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## Optical system


### Abstract

An optical system includes an optical module with a main axis is provided. The optical module includes a fixed portion, a movable portion, and a driving mechanism. The movable portion is connected to an optical element and is movable relative to the fixed portion. The driving mechanism drives the movable portion to move relative to the fixed portion. When viewed along a direction that is parallel with the main axis, the fixed portion is a polygonal structure with a first side, a second side, a third side, and a fourth side. The first side is parallel with the third side, the second side is parallel with the fourth side, and the first side is not parallel with the second side.



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## Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application is a Continuation application of U.S. patent application Ser. No. 17/155,964, filed on Jan. 22, 2021, which claims the benefit of U.S. Provisional Application No. 62/964,377, filed on Jan. 22, 2020, U.S. Provisional Application No. 63/017,313, filed on Apr. 29, 2020, U.S. Provisional Application No. 63/056,183, filed on Jul. 24, 2020, U.S. Provisional Application No. 63/058,932, filed on Jul. 30, 2020, and U.S. Provisional Application No. 63/121,415, filed on Dec. 4, 2020, the entirety of which are incorporated by reference herein.

BACKGROUND OF THE INVENTION
Field of the Invention
(1) The present invention relates to an optical system.
Description of the Related Art
(2) As technology has developed, optical elements and optical systems, which are used for driving optical elements, have become miniaturized. Many electronic devices (such as tablet computers and smartphones) are equipped with at least one optical element, at least one optical system, and at least one light-detection element for capturing images and recording videos. When a user uses an

electronic device, shock or vibration may occur, and this may cause the images or videos to come out blurry. However, as the demand for higher quality in images and videos is increasing, an optical system that is able to perform displacement-correction and shake-compensation has been developed.

(3) The optical system may drive the optical element to move along a direction that is parallel with the optical axis to autofocus (AF) on the scene to be shot. Additionally, the optical system may also drive the optical element to move along a direction that is perpendicular to the optical axis to perform optical image stabilization (OIS), which compensates for the deviation of the image caused by shaking or impact, and solve the problem of blurry images and videos. AF and OIS may enhance the quality of the image.

BRIEF SUMMARY OF THE INVENTION

(4) An optical system includes an optical module with a main axis is provided. The optical module includes a fixed portion, a movable portion, and a driving mechanism. The movable portion is connected to an optical element and is movable relative to the fixed portion. The driving mechanism drives the movable portion to move relative to the fixed portion. When viewed along a direction that is parallel with the main axis, the fixed portion is a polygonal structure with a first side, a second side, a third side, and a fourth side. The first side is parallel with the third side, the second side is parallel with the fourth side, and the first side is not parallel with the second side.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The present invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

(2) FIG. **1** is a perspective view of the optical system.

(3) FIG. **2** is a schematic diagram of optical elements in the optical system.

(4) FIG. **3** is a perspective view of an optical module according to an embodiment of the disclosure.

(5) FIG. **4** is an exploded view of the optical module according to an embodiment of the disclosure.

(6) FIG. **5** is a perspective view of a partial structure of the optical module according to an embodiment of the disclosure.

(7) FIG. **6** is a cross-sectional view of the optical module taken along the line A-A′ in FIG. **3**.

(8) FIG. **7** is a schematic diagram of the configuration of reference elements in an optical module according to an embodiment of the disclosure.

(9) FIG. **8** is a schematic diagram of a partial structure of an optical module according to another embodiment of the disclosure.

(10) FIG. **9** is a schematic diagram of a partial structure of an optical module according to another embodiment of the disclosure.

(11) FIG. **10** is a schematic diagram of a partial structure of an optical module according to another embodiment of the disclosure.

(12) FIG. **11** is a schematic diagram of a partial structure of an optical module according to another embodiment of the disclosure.

(13) FIG. **12** is a schematic diagram of a partial structure of an optical module according to another embodiment of the disclosure.

(14) FIG. **13** is a schematic diagram of a partial structure of an optical module according to an embodiment of the disclosure.

(15) FIG. **14** is a schematic diagram of a partial structure of an optical module according to an embodiment of the disclosure.

(16) FIG. **15** is a schematic diagram of a partial structure of an optical module according to an embodiment of the disclosure.

## DETAILED DESCRIPTION OF THE INVENTION

(17) The following description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is best determined by reference to the appended claims.

(18) According to some embodiments, an optical system **1** is provided. FIG. **1** is a perspective view of the optical system **1**. FIG. **2** is a schematic diagram of the optical elements in the optical system **1**. For simplicity, only the optical elements are shown in FIG. **2**. The optical system **1** may be a periscope optical system. The optical system **1** includes a first optical module **101**, a second optical module **102**, a third optical module **103**, a fourth optical module **104**, and a fifth optical module **105**.

(19) Light above the first optical module **101** enters the first optical module **101** along a first incident direction L**1**, and is adjusted to pass through the third optical module **103**, the second optical module **102**, and the fourth optical module **104** sequentially along a second incident direction L**2** by the first optical module **101**, and the optical path of the light is adjusted to be along a third incident direction L**3** in the fifth optical module **105**, and imaging in the fifth optical module **105**.

(20) The first optical module **101** and the fifth optical module **105** may include a first optical element **111** and a fifth optical element **115**, respectively. The first optical element **111** and the fifth optical element **115** may be a prism, a mirror, a refractive prism, or a beam splitter, etc. By rotating the first optical element **111** and the fifth optical element **115**, the optical path of the light may be changed. The second optical module **102**, the third optical module **103**, and the fourth optical module **104** may respectively include a second optical element **112**, a third optical element **113**, and a fourth optical element **114**. The second optical module **102**, the third optical module **103**, and the fourth optical module **104** may drive the second optical element **112**, the third optical element **113**, and the fourth optical element **114** respectively. The second optical element **112**, the third optical element **113**, and the fourth optical element **114** may be one or more lenses, optical lenses, etc., and are made of materials such as glass and resin. The fifth optical module **105** may also include a sixth optical element **116**. The sixth optical element **116** may be an image sensor (or called a photosensitive element), etc., for example, a charge-coupled Device (CCD).

(21) In some embodiments, an optical element corresponding to a focal length of the first optical element **111** that is not zero (not shown, for example, one or more lens, optical lens, etc.) may be provided above the first optical element **111**. In other words, the optical element whose focal length is not zero may be fixedly connected to the first optical element **111**, and arranged along the first incident direction L**1** with the first optical element **111**, and the shooting effect of the optical system **1** may be enhanced by increasing the quantity of the optical element.

(22) In some embodiments, the first optical module **101** and the fifth optical module **105** may perform yawing and pitching, respectively. In some embodiments, the first optical module **101** may also perform pitching, and the fifth optical module **105** may perform yawing. In some embodiments, the first optical module **101** and the fifth optical module **105** may both perform pitching. In some embodiments, the first optical module **101** and the fifth optical module **105** may both perform yawing. In some embodiments, the second optical module **102** and the third optical module **103** may achieve the functions of zooming and auto focusing (AF), respectively. In some embodiments, the second optical module **102** may also perform auto focusing, and the third optical module **103** may perform zooming. In other words, terms such as yawing, pitching, zooming, and auto focusing, etc., do not constitute limitations.

(23) In some embodiments, the fourth optical module **104** may achieve the function of Optical Image Stabilization (OIS). In some embodiments, the position of the fourth optical module **104** may be changed, for example, the fourth optical module **104** is disposed between the third optical module **103** and the fifth optical module **105**. In some embodiments, the fourth optical module **104** may be integrated into the second optical module **102** or the third optical module **103**, and the

functions of auto focusing and optical image stabilization may be simultaneously achieved through a single second optical module **102** or a single third optical module **103**. In some embodiments, the fourth optical module **104** may be omitted.

(24) Refer to FIG. **3** to FIG. **6**. FIG. **3** is a perspective view of an optical module **1000** according to an embodiment of the present disclosure. FIG. **4** is an exploded view of the optical module **1000** according to an embodiment of the disclosure. FIG. **5** is a perspective view a partial structure of the optical module **1000** according to an embodiment of the disclosure. FIG. **6** is a cross-sectional view of the optical module **1000** taken along the line A-A′ in FIG. **3**. In the following embodiments, the optical module **1000** has a similar structure to the fifth optical module **105** described above. The optical module **1000** has a main axis M, and includes an optical path adjustment element **1010**, an optical element **1020**, a fixed portion **1100**, a movable portion **1200**, a driving mechanism **1300**, a position sensing module **1400**, a supporting assembly **1500**, and a stopping assembly **1600**.

(25) The optical path adjustment element **1010** has a structure similar to the fifth optical element **115** mentioned above. In some embodiments, the optical path adjustment element **1010** is a right-angle prism, but is not limited to this. The optical element **1020** has a structure similar to the sixth optical element **116** mentioned above. In some embodiments, the optical element **1020** is an image sensor, but is not limited to this.

(26) When viewed along a direction that is parallel with the main axis M, the fixed portion **1100** is a polygonal structure with a first side **1101**, a second side **1102**, a third side **1103** and a fourth side **1104**. The first side **1101** is parallel with the third side **1103**, the second side **1102** is parallel with the fourth side **1104**, and the first side **1101** and the second side **1102** are not parallel.

(27) As shown in FIG. **4** and FIG. **5**, the fixed portion **1100** includes a base **1110**, an outer frame **1120**, and a frame **1130**. The base **1110** has a plate-like structure and is perpendicular to the main axis M. The outer frame **1120** and the base **1110** are arranged along the main axis M. The outer frame **1120** includes a top wall **1120**T, a first side wall **1121**, a second side wall **1122**, a third side wall **1123**, and a fourth side wall **1124**. The top wall **1110**T has a plate-like structure and is not parallel with the main axis M. In more detail, the top wall **1121**T is parallel with the base **1110**. The first side wall **1121** extends from an edge of the top wall **1120**T and is not parallel with the top wall **1120**T. When viewed along a direction that is parallel with the main axis M, the first side wall **1121** is disposed on the first side **1101**. The second side wall **1122** extends from an edge of the top wall **1120**T and is not parallel with the top wall **1120**T. When viewed along a direction that is parallel with the main axis M, the second side wall **1122** is disposed on the second side **1102**. The third side wall **1123** extends from an edge of the top wall **1120**T and is not parallel with the top wall **1120**T. When viewed along a direction that is parallel with the main axis M, the third side wall **1123** is disposed on the third side **1103**. The fourth side wall **1124** extends from an edge of the top wall **1120**T and is not parallel with the top wall **1120**T. It has an opening **11240** corresponding to the incident light L. The opening **11240** is disposed between the outer frame **1120** and the base **1110**. When viewed along a direction that is parallel with the main axis M, the fourth side wall **1124** is disposed on the fourth side **1104**.

(28) As shown in FIG. **6**, the base **1110** and the outer frame **1120** form a first accommodating space S**1**. The first accommodating space S**1** accommodates the movable portion **1200** and the frame **1130**. There is a second accommodating space S**2** between the frame **1130** and the movable portion **1200** for accommodating the optical path adjustment element **1010**. Although in this embodiment, the frame **1130** is connected and fixed to the outer frame **1120**, and the optical path adjustment element **1010** is connected and fixed to the frame **1130**, it is not limited to this. In some embodiments, the frame **1130** may be included in the movable portion **1200**, and the frame **1130** and the optical path adjustment element **1010** may move relative to the fixed portion **1100**.

(29) As shown in FIG. **4** and FIG. **6**, the movable portion **1200** is connected to the optical element **1020** and may move relative to the fixed portion **1100**. The movable portion **1200** includes a pedestal **1210** and a holder **1220**. The pedestal **1210** is connected to the optical element **1020** and

has a plate-like structure. The holder **1220** is fixedly disposed on the pedestal **1210**, and has a shielding portion **1221**, which is arranged near the fourth side **1104**. In more detail, when viewed along a direction that is parallel with the main axis M, the light enters the optical module **1000** from the fourth side **1104**, and enters the optical element **1020** through the optical path adjustment element **1010**. The optical path adjustment element **1010** is configured to adjust the light traveling in the direction that is parallel with the first side **1101** to travel in a direction that is parallel with the main axis M. The shielding portion **1221** is a protruding structure which protrudes along a direction that is parallel with the main axis M. When viewed along the direction that is parallel with the first side **1101**, the shielding portion **1221** and the optical element **1020** at least partially overlap, so a stray light may be shielded, and the stray light may not enter the optical element **1020**.

(30) The shielding portion **1221** may also be used as a stopping portion **1221**. An inner side wall located on the fourth side **1104** and close to the stopping portion **1221** may be used as a stopping surface **1124**A, so the stopping portion **1221** and the stopping surface **1124**A may form a stopping assembly **1600** configured to restrict the movable portion **1200** to move within a moving range relative to the fixed portion **1100**. In more detail, when the stopping portion **1221** touches the stopping surface **1124**A, the movable portion **1200** stops moving, so the movable portion **1200** moving along a direction that is not parallel with the main axis M may be restricted within a moving range relative to the fixed portion **1100**.

(31) The supporting assembly **1500** is connected to the movable portion **1200** and the fixed portion **1100**. The supporting assembly **1500** includes a first elastic element **1510** and a second elastic element **1520**. The first elastic element **1510** is a long strip structure extending along a direction that is parallel with the main axis M, and has a first end portion **1511** and a second end portion **1512**. The first end portion **1511** is fixed to the frame **1130**, and the second end portion **1512** is connected to the second elastic element **1520**. The second elastic element **1520** is a plate-like structure, which is not parallel with the first elastic element **1510**, and has an impact absorbing portion **1521** and a fixed end portion **1522**. The impact absorbing portion **1521** is connected to the second end portion **1512**. The impact absorbing portion **1521** absorbs the impact of the first elastic element **1510**. The fixed end portion **1522** is fixed to the holder **1220**. Therefore, the second elastic element **1520** is contacted to the holder **1220**, and does not directly contact the pedestal **1210**. When viewed along a direction that is perpendicular to the main axis M, the second elastic element **1520** is located between the pedestal **1210** and the holder **1220**. When viewed along a direction that is parallel with the main axis M, the first elastic element **1510**, the pedestal **1210** and the holder **1220** at least partially overlap.

(32) The driving mechanism **1300** drives the movable portion **1200** to move relative to the fixed portion **1100**. The driving mechanism **1300** includes a first driving assembly **1310**, a second driving assembly **1320**, and a third driving assembly **1330**. The first driving assembly **1310** is disposed on the first side **1101**, and includes a first coil **1311**, a first magnetic element **1312**, a second coil **1313**, and a second magnetic element **1314**. The first magnetic element **1312** corresponds to the first coil **1311**, and the first coil **1311** and the first magnetic element **1312** are arranged along a direction that is parallel with the main axis M. The second coil **1313** and the first coil **1311** are arranged along a first direction D**1**, and the first direction D**1** is parallel with the first side **1101**. The second magnetic element **1314** corresponds to the second coil **1313**, and the second magnetic element **1314** and the first magnetic element **1312** are arranged along the first direction D**1**. The second driving assembly **1320** is disposed on the second side **1102**, and includes a third coil **1321**, a third magnetic element **1322**, a fourth coil **1323**, and a fourth magnetic element **1324**. The third magnetic element **1322** corresponds to the third coil **1321**, and the third coil **1321** and the third magnetic element **1322** are arranged along a direction that is parallel with the main axis M. The fourth coil **1323** and the third coil **1321** are arranged along the second direction D**2**, and the second direction D**2** is parallel with the second side **1102**. The fourth magnetic element **1324** corresponds to the fourth coil **1323**. The third driving assembly **1330** is disposed on the third side **1103**, and

includes a fifth coil **1331**, a fifth magnetic element **1332**, a sixth coil **1333**, and a sixth magnetic element **1334**. The fifth magnetic element **1332** corresponds to the fifth coil **1331**, and the fifth coil **1331** and the fifth magnetic element **1332** are arranged along a direction that is parallel with the main axis M. The sixth coil **1333** and the fifth coil **1331** is arranged along a third direction D**3**, and the third direction D**3** is parallel with the third side **1103**. The sixth magnetic element **1334** corresponds to the sixth coil **1333**. A winding axis of the second coil **1313** is parallel with a winding axis of the first coil **1311**. The winding axis of the first coil **1311** is parallel with the main axis M. A winding axis of the fourth coil **1323** is parallel with a winding axis of the third coil **1321**. The winding axis of the fourth coil **1323** is parallel with the main axis M. A winding axis of the sixth coil **1333** is parallel with a winding axis of the fifth coils **1331**. The winding axis of the sixth coil **1333** is parallel with the main axis M. When viewed along a direction that is parallel with the main axis M, the driving mechanism **1300** is not disposed on the fourth side **1104**. The driving assembly is at least partially fixedly disposed on the holder **1220**.

(33) In the embodiment of FIG. **4**, the first coil **1311**, the second coil **1313**, the third coil **1321**, the fourth coil **1323**, the fifth coil **1331**, and the sixth coil **1333** are disposed on the holder **1220** of the movable portion **1200**, the first magnetic element **1312**, the second magnetic element **1314**, the third magnetic element **1322**, the fourth magnetic element **1324**, the fifth magnetic elements **1332**, and the sixth magnetic element **1334** are disposed on the frame **1130** of the fixed portion **1100**, but not limited to this. In some embodiments, the first coil **1311**, the second coil **1313**, the third coil **1321**, the fourth coil **1323**, the fifth coil **1331**, and the sixth coil **1333** are disposed on the frame **1130** of the fixed portion **1100**, and the first magnetic element **1312**, the second magnetic element **1314**, the third magnetic element **1322**, the fourth magnetic element **1324**, the fifth magnetic element **1332**, and the sixth magnetic element **1334** are disposed on the holder **1220** of the movable portion **1200**.

(34) In addition, in the embodiment of FIG. **4**, the first driving assembly **1310**, the second driving assembly **1320**, and the third driving assembly **1330** respectively include two magnetic elements, but it is not limited to this. In some embodiments, the first magnetic element **1312** and the second magnetic element **1314** have an integrally formed structure, the third magnetic element **1322** and the fourth magnetic element **1324** have an integrally formed structure, and the fifth magnetic element **1332** and the sixth magnetic element **1334** have an integrally formed structure.

(35) The position sensing module **1400** is configured to sense the movement of the movable portion **1200** relative to the fixed portion **1100**, and includes a first position sensing assembly **1410**, a second position sensing assembly **1420**, and a third position sensing assembly **1430**. The first position sensing assembly **1410** has a first reference element **1411** and a first sensing element **1412**, and the first sensing element **1412** is configured to sense a first magnetic field generated by the first reference element **1411**. When viewed along a direction that is parallel with the main axis M, the first sensing element **1412** and the first reference element **1411** are disposed on the first side **1101**. The second position sensing assembly **1420** has a second reference element **1421** and a second sensing element **1422**, and the second sensing element **1422** is configured to sense the second magnetic field generated by the second reference element **1421**. When viewed along a direction that is parallel with the main axis M, the second sensing element **1422** and the second reference element **1421** are disposed on the second side **1102**. The third position sensing assembly **1430** has a third reference element **1431** and a third sensing element **1432**. The third sensing element **1432** is configured to sense a third magnetic field generated by the third reference element **1431**. When viewed in a direction that is parallel with the main axis M, the third sensing element **1432** and the third reference element **1431** are disposed on the third side **1103**. When viewed along a direction that is parallel with the main axis M, the position sensing module **1400** is not disposed on the fourth side **1104**.

(36) In the embodiment of FIG. **4**, the first reference element **1411**, the second reference element **1421**, and the third reference element **1431** are respectively magnetic elements, which are disposed

on the frame **1130**. When viewed along a direction that is perpendicular to the main axis M, the first reference element **1411** is disposed between the first magnetic element **1312** and the second magnetic element **1314**, the second reference element **1421** is disposed between the third magnetic elements **1322** and the fourth magnetic element **1324**, the third reference element **1431** is arranged between the fifth magnetic element **1332** and the sixth magnetic element **1334**. The first sensing element **1412**, the second sensing element **1422**, and the third sensing element **1432** may be, for example, a Hall effect sensor, a magnetoresistive (MR) sensor, or a Fluxgate, etc. The first sensing element **1412**, the second sensing element **1422**, and the third sensing element **1432** are disposed on the holder **1220**. When viewed along a direction that is perpendicular to the main axis M, the first sensing element **1412** is disposed between the first coil **1311** and the second coil **1313**, the second sensing element **1422** is located between the third coil **1321** and the fourth coil **1323**, and the third sensing element **1432** is located between the fifth coil **1331** and the sixth coil **1333** to respectively sense the first magnetic field of the first reference element **1411**, the second magnetic field of the second reference element **1421**, and the third magnetic field of the third reference element **1431** to obtain the position of the holder **1220** relative to the frame **1130**.

(37) In the embodiment of FIG. **4**, three sets of position sensing assemblies are provided (a first position sensing assembly **1410**, a second position sensing assembly **1420**, and a third position sensing assembly **1430**) to sense the movement and rotation of the movable portion **1200** relative to the fixed portion **1100**, but not limited to this. In some embodiments, only two sets of position sensing assemblies that are not parallel with each other may be provided to sense the movement of the movable portion **1200** relative to the fixed portion **1100**.

(38) Please refer to FIG. **7**. FIG. **7** is a schematic diagram of the configuration of the reference elements in the optical module **1000** according to an embodiment of the present disclosure. In some embodiments, the driving mechanism **1300** may drive the movable portion **1200** to rotate relative to the fixed portion **1100** around a rotating axis A, and the rotating axis A is parallel with the main axis M. As mentioned above, the reference elements (the first reference element **1411**, the second reference element **1421**, and the third reference element **1431**) are magnetic elements, and the first reference element **1411**, the second reference element **9-1421** and the third reference element **1431** respectively have a first N-pole and a first S-pole. The first reference element **1411** has a first line C**1**, and the first line C**1** is an imaginary line between the center of the first N-pole of the first reference element **1411** and the center of the S-pole of the first reference element **1411**. The second reference element **1421** has a second line C**2**, and the second line C**2** is an imaginary line between the center of the first N-pole of the second reference element **1421** and the center of the S-pole of the second reference element **1421**. The third reference element **1431** has a third line C**3**, and the third line C**3** is an imaginary line between the center of the first N-pole of the third reference element **1431** and the center of the S-pole of the third reference elements **1431**. When viewed along a direction that is parallel with the main axis M, the rotating axis A does not overlap with the first reference element **1411**, the second reference element **1421**, and the third reference element **1431**. In some embodiments, when viewed along a direction that is parallel with the main axis M, at least one of the first line C**1**, the second line C**2**, and the third line C**3** does not pass through the rotating axis A. In other embodiments, when viewed along a direction that is parallel with the main axis M, at least two of the first line C**1**, the second line C**2**, and the third line C**3** pass through the rotating axis A.

(39) In the embodiment shown in FIG. **7**, the third line C**3** does not pass through the rotating axis A. One reference element is disposed to make the imaginary line does not pass the rotating axis A to sense the rotation of the movable portion **1200** relative to the fixed portion **1100**, and the other two reference elements are disposed to make the imaginary lines pass the rotating axis A to respectively sense the movement of the movable portion **1200** relative to the fixed portion **1100** in two different directions. But it is not limited to this. Three reference elements may be disposed to make the imaginary lines to pass through the rotating axis A, and the measured values of the three

reference elements may be calculated to obtain the rotation of the movable portion **1200** relative to the fixed portion **1100**.

(40) Therefore, it can be seen from the above that the configuration between the magnetic element, the coil, the reference element, and the sensing element may include various combinations in addition to the embodiment shown in FIG. **4**. Then please refer to FIG. **8** to FIG. **12**, and several examples are illustrated. FIG. **8** to FIG. **12** are schematic diagrams of a partial structure of an optical module **1000** according to another embodiment of the present disclosure. Although FIG. **8** to FIG. **12** only show a partial structure of the first side **1101**, the similar elements in the second side **1102** and the third side **1103** may also have the same configuration.

(41) In the example of FIG. **8**, it has a similar configuration to FIG. **4**, except that the first sensing element **1412**, the first coil **1311** and the second coil **1313** are disposed on the frame **1130**, the first reference element **1411**, the first magnetic element **1312**, and the second magnetic element **1314** are disposed on the holder **1220**.

(42) In the examples of FIG. **9** and FIG. **10**, the first reference element **1411**, the first magnetic element **1312**, and the second magnetic element **1314** have an integrally formed structure. That is, the magnetic element may also be used as a reference element at the same time.

(43) In the example of FIG. **9**, the first reference element **1411** (the first magnetic element **1312**/the second magnetic element **1314**) is disposed on the frame **1130**, and the first sensing element **1412**, the first coil **1311**, and the second coil **1313** are disposed on the holder **1220**. In the example of FIG. **10**, the first reference element **1411** (the first magnetic element **1312**/the second magnetic element **1314**) is disposes on the holder **1220**, and the first sensing element **1412**, the first coil **1311**, and a second coil **1313** are disposed on the frame **1130**.

(44) In the examples in FIG. **11** and FIG. **12**, when viewed along a direction that is perpendicular to the main axis M, the first sensing element **1412** and the first magnetic element **1312** at least partially overlap, and the first reference element **1411** and the first coil **1311** at least partially overlap. That is, the first sensing element **1412** is disposed between the first magnetic element **1312** and the second magnetic element **1314**, and the first reference element **1411** is disposed between the first coil **1311** and the second coil **1313**.

(45) In the example of FIG. **11**, the first sensing element **1412**, the first magnetic element **1312**, and the second magnetic element **1314** are disposed on the frame **1130**, and the first reference element **1411**, the first coil **1311**, and the second coil **1313** are disposed on the holder **1220**. In the example of FIG. **12**, the first sensing element **1412**, the first magnetic element **1312**, and the second magnetic element **1314** are disposed on the holder **1220**, and the first reference element **1411**, the first coil **1311**, and the second coil **1313** are disposed on the frame **1130**.

(46) The above-mentioned example with the position sensing module **1400** is driven by a closed-loop control. That is, the position sensing module **1400** is used to sense whether the movable portion **1200** reaches the expected position, and if it does not reach the expected position, a command may be made by a controller of the driving mechanism **1300** to make corrections until the movable portion **1200** reaches the expected position. However, the present disclosure is not limited to this. It may also be driven by an open-loop control without the position sensing module **1400** with the position feedback, and by establishing a database in advance, then the movable portion **1200** may be driven directly to the expected position.

(47) Next, refer to FIG. **13** to FIG. **15**, and the operation of the driving mechanism is described as the following. FIG. **13** to FIG. **15** are schematic diagrams of a partial structure of the optical module **1000** according to an embodiment of the disclosure. In some embodiments, the first driving assembly **1310** is configured to drive the movable portion **1200** to move relative to the fixed portion **1100**, and the first driving assembly **1310** is configured to drive the movable portion **1200** to rotates around the rotating axis A relative to the fixed portion **1100**. The second driving assembly **1320** is configured to drive the movable portion **1200** to move relative to the fixed portion **1100**, but the second driving assembly **1320** is not configured to drive the movable portion **1200** to rotate

relative to the fixed portion **1100**. The third driving assembly **1330** is configured to drive the movable portion **1200** to move relative to the fixed portion **1100**, and the third driving assembly **1330** is configured to drive the movable portion **1200** to rotate relative to the fixed portion **1100**.
(48) The first driving assembly **1310** is configured to generate a first driving force F**1** and a second driving force F**2**. The second driving assembly **1320** is configured to generate a third driving force F**3** and a fourth driving force F**4**. The third driving assembly **1330** is configured to generate a fifth driving force F**5** and a sixth driving force F**6**. When viewed along a direction that is parallel with the main axis M, the first driving force F**1**, the second driving force F**2**, the third driving force F**3**, the fourth driving force F**4**, the fifth driving force F**5**, and the sixth driving force F**6** do not pass through the rotating axis A. The first driving force F**1**, the second driving force F**2**, and the third driving force F**3**, the fourth driving force F**4**, the fifth driving force F**5**, and the sixth driving force F**6** are generated at different positions.
(49) As shown in FIG. **13**, the movable portion **1200** may move relative to the fixed portion **1100** by switching on different magnitude of current to the coil to generate a driving force between the coil and the magnetic element. That is, the first driving assembly **1310**, the second driving assembly **1320**, and the third driving assembly **1330** may be separately controlled to make the first driving force F**1** and the second driving force F**2** have the same magnitude and opposite directions, the fifth driving force F**5** and the sixth driving force F**6** have the same magnitude and opposite directions, the first driving force F**1** and the fifth driving force F**5** have the same magnitude, the second driving force F**2** and the sixth driving force F**6** have the same magnitude, the first driving force F**1** and the sixth driving force F**6** have the same direction, and the second driving force F**2** and the fifth driving force F**5** have the same direction, so that the movable portion **1200** is driven to rotate relative to the fixed portion **1100**.
(50) In another control mode, as shown in FIG. **14**, the magnitude of the first driving force F**1** and the magnitude of the second driving force F**2** are different, the magnitude of the fifth driving force F**5** and the magnitude of the sixth driving force F**6** are different, the magnitude of the first driving force F**1** is different from the magnitude of the fifth driving force F**5**, the magnitude of the second driving force F**2** is different from the magnitude of the sixth driving force F**6**, the magnitude difference between the first driving force F**1** and the second driving force F**2** is the same as the magnitude difference between the fifth driving force F**5** and the sixth driving force F**6**, so that the movable portion **1200** is driven to rotate relative to the fixed portion **1100** and simultaneously move in the second direction D**2**.
(51) In addition, in another control mode, as shown in FIG. **15**, the magnitude of the first driving force F**1** and the magnitude of the second driving force F**2** are different, the magnitude of the fifth driving force F**5** and the magnitude of the sixth driving force F**6** are different, the magnitude of the first driving force F**1** and the magnitude of the fifth driving force F**5** are different, the magnitude of the second driving force F**2** and the magnitude of the sixth driving force F**6** are different, and the magnitude of the third driving force F**3** and the magnitude of the fourth driving force F**4** are the same, so that the movable portion **1200** is driven to rotate relative to the fixed portion **1100** and move along the first direction D**1** at the same time. Although some examples of the movement that the driving mechanism drives the movable portion relative to the fixed portion have disclosed above, it is not limited to this, and may be changed as required.
(52) As described above, an embodiment of the present invention provides an optical system includes an optical module with a main axis. The optical module includes a fixed portion, a movable portion, and a driving mechanism. The movable portion is connected to an optical element and is moved relative to the fixed portion. The driving mechanism drives the movable portion to move relative to the fixed portion. When viewed along a direction that is parallel with the main axis, the fixed portion is a polygonal structure with a first side, a second side, a third side, and a fourth side, the first side is parallel with the third side, the second side is parallel with the fourth side, the first side is not parallel with the second side. The special position and size relationship of

each element disclosed in the present invention may enable the optical element drive mechanism to achieve a specific direction of thinning and overall miniaturization. In addition, by applying with different optical modules, the optical element driving mechanism may further improve the optical quality (such as shooting quality or depth sensing accuracy, etc.).
(53) While the invention has been described by way of example and in terms of the preferred embodiments, it should be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

## Claims

1. An optical system, comprising: an optical module with a main axis, comprising; a fixed portion; a movable portion connected to an optical element, wherein the movable portion is movable relative to the fixed portion; and a driving mechanism driving the movable portion to move relative to the fixed portion, wherein when viewed along a direction that is parallel with the main axis, the fixed portion is a polygonal structure with a first side, a second side, a third side, and a fourth side, the first side is parallel with the third side, the second side is parallel with the fourth side, and the first side is not parallel with the second side, wherein the driving mechanism comprises: a first driving assembly disposed on the first side, comprising: a first coil; a first magnetic element corresponding to the first coil, wherein the first coil and the first magnetic element are arranged along the direction that is parallel with the main axis; a second coil arranged along a first direction with the first coil, wherein the first direction is parallel with the first side; and a second magnetic element corresponding to the second coil, wherein the second magnetic element and the first magnetic element are arranged along the first direction; a second driving assembly disposed on the second side, comprising: a third coil; a third magnetic element corresponding to the third coil, wherein the third coil and the third magnetic element are arranged along the direction that is parallel with the main axis; a fourth coil arranged along a second direction with the third coil, wherein the second direction is parallel with the second side; and a fourth magnetic element corresponding to the fourth coil; and a third driving assembly disposed on the third side, comprising: a fifth coil; a fifth magnetic element corresponding to the fifth coil, wherein the fifth coil and the fifth magnetic element are arranged along the direction that is parallel with the main axis; a sixth coil arranged along a third direction with the fifth coil, wherein the third direction is parallel with the third side; and a sixth magnetic element corresponding to the sixth coil, wherein a winding axis of the first coil is parallel with a winding axis of the second coil and the main axis, wherein a winding axis of the fourth coil is parallel with a winding axis of the third coil and the main axis, and wherein a winding axis of the sixth coil is parallel with a winding axis of the fifth coil and the main axis.
2. The optical system as claimed in claim 1, wherein when viewed along the direction that is parallel with the main axis, the driving mechanism is not disposed on the fourth side.
3. The optical system as claimed in claim 1, wherein the optical module further comprises an optical path adjustment element, and light enters the optical module through the optical path adjustment element, wherein the optical path adjustment element is configured to adjust a travel direction of the light from a direction that is parallel with the first side to the direction that is parallel with the main axis, and wherein when viewed along the direction that is parallel with the main axis, the light enters the optical module from the fourth side.
4. The optical system as claimed in claim 1, wherein the first magnetic element and the second magnetic element have an integrally formed structure, the third magnetic element and the fourth magnetic element have an integrally formed structure, and the fifth magnetic element and the sixth

magnetic element have an integrally formed structure.
5. The optical system as claimed in claim 1, wherein the optical module further comprises a position sensing module configured to sense a movement of the movable portion relative to the fixed portion, wherein the position sensing module comprises: a first position sensing assembly, comprising: a first reference element; and a first sensing element configured to sense a first magnetic field generated by the first reference element, wherein when viewed along the direction that is parallel with the main axis, the first sensing element and the first reference element are disposed on the first side; a second position sensing assembly, comprising: a second reference element; and a second sensing element configured to sense a second magnetic field generated by the second reference element, wherein when viewed along the direction that is parallel with the main axis, the second sensing element and the second reference element are disposed on the second side; and a third position sensing assembly, comprising: a third reference element; and a third sensing element configured to sense a third magnetic field generated by the third reference element, wherein when viewed along the direction that is parallel with the main axis, the third sensing element and the third reference element are disposed on the third side.
6. The optical system as claimed in claim 5, wherein when viewed along the direction that is parallel with the main axis, the position sensing module is not disposed on the fourth side.
7. The optical system as claimed in claim 5, wherein the first reference element, the first magnetic element, and the second magnetic element have an integrally formed structure, the second reference element, the third magnetic element, and the fourth magnetic element have an integrally formed structure, and the first reference element, the fifth magnetic element, and the sixth magnetic element have an integrally formed structure.
8. The optical system as claimed in claim 5, wherein when viewed along a direction that is perpendicular to the main axis, the first sensing element is located between the first coil and the second coil, the second sensing element is located between the third coil and the fourth coil, and the third sensing element is located between the fifth coil and the sixth coil.
9. The optical system as claimed in claim 5, wherein when viewed along a direction that is perpendicular to the main axis, the first sensing element and the first magnetic element at least partially overlap, and the first reference element and the first coil at least partially overlap.
10. The optical system as claimed in claim 5, wherein the second sensing element and the second magnetic element at least partially overlap, the second reference element and the second coil at least partially overlap, the third sensing element and the third magnetic element at least partially overlap, and the third reference element and the third coil at least partially overlap.
11. The optical system as claimed in claim 5, wherein the driving mechanism drives the movable portion to rotate relative to the fixed portion around a rotating axis, and the rotating axis is parallel with the main axis, and wherein: the first reference element, the second reference element, and the third reference element each have a first N-pole and a first S-pole; the first reference element has a first line that is an imaginary line between a center of the first N-pole of the first reference element and a center of the first S-pole of the first reference element; the second reference element has a second line that is an imaginary line between a center of the first N-pole of the second reference element and a center of the first S-pole of the second reference element; the third reference element has a third line that is an imaginary line between a center of the first N-pole of the third reference element and a center of the first S-pole of the third reference element; when viewed along the direction that is parallel with the main axis, the first line passes through the rotating axis, at least one of the first line, the second line, and the third line does not pass through the rotating axis, and at least two of the first line, the second line, and the third line pass through the rotating axis; when viewed along the direction that is parallel with the main axis, the rotating axis does not overlap with the first reference element, the second reference element, and the third reference element.
12. The optical system as claimed in claim 5, wherein: the first driving assembly is configured to drive the movable portion to move relative to the fixed portion; the first driving assembly is

configured to drive the movable portion to rotate around a rotating axis relative to the fixed portion; the second driving assembly is configured to drive the movable portion to move relative to the fixed portion; the second driving assembly is not configured to drive the movable portion to rotate relative to the fixed portion; the third driving assembly is configured to drive the movable portion to move relative to the fixed portion; the third driving assembly is configured to drive the movable portion to rotate relative to the fixed portion; the first driving assembly is configured to generate a first driving force; when viewed along the direction that is parallel with the main axis, the first driving force does not pass through the rotating axis; the first driving assembly is configured to generate a second driving force; when viewed along the direction that is parallel with the main axis, the second driving force does not pass through the rotating axis; when viewed along a direction that is parallel with the rotating axis, the first driving force and the second driving force are generated at different positions; the second driving assembly is configured to generate a third driving force; when viewed along the direction that is parallel with the main axis, the third driving force does not pass through the rotating axis; the second driving assembly is configured to generate a fourth driving force; when viewed along the direction that is parallel with the main axis, the fourth driving force does not pass through the rotating axis; when viewed along the direction that is parallel with the rotating axis, the third driving force and the fourth driving force are generated at different positions; the third driving assembly is configured to generate a fifth driving force; when viewed along the direction that is parallel with the main axis, the fifth driving force does not pass through the rotating axis; the third driving assembly is configured to generate a sixth driving force; when viewed along the direction that is parallel with the main axis, the sixth driving force does not pass through the rotating axis; when viewed along the direction that is parallel with the rotating axis, the fifth driving force and the sixth driving force are generated at different positions.

13. The optical system as claimed in claim 12, wherein when the driving mechanism drives the movable portion to rotate relative to the fixed portion, the magnitude of the first driving force is different from the magnitude of the second driving force, the magnitude of the fifth driving force is different from the magnitude of the sixth driving force, the magnitude of the first driving force is the same as the magnitude of the fifth driving force, and the magnitude of the second driving force is the same as the magnitude of the sixth driving force.

14. The optical system as claimed in claim 12, wherein the direction of the first driving force is opposite to the direction of the second driving force, the direction of the fifth driving force is opposite to the direction of the sixth driving force, the direction of the first driving force is the same as the direction of the sixth driving force, and the direction of the second driving force is the same as the direction of the fifth driving force.

15. The optical system as claimed in claim 12, wherein when the driving mechanism drives the movable portion to rotate relative to the fixed portion and simultaneously move along the first direction, the magnitude of the first driving force is different from the magnitude of the second driving force, the magnitude of the fifth driving force is different from the magnitude of the sixth driving force, the magnitude of the first driving force is different from the magnitude of the fifth driving force, the magnitude of the second driving force is different from the magnitude of the sixth driving force, and the magnitude of the third driving force is the same as the magnitude of the fourth driving force.

16. The optical system as claimed in claim 12, wherein when the driving mechanism drives the movable portion to rotate relative to the fixed portion and simultaneously move along the second direction, the magnitude of the first driving force is different from the magnitude of the second driving force, the magnitude of the fifth driving force is different from the magnitude of the sixth driving force, the magnitude of the first driving force is different from the magnitude of the fifth driving force, the magnitude of the second driving force is different from the magnitude of the sixth driving force, and the magnitude difference between the first driving force and the second driving force is the same as the magnitude difference between the fifth driving force and the sixth driving

force.

17. The optical system as claimed in claim 1, wherein the optical module further comprises: a stopping assembly configured to restrict the movable portion moving within a moving range relative to the fixed portion, wherein the stopping assembly comprises: a stopping portion; and a stopping surface, wherein the stopping portion and the stopping surface are configured to restrict the movable portion moving along a direction that is not parallel with the main axis within the moving range relative to the fixed portion; and a shielding portion configured to shield stray light so that stray light cannot enter the optical element, wherein the shielding portion has a protruding structure that protrudes along the direction that is parallel with the main axis.

18. The optical system as claimed in claim 17, wherein the fixed portion comprises: a base; and an outer frame, wherein the base and the outer frame are arranged along the main axis, and the base and the outer frame form an accommodating space for accommodating the movable portion, and wherein the outer frame comprises a first side wall disposed on the first side, a second side wall disposed on the second side, a third side wall disposed on the third side, and a fourth side wall disposed on the fourth side, and the fourth side wall comprises an opening corresponding to light entering the optical module.

19. The optical system as claimed in claim 18, wherein the stopping assembly is at least partially disposed on the fourth side wall, wherein the stopping assembly is at least partially disposed on the movable portion, wherein the stopping assembly is adjacent to the opening of the fourth side wall, wherein the shielding portion is fixedly connected to the movable portion, wherein the shielding portion and the movable portion have an integrally formed structure, wherein the stopping portion and the shielding portion have an integrally formed structure, and wherein when viewed along the direction that is parallel with the first side, the shielding portion and the optical element at least partially overlap.