portion **311** formed on one side of the carrier **310**, and the seating recess portion **311** may be provided as an inclined surface so that the focus adjustment magnet **331** is tilted obliquely with respect to the focus adjustment coil **333**.

[0066] A back yoke **332** that focuses a magnetic force generated by the focus adjustment magnet **331** may be disposed between the focus adjustment magnet **331** and the carrier **310**. In an example, the back yoke **332** may be insert-molded into the carrier **310** to be integrally provided with the carrier **310**, and may be exposed externally through the seating recess portion **311**. The back yoke **332** may be disposed on the inclined surface of the seating recess portion **311**, and thus may be disposed parallel to the focus adjustment magnet **331**.

[0067] The focus adjustment driving unit **330** may use a closed-loop control method of detecting a position of the lens module **200** and providing feedback during focus adjustment. Accordingly, the focus adjustment driving unit **330** may include a position sensor **335** that senses the position of the lens module **200** in the optical axis direction (the Z-axis direction) through the focus adjustment magnet **331**. In a non-limited example, the position sensor **335** may be a Hall sensor.

[0068] The position sensor **335** may be disposed on the substrate **600** together with the focus adjustment coil **333**, and may face the focus adjustment magnet **331**. The position sensor **335** may be disposed not to overlap the pattern of the focus adjustment coil **333** provided on one surface of the substrate **600** facing the focus adjustment magnet **331**. In an example, the position sensor **335** may be disposed inside or outside the focus adjustment coil **333**.

[0069] In an example, the position sensor **335** may be disposed to face the other side **331***b* of the focus adjustment magnet **331***b* in which the gap between the focus adjustment magnet **331** and the focus adjustment coil **333** is relatively large. In an example, since the focus adjustment coil **333** may be provided as a fine pattern coil, the position sensor **335** may protrude further toward the focus adjustment magnet **331** from one surface of the substrate **600** than the focus adjustment coil **333**. That is, a thickness of the position sensor **335** may be greater than a thickness of the focus adjustment coil **333**. Therefore, in an example, a space in which the position sensor **335** may be disposed may be secured by disposing the focus adjustment magnet **331** obliquely with respect to the focus adjustment coil **333**.

[0070] A first yoke **337** may be disposed on the other surface of the substrate **600** (in an example, the other surface refers to a surface opposite to the surface on which the focus adjustment coil **333** is disposed). The first yoke **337** may prevent leakage of magnetic flux generated by the focus adjustment magnet **331**. Additionally, the first yoke **337** may form an attractive force with the focus adjustment magnet **331**. Details thereof are described below.

[0071] A first ball group **340** may be disposed between the carrier **310** and the housing **110** to guide movement of the carrier **310** and maintain the gap therebetween.

[0072] The first ball group **340** may include a first ball member **341** disposed to be close to one longitudinal side **331***a* of the focus adjustment magnet **331** and a second ball member **343** disposed to be close to the other longitudinal side **331***b* of the focus adjustment magnet **331**.

[0073] The first ball member **341** and the second ball member **343** may include a plurality of ball members arranged in the optical axis direction (the Z-axis direction), and may respectively include different numbers of ball members.

[0074] Referring to the accompanied drawings, in an example, the first ball member **341** may include three ball members, and the second ball member **343** may include two ball members. In another examples, the number of ball members included in the first ball member **341** and the

second ball member **343** may be changed. However, in an example, the first ball member **341** may include more ball members than the second ball member **343**.

[0075] In an example, the first ball group **340**, that is, the first ball member **341** and the second ball member **342**, may guide a movement of the carrier **310** in the optical axis direction (the Z-axis direction) when a driving force is generated in the optical axis direction (the Z-axis direction) of the carrier **310**.

[0076] The carrier **310** and the housing **110** may include guide recess portions **313**, **315**, **113**, and **115** which extend in the optical axis direction (the Z-axis direction) on surfaces thereof facing each other in a direction, perpendicular to the optical axis (the Z-axis), for example, in the first axis direction (the Y-axis direction) based on the drawing.

[0077] In an example, the carrier **310** may include a first guide recess portion **313** disposed to be adjacent to one side **331***a* of the focus adjustment magnet **331** and a second guide recess portion **315** disposed to be adjacent to the other side **331***b* of the focus adjustment magnet **331**, and the housing **110** may include a third guide recess portion **113** disposed to face the first guide recess portion **313**, and a fourth guide recess portion **115** disposed to face the second guide recess portion **315**.

[0078] The first ball member **341** may roll in the optical axis direction (the Z-axis direction), while being inserted into the first guide recess portion **313** and the third guide recess portion **113**, and the second ball member **343** may roll in the optical axis direction (the Z-axis direction), while being inserted into the second guide recess portion **315** and the fourth guide recess portion **115**.

[0079] In an example, the first guide recess portion **313** and the second guide recess portion **315** disposed on the carrier **310** may have different cross-sectional shapes. Accordingly, the number of contact points between the first ball member **341** and the first guide recess portion **313** and the number of contact points between the second ball member **343** and the second guide recess portion **315** may be different from each other.

[0080] Referring to FIG. **6**, the first ball member **341** may contact each of the two sides of the first guide recess portion **313**, while being inserted into the first guide recess portion **313**. That is, in an example, the first ball member **341** may form two contact points with the first guide recess portion **313**. In an example, the second ball member **343** may contact a bottom surface of the second guide recess portion **315**, while being inserted into the second guide recess portion **315**. That is, in an example, the second ball member **343** may form one contact point with the second guide recess portion **315**.

[0081] According to this structure, the first guide recess portion **313** disposed on one side **331***a* of the focus adjustment magnet may be a main guide that guides a movement of the carrier **310** in the optical axis direction (the Z-axis direction) by providing a movement direction to the first ball member **341**, and the second guide recess portion **315** disposed on the other side **331***b* of the focus adjustment magnet may be an auxiliary guide that stably supports movement of the carrier **310** in the optical axis direction (the Z-axis direction) by allowing the second ball member **343** to roll smoothly therein.

[0082] In an example, the third guide recess portion **113** that faces the first guide recess portion **313** in the housing **110**, and the fourth guide recess portion **113** that faces the second guide recess portion **315** in the housing **110** may have the same cross-sectional shape, and for example, the third guide recess portion **113** may have the same cross-sectional shape as the first guide recess portion **313**. Accordingly, the first ball member **341** and the second ball member **343** may each form two contact points with the respective third guide recess portion **113** and fourth guide recess portion **115**.

[0083] In relation to the above description, the plurality of ball members included in the first ball member **341** and the second ball member **343** may not all be in contact with the guide recess portions **313**, **315**, **113**, and **115**. For example, at least some of the plurality of ball members included in the first ball member **341** and the second ball member **343** may have a smaller diameter than other ball members, and the corresponding ball members may not contact the guide recess portions **313**, **315**, **113**, and **115**. Instead, the corresponding ball members may contact a ball member disposed to be adjacent in the optical axis direction (the Z-axis direction) and may roll together in the optical axis direction (the Z-axis direction).

[0084] A first yoke **337** may be disposed in the housing **110** to maintain contact between the first ball group **340** and the guide recess portions **313**, **315**, **113**, and **115**. The first yoke **337** may be formed of a magnetic material. In an example, the first yoke **337** may be disposed in the housing **110** to face the focus adjustment magnet **331** in the first axis direction (the Y-axis direction), perpendicular to the optical axis. Accordingly, an attractive force F may be generated between the first yoke **337** and the focus adjustment magnet **331** in the first axis direction (the Y-axis direction), and the carrier **310** may be pressed toward the housing **110** by the attractive force.

[0085] In an example, the focus adjustment magnet **331** may be disposed obliquely with respect to the focus adjustment coil **333**, and thus, the focus adjustment magnet **331** may also be disposed obliquely with respect to the first yoke **337**.

[0086] Referring to FIG. **6**, a gap between one side **331***a* of the focus adjustment magnet **331** and the first yoke **337** may be shorter than a gap between the other side **331***b* of the focus adjustment magnet and the first yoke **337**.

[0087] In an example, the first guide recess portion **313** corresponding to the main guide may be disposed on one side **331***a* of the focus adjustment magnet, and the second guide recess portion **315** corresponding to an auxiliary guide may be disposed on the other side **331***b* of the focus adjustment magnet. Accordingly, the magnitude of pressing force F**1** applied to the first ball member **341** disposed in the main guide may be greater than the magnitude of pressing force F**2** applied to the second ball member **343** disposed in the auxiliary guide.

[0088] According to the above structure, the first ball member **341** may be in stable contact with the first guide recess portion **313** and the third guide recess portion **113**, which are the main guides, and the second ball member **343** may smoothly roll in the second guide recess portion **315** and the fourth guide recess portion **115**, which are auxiliary guides, and thus, linearity of movement of the carrier **310** in the optical axis direction (the Z-axis direction) may be secured and tilt defects may be improved.

[0089] Next, the shake correction unit, in accordance with one or more embodiments, is described with reference to FIGS. **7** and **8**.

[0090] The shake correction unit may be a part that corrects a shaking of an image or a video due to factors, such as a user's hand shaking during imaging. Specifically, the shake correction unit may correct shake by moving the lens module **200** in directions (the X-axis and Y-axis directions), perpendicular to the optical axis, based on a relative displacement corresponding to a shake that occurs when an image or video is captured.

[0091] The shake correction unit includes first and second frames **410** and **420** that guide a movement of the lens module **200** in directions (the X-axis and Y-axis directions), perpendicular to the optical axis, and a shake correction driving unit **430** that generates a driving force in the directions (the X-axis and Y-axis directions) perpendicular to the optical axis.

[0092] The first frame **410** and the second frame **420** may be accommodated in the carrier **310**, and the first frame **410**, the second frame **420**, and the carrier **310** may be disposed in order according to the optical axis direction (the Z-axis direction). In an example, the first frame **410** may be disposed on the second frame **420**, and the second frame **420** may be disposed on the carrier **310**.

[0093] The first frame **410** and the second frame **420** may be provided with a space into which the lens barrel **210** may be inserted. The lens barrel **210** may be coupled to the first frame **410**, and may be disposed to penetrate through the first frame **410** and the second frame **420** in the optical axis direction (the Z-axis direction).

[0094] The first frame **410** and the second frame **420** may be moved relative to the carrier **310** in directions (the X-axis and Y-axis directions), perpendicular to the optical axis, while accommodated in the carrier **310**. Since the lens barrel **210** is coupled to the first frame **410**, the lens barrel **210** may be moved together with the first frame **410**. Additionally, since the first frame **410** is disposed on the second frame **420**, the first frame **410** may be moved together with the second frame **420**. In an example, the first frame **410** may be moved in the first axis direction (the Y-axis direction), perpendicular to the optical axis (the Z-axis), and the second frame **420** may be moved in the second axis direction (the X-axis direction), perpendicular to the optical axis (the Z-axis) and the first axis (the Y-axis).

[0095] The shake correction driving unit **430** may generate a driving force to move the first and second frames **410** and **420**.

[0096] The shake correction driving unit **430** may include a first shake correction driving unit **431** which generates a driving force in the first axis direction (the Y-axis direction) and a second shake correction driving unit **433** which generates a driving force in the second axis direction (the X-axis direction). The first and second shake correction driving units **431** and **433** may be arranged to be perpendicular to each other.

[0097] The first and second shake correction driving units **431** and **433** may include shake correction magnets **4311** and **4331** and shake correction coils **4313** and **4333** arranged to face each other. In an example, the respective shake correction magnets **4311** and **4331** may be disposed on two sides of the first frame **410** perpendicular to each other, and the respective shake correction coils **4313** and **4333** may be disposed on two sides of the housing **110** perpendicular to each other to face the respective shake correction magnets **4311** and **4331**. Accordingly, the shake correction magnets **4311** and **4331** may be moving members that move in the directions (the X-axis and Y-axis directions), perpendicular to the optical axis, together with the first frame **410**, and the shake correction coils **4313** and **4333** may be fixing members that are fixed to the housing **110**. However, the positions of the shake correction magnets **4311** and **4331** and the shake correction coils **4313** and **4333** may be changed.

[0098] The shake correction coils **4313** and **4333** may be mounted on the housing **110** via the substrate **600**. In an example, the shake correction coils **4313** and **4333** may be provided as winding coils, unlike the focus adjustment coil **333**. In another example, the shake correction coils **4313** and **4333** may be provided as fine pattern (FP) coils, similar to the focus adjustment coil **333**.

[0099] Although not illustrated in the drawing, a back yoke may be disposed between the shake correction magnets **4311** and **4331** and the first frame **410** to focus a magnetic force generated by the shake correction magnets **4311** and **4331**. The back yoke may be insert-molded into the first frame **410**, and may be provided integrally with the first frame **410**.

[0100] Similarly, a second **4317** and a third yoke (not shown) may be disposed on the other surface of the substrate **600** (here, the other surface means the surface opposite to the surface on which the shake correction coils **4313** and **4333** are disposed) to prevent leakage of magnetic flux generated by the shake correction magnets **4311** and **4331**.

[0101] A second ball group **440** that guides a movement of the first and second frames **410** and **420** and maintains the gap between the above components may be disposed between the first frame **410** and the second frame **420** and between the second frame **420** and the carrier **310**.

[0102] The second ball group **440** may include a third ball member **441** disposed between the first frame **410** and the second frame **420**, and a third ball member **443** disposed between the second frame **420** and the carrier **310**.

[0103] The third ball member **441** and the fourth ball member **443** may include a plurality of ball members. According to the accompanied drawings, in a non-limited example, the third ball member **441** and the fourth ball member **443** may each include three ball members, and the third ball member **441** and the fourth ball member **443** may include three or more ball members.

[0104] In an example, the third ball member **441** may guide movement of the first frame **410** in the first axis direction (the Y-axis direction) when a driving force is generated in the first axis direction (the Y-axis direction), and the fourth ball member **443** may guide a movement of the first frame **410** and the second frame **420** in the second axis direction (the X-axis direction) when a driving force is generated in the second axis direction (the X-axis direction).

[0105] The first frame **410** and the second frame **420** may include a fourth guide recess portion **411** and a fifth guide recess portion **421** each extending in the first axis direction (the Y-axis direction) on surfaces thereof facing each other in the optical axis direction (the Z-axis direction). The third ball member **441** may roll in the first axis direction (the Y-axis direction), while being inserted between the fourth guide recess portion **411** and the fifth guide recess portion **421** and movement of the third ball member **441** in the second axis direction (the X-axis direction) may be restricted.

[0106] The second frame **420** and the carrier **310** may include a sixth guide recess portion **423** and a seventh guide recess portion **317** each extending in the second axis direc-

tion (the X-axis direction) on surfaces thereof facing each other in the optical axis direction (the Z-axis direction). The fourth ball member **443** may roll in the second axis direction (the X-axis direction), while being inserted between the sixth guide recess portion **423** and the seventh guide recess portion **317**, and movement of the fourth ball member **443** in the first axis direction (the Y-axis direction) may be restricted.

[0107] A pulling yoke **450** may be disposed on the carrier **310** to maintain contact between the second ball group **440** and the guide recess portions **411**, **421**, **423**, and **317**. The pulling yoke **450** may be formed of a magnetic material. In an example, the pulling yoke **450** may be disposed on the carrier **310** to face the magnets **4311** and **4331** disposed on the first frame **410** in the optical axis direction (the Z-axis direction). Accordingly, an attractive force may be generated between the pulling yoke **450** and the magnets **4311** and **4331** in the optical axis direction (the Z-axis direction), and the first frame **410** and the second frame **420** may be pressed toward the carrier **310** by the attractive force.

[0108] The shake correction driving unit **430** may use a closed-loop control method of detecting the position of the lens module **200** and providing feedback during shake correction. Accordingly, the first and second shake correction driving units **431** and **433** may include position sensors **4315** and **4335** which sense positions of the lens module **200** in the first axis direction (the Y-axis direction) and the second axis direction (the X-axis direction) through the shake correction magnets **4311** and **4331**, respectively. In an example, the position sensors **4315** and **4335** may be Hall sensors. The position sensors **4315** and **4335** may be mounted on the substrate **600** to be disposed inside the shake correction coils **4313** and **4333** and may face the shake correction magnets **4311** and **4331**.

[0109] The camera module according to the one or more examples may improve a posture difference when moving in the optical axis direction. Additionally, as some components are omitted, manufacturing costs may be reduced and driving stability may be ensured.

[0110] While this disclosure includes specific examples, it will be apparent after an understanding of the disclosure of this application that various changes in form and details may be made in these examples without departing from the spirit and scope of the claims and their equivalents. The examples described herein are to be considered in a descriptive sense only, and not for purposes of limitation. Descriptions of features or aspects in each example are to be considered as being applicable to similar features or aspects in other examples. Suitable results may be achieved if the described techniques are performed in a different order, and/or if components in a described system, architecture, device, or circuit are combined in a different manner, and/or replaced or supplemented by other components or their equivalents.

[0111] Therefore, in addition to the above and all drawing disclosures, the scope of the disclosure is also inclusive of the claims and their equivalents, i.e., all variations within the scope of the claims and their equivalents are to be construed as being included in the disclosure.

What is claimed is:

1. A camera module, comprising:

a lens module comprising at least one lens;

a carrier, that accommodates the lens module, and is configured to move in an optical axis direction;

a housing that accommodates the carrier;

a focus adjustment driving unit comprising a focus adjustment magnet disposed on the carrier and a focus adjustment coil disposed on the housing to face the focus adjustment magnet, and configured to generate a driving force to move the carrier in the optical axis direction; and

a first ball group disposed between the carrier and the housing to guide movement of the carrier in the optical axis direction,

wherein a gap between the focus adjustment magnet and the focus adjustment coil increases or decreases in a longitudinal direction of the focus adjustment magnet.

2. The camera module of claim **1**, further comprising:

a substrate on which the focus adjustment coil is disposed,

wherein the focus adjustment coil is patterned and formed on one surface of the substrate.

3. The camera module of claim **2**, further comprising:

a position sensor disposed on one surface of the substrate,

wherein the position sensor protrudes further from one surface of the substrate toward the focus adjustment magnet than the focus adjustment coil.

4. The camera module of claim **3**, wherein:

the gap between the focus adjustment magnet and the focus adjustment coil increases from a first side of the focus adjustment magnet to a second side of the focus adjustment magnet in the longitudinal direction, and

the position sensor is disposed to face the second side of the focus adjustment magnet.

5. The camera module of claim **1**, further comprising:

a first yoke disposed to face the focus adjustment magnet with the focus adjustment coil interposed therebetween,

wherein the first yoke is provided as a magnetic material to generate an attractive force with the focus adjustment magnet.

6. The camera module of claim **5**, wherein:

the gap between the focus adjustment magnet and the focus adjustment coil increases from a first side of the focus adjustment magnet to a second side of the focus adjustment magnet in the longitudinal direction, and

the first ball group comprises:

a first ball member disposed to be close to the first side of the focus adjustment magnet in the longitudinal direction; and

a second ball member disposed to be close to the second side of the focus adjustment magnet in the longitudinal direction.

7. The camera module of claim **6**, wherein a number of contact points at which the first ball member contacts the carrier and the housing is greater than a number of contact points at which the second ball member contacts the carrier and the housing.

8. The camera module of claim **1**, wherein the carrier comprises a seating recess comprising an inclined surface that is disposed obliquely with respect to the focus adjustment coil, and in which the focus adjustment magnet is disposed.

9. The camera module of claim **1**, further comprising:

a back yoke disposed between the carrier and the focus adjustment magnet,

wherein the back yoke is arranged parallel to the focus adjustment magnet.

10. The camera module of claim **1**, further comprising a first frame and a second frame that accommodate the lens

module, and are configured to move in a direction, perpendicular to the optical axis direction.

11. A camera module, comprising:

a housing that accommodates a lens module;

a carrier, configured to move in an optical axis direction with respect to the housing;

a first ball member and a second ball member disposed between the housing and the carrier, spaced apart from each other in a first axis direction, perpendicular to the optical axis direction, and respectively including one or more balls;

a driving unit comprising a focus adjustment magnet disposed on the carrier; and

a yoke facing the focus adjustment magnet in a second axis direction, perpendicular to the optical axis direction and the first axis direction,

wherein a number of balls included in the first ball member is greater than a number of balls included in the second ball member, and

a gap between the yoke and the focus adjustment magnet decreases at a position closer to the first ball member than the second ball member.

12. The camera module of claim **11**, wherein:

the focus adjustment magnet is disposed between the first ball member and the second ball member, the yoke is disposed on the housing, and

the focus adjustment magnet is disposed obliquely with respect to the yoke.

13. The camera module of claim **11**, wherein:

a focus adjustment coil, facing the focus adjustment magnet in the second axis direction, is disposed on the housing, and

the focus adjustment magnet is disposed obliquely with respect to the focus adjustment coil.

14. The camera module of claim **13**, further comprising:

a substrate on which the focus adjustment coil is disposed,

wherein the focus adjustment coil is patterned and formed on a first surface of the substrate.

15. The camera module of claim **14**, further comprising:

a position sensor disposed on the first surface of the substrate,

wherein the position sensor protrudes further from the first surface of the substrate toward the focus adjustment magnet than the focus adjustment coil.

16. The camera module of claim **15**, wherein:

a gap between the focus adjustment magnet and the focus adjustment coil increases from a first side of the focus adjustment magnet to a second side of the focus adjustment magnet in the longitudinal direction, and

the position sensor is disposed to face the second side of the focus adjustment magnet.

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