Title: AN OPTICAL MODULE INCLUDING A PLURALITY OF DETECTORS FOR AN OPTICAL SIGNAL

Abstract: An optical module is disclosed. The optical module includes: a mirror whose reflection angle is controllable in an analog method; a first optical signal detector for detecting an optical signal transmitted from the mirror, the first optical signal being disposed at a first location with respect to the mirror; at least one or more second optical signal detectors for detecting optical signals transmitted from the mirror, at least one or more second optical signal detectors being disposed at a different location from the first location, with respect to the mirror; a controller for determining whether an object detected by the first optical signal detector is an object of observation, and controlling the mirror so that at least one of the at least one or more second optical signal detectors can observe in detail the detected object when it is determined that the detected object is the object of observation; and a body for providing an optical path from the mirror to the first optical signal detector or at least one or more second optical signal detectors. Here, the body comprises the mirror, the first optical signal detector, at least one or more second optical signal detectors, and the controller, and forms an aperture for the mirror. The optical module can observe an object both in a wide field of view (FOV) and in detail, and, in particular, can effectively track a rapidly moving object. The optical module is configured to include a mirror whose reflection angle is controllable in an analog method, and a plurality of optical signal detectors located at different positions to create different focal lengths with respect to the mirror.
Description

AN OPTICAL MODULE INCLUDING A PLURALITY OF DETECTORS FOR AN OPTICAL SIGNAL

Technical Field

The present invention relates to optical modules. More particularly, this invention relates to an optical module that can observe an object both in a wide field of view (FOV) and in detail, and, in particular, can effectively track a rapidly moving object. The optical module is configured to include a mirror whose reflection angle is controllable in an analog method, and a plurality of optical signal detectors located at different positions to create different focal lengths with respect to the mirror.

Background Art

In recent years, a mega lightning, or ultimate discharge phenomenon, appearing above the stratosphere of 10 km from the ground, i.e., at high-altitude atmosphere, has becomes an important object of study. Such a phenomenon is technically known as transient luminous events (TLE). Since discharge phenomena, such as TLE, include a great deal of information about the earth and space, it is important to observe the ultimate large discharge phenomena of high-altitude atmosphere. That is, the global electrical phenomena at the atmosphere can be understood; these phenomena can be applied to weather and an ozone state and associated with the establishment of the global electromagnetic model and the activity of the sun. Since TLE emerges at random up to ten of thousands of times per day, it is not easy to determine and observe them in detail. It is most effective to observe TEL from space. To this end, an optical system is required which can monitor a wide field of view (FOV), detect an emerged event, and immediately zoom in on the event. Such an optical system may have a function to track a corresponding event, depending on the situation.

The optical system can be used to observe a variety of phenomena that occur on the earth, such as aurora, a meteorite falling, the remains of a satellite falling, a forest fire, a large explosion, etc. Also, the optical system can be utilized as a security monitoring system as well as a monitoring system mounted on satellites, which observes objects on the ground.

Recently, micro-electro-mechanical systems (MEMS) have come under the spotlight. MEMS are a computer combined with a small mechanism, such as a sensor valve, a gear, a reflector and a semiconductor chip manipulator, etc. MEMS, also referred to as a smart meter, are a device with a microcircuit in a small silicon chip, installed into mechanical apparatuses such as a reflector or a sensor. For example, MEMS are utilized a variety of applications, such as a device inflating an air bag to match a
passenger's weight with a car's speed detected by the air bag, a global positioning system (GPS) sensor that reads a continuous track and a treatment process for freight transportation, an interactive sensor for sensing changes in the air flow on the surface of airplane wings according to the air resistance and performing a corresponding operation according to the sensing result, an optical switch for outputting an optical signal at 20 nanometers per second, a sensor-manipulated heating/cooling device, and a sensor installed in a building for changing the flexibility of matter that reacts to atmospheric pressure.

In particular, it is necessary to combine a micro-mirror or a micro-mirror array, manufactured according to optical MEMS technology, with the optical system described above, which has the following functions: a wide FOV monitoring, a high-speed zoom, and a high speed tracking.

Disclosure of Invention

Technical Problem

The present invention solves the above problems, and provides an optical module that can observe an object both in a wide field of view (FOV) and in detail, and, in particular, can effectively track a rapidly moving object, in which the optical module is configured to include a mirror whose reflection angle is controllable in an analog method, and a plurality of optical signal detectors located at different positions to create different focal lengths with respect to the mirror.

Technical Solution

In accordance with an exemplary embodiment of the present invention, the present invention provides an optical module including: a mirror whose reflection angle is controllable in an analog method; a first optical signal detector for detecting an optical signal transmitted from the mirror, the first optical signal being disposed at a first location with respect to the mirror; at least one or more second optical signal detectors for detecting optical signals transmitted from the mirror, at least one or more second optical signal detectors being disposed at a different location from the first location, with respect to the mirror; a controller for determining whether an object detected by the first optical signal detector is an object of observation, and controlling the mirror so that at least one of the at least one or more second optical signal detectors can observe in detail the detected object when it is determined that the detected object is the object of observation; and a body for providing an optical path from the mirror to the first optical signal detector or at least one or more second optical signal detectors. Here, the body comprises the mirror, the first optical signal detector, at least one or more second optical signal detectors, and the controller, and forms an aperture for the mirror.

Preferably, the first location allows the detected object to be observed in a wide field
of view, and the location where the second optical signal detectors are disposed allows the detected object to be observed in detail.

[9] Preferably, the mirror comprises an analog type of micro-mirror or an micro-mirror array, fabricated by micro-electro-mechanical systems (MEMS), wherein the mirror is tilted at a high speed and has a relatively large tilt angle.

[10] Preferably, the mirror is configured in such a way that the entire micro-mirror array forms a Fresnel mirror of a spherical surface or a parabolic surface to efficiently collect light; and the controller controls the respective micro-mirrors of the micro-mirror array so that the shape of the entire micro-mirror array can be controlled.

[11] In accordance with another exemplary embodiment of the present invention, the optical module further includes at least one or more second optical signal detectors further comprises at least one or more pairs of even-numbered reflection mirrors; the body comprises at least one or more pairs of even-numbered reflection mirrors, the body providing an optical path from the mirror to the first optical signal detector via at least one or more pairs of even-numbered reflection mirrors; and the controller allows for a direct optical path from the mirror to the first optical signal detector and controls the mirror to provide the optical path from the first optical signal detector via at least one or more pairs of even-numbered reflection mirrors.

Advantageous Effects

[12] As described above, the optical module, according to the present invention, can observe an object both in a wide field of view (FOV) and in detail, and, in particular, can effectively track a rapidly moving object, in which the optical module is configured to include a mirror whose reflection angle is controllable in an analog method, and a plurality of optical signal detectors located at different positions to create different focal lengths with respect to the mirror.

Brief Description of the Drawings

[13] The features and advantages of the present invention will be more apparent from the following detailed description in conjunction with the accompanying drawings, in which:

[14] Figure 1 is a view illustrating an optical module according to an embodiment of the present invention; and

[15] Figure 2 is a view illustrating an optical module according to another embodiment of the present invention, in which the optical module forms images at a plurality of focal lengths using only one optical signal detector and a normal reflection mirror.

[16] <Brief Description of Symbols in the Drawings>

[17] 100: optical module (an embodiment of the present invention)
Best Mode for Carrying Out the Invention

Now, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

Figure 1 is a view illustrating an optical module according to an embodiment of the present invention. As shown in Figure 1, the optical module 100 is configured in such a way that: a mirror 110 controls its reflection angle in an analog method; a first optical signal detector 120 is disposed at a location relatively close to the mirror 110 and detects an optical signal transmitted from the mirror 110 to observe an object at a wide field of view (FOV); at least one or more second optical signal detectors 130 and 140 are located at a location relatively far from the mirror 110 and they detect optical signals transmitted from the mirror 110 to observe an object in detail; and a body 150 includes the mirror 110, the first optical signal detector 120, at least one or more second optical signal detectors 130 and 140, and an aperture 115 for the mirror 110, and provides an optical path from the mirror 110 to the first optical signal detector 110 or at least one or more second optical signal detectors 130 and 140. Also, although not shown in Figure 1, the optical module 100 further includes a controller that determines whether an object detected by the first optical signal detector 120 is an object of observation, and controls the mirror 110 so that at least one of at least one or more second optical signal detectors 130 and 140 can observe in detail the detected object after it is determined that the detected object is an object of observation.

The mirror 110 transmits a signal corresponding to an object of observation to the first optical signal detector 120 or at least one or more second optical signal detectors 130 and 140 at a reflection angle controlled by the controller. The mirror 110 changes its reflection angle in an analog method to provide the optical path for an image of the object to the first optical signal detector 120 or at least one or more second optical
The mirror 110 can also change its reflection angle in an analog method to effectively track and observe a rapidly moving object. In particular, the mirror 110 can be rapidly tilted. It is preferable that the mirror 110 is implemented by a micro-mirror or a micro-mirror array, both of which have relatively large tilt angles.

The mirror 110 is implemented by a small plane mirror whose operating principle is the same that as of pin-hole camera. Also, when the mirror 110 is implemented by a micro-mirror array, the micro-mirror array is configured in such a way that its entire shape is formed as a spherical surface or a parabolic surface of the Fresnel to increase the collection of light. When the light is efficiently collected by the micro-mirror array, the respective micro-mirrors must be controlled to adjust their focal lengths so that the respective optical signal detectors 120, 130 and 140 can form images thereon.

The first optical signal detector 120 serves to detect an optical signal from light transmitted from the mirror 110. As shown in Figure 1, since the first optical signal detector 120 is located close to the mirror 110, it has a relatively short focal length 125. That is, the first optical signal detector 120 is suitable for observing an object at a wide field of view (FOV). Referring to Figure 1, an area observed by the first optical signal detector 120 is indicated by reference number 122.

At least one or more second optical signal detectors 130 and 140 detect an optical signals transmitted from the mirror 110. As shown in Figure 1, the second optical signal detectors 130 and 140 are disposed at a position relatively far from the mirror 110, so they have long focal lengths 135 and 140. That is, the second optical signal detectors 130 and 140 are used to observe an object in detail. Referring to Figure 1, areas observed by the second optical signal detectors 130 and 140 are indicated by reference numbers 132 and 142.

It should be understood that the range of optical signals, detected by the first optical signal detector 120 and at least one or more second optical signal detectors 130 and 140, is not limited.

The body 150 includes the mirror 110, the first optical signal detector 120, and at least one or more second optical signal detectors 130 and 140. The body 150 provides an optical path from the mirror 110 to the first optical signal detector 120 or at least one or more second optical signal detectors 130 and 140. The body 150 further forms an aperture 115 at its lower side under the mirror 110. The aperture 115 may include an aperture collimator (not shown).

The controller determines whether an object detected by the first optical signal detector 120 is an object of observation, and controls the mirror 110 so that at least one of the at least one or more second optical signal detectors 130 and 140 can observe in detail the detected object when it is determined that the detected object is an object of
observation. The controller may be configured to control the entire system as well as the optical module. The controller for controlling an optical module is implemented in such a way to operate separately from a system controller for controlling the entire system.

Although not shown in Figure 1, the optical module 100 according to the present invention is connected to a data storage unit, an interface unit, and a power supply. The data storage unit serves to store detected optical signals. The storage unit is implemented by a flash memory or a hard disc. The interface unit serves as an interface between elements in the system. The interface unit is implemented by a bus interface unit. The power supply provides power to the elements in the system.

The present invention may be implemented in such a way as to form images at a plurality of focal lengths using only one optical signal detector and a normal reflection mirror, instead of using a plurality of optical signal detectors in the embodiment shown in Figure 1. Such an embodiment is shown in Figure 2, illustrating an optical module according to another embodiment of the present invention, in which the optical module forms images at a plurality of focal lengths using only one optical signal detector and a normal reflection mirror. As shown in Figure 2, the optical module 200 is the same as the optical module 100 of Figure 1 except that at least one or more second optical signal detectors of Figure 1 are replaced by at least one or more pairs of even-numbered reflection mirrors 260a and 260b, and thus the elements that are the same as those of the optical module 100 will not be described below. More specifically, at least one or more pairs of even-numbered reflection mirrors 260a and 260b are included in the body 250. On the contrary, the body 150 of Figure 1 includes at least one or more second optical signal detectors. The body 250 of Figure 2 provides an optical path from the mirror 210 to the first optical signal detector 220 via at least one or more pairs of even-numbered reflection mirrors 260a and 260b. On the contrary, the body 150 of the optical module 100 of Figure 1 provides an optical path from the mirror 110 to the first optical signal detector or at least one or more second optical signal detectors. The controller of the optical mirror 200 of Figure 2 can control the mirror 210 so that an optical path can be directly provided from the mirror 210 to the first optical signal detector 220, and from the mirror 210 to the first optical signal detector 220 via at least one or more pairs of even-numbered reflection mirrors 260a and 260b. On the contrary, the controller of the optical module 100 of Figure 1 controls the mirror 110 so that at least one of the at least one or more second optical signal detectors 130 and 140 can observe a detected object in detail. In another embodiment of the present invention, since an image is formed at a plurality of focal lengths by using only one optical signal detector, the body 150 can be reduced in size and thus the optical module 200 can be entirely reduced in size at a relatively large rate. When taking the size of
the elements into consideration, the body 150 of the optical module 100 shown in Figure 1 may be larger than the body 250 of the optical module 200 shown in Figure 2.

[41] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.
Claims

[1] An optical module comprising:
a mirror whose reflection angle is controllable in an analog method;
a first optical signal detector for detecting an optical signal transmitted from the
mirror, the first optical signal being disposed at a first location with respect to the
mirror;
at least one or more second optical signal detectors for detecting optical signals
transmitted from the mirror, at least one or more second optical signal detectors
being disposed at a different location from the first location, with respect to the
mirror;
a controller for determining whether an object detected by the first optical signal
detector is an object of observation, and controlling the mirror so that at least one
of the at least one or more second optical signal detectors can observe in detail
the detected object when it is determined that the detected object is the object of
observation; and
a body for providing an optical path from the mirror to the first optical signal
detector or at least one or more second optical signal detectors,
wherein the body comprises the mirror, the first optical signal detector, at least
one or more second optical signal detectors, and the controller, and forms an
aperture for the mirror.

[2] The optical module according to claim 1, wherein:
the first location allows the detected object to be observed in a wide field of
view; and
the location where the second optical signal detectors are disposed allows the
detected object to be observed in detail.

[3] The optical module according to claim 1 or 2, wherein the mirror comprises an
analog type of micro-mirror or an micro-mirror array, fabricated by micro-
electro-mechanical systems (MEMS), wherein the mirror is tilted at a high speed
and has a relatively large tilt angle.

[4] The optical module according to claim 3, wherein:
the mirror is configured in such a way that the entire micro-mirror array forms a
Fresnel mirror of a spherical surface or a parabolic surface to efficiently collect
light; and
the controller controls the respective micro-mirrors of the micro-mirror array so
that the shape of the entire micro-mirror array can be controlled.

[5] The optical module according to claim 1, wherein:
at least one or more second optical signal detectors further comprises at least one
or more pairs of even-numbered reflection mirrors;
the body comprises at least one or more pairs of even-numbered reflection mirrors, the body providing an optical path from the mirror to the first optical signal detector via at least one or more pairs of even-numbered reflection mirrors; and
the controller allows for a direct optical path from the mirror to the first optical signal detector and controls the mirror to provide the optical path from the first optical signal detector via at least one or more pairs of even-numbered reflection mirrors.
A. CLASSIFICATION OF SUBJECT MATTER

G02B 23/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 G02B 6/00, G02B 17/06, G02B 26/08, G02B 27/00, H04N 5/225, G02F 1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models since 1975
Japanese utility models and applications for utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) "optical module", "mirror", "detector", "controller"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C

See patent family annex

* Special categories of cited documents
A document defining the general state of the art which is not considered to be of particular relevance
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