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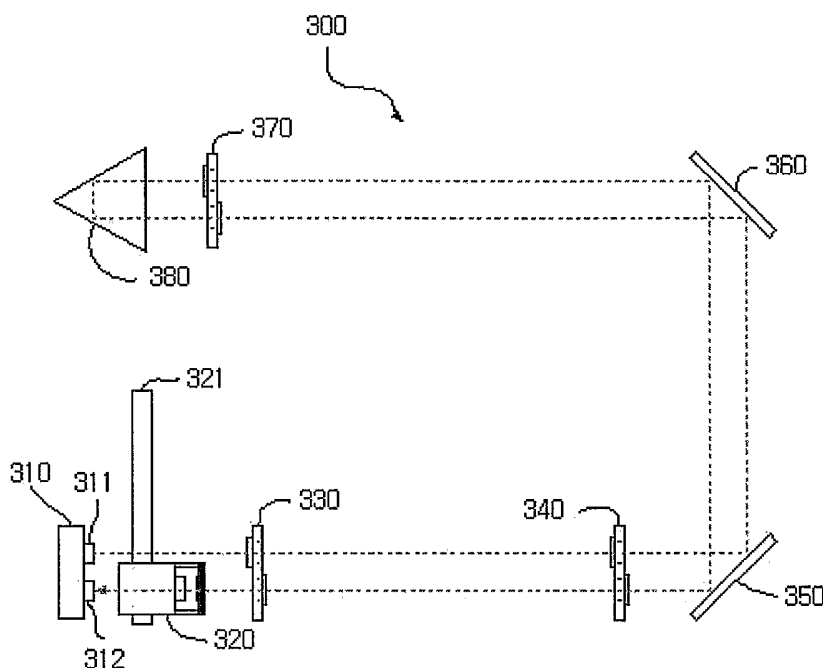
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(54) Title: PACKAGING METHOD FOR FABRICATION OF THE OPTICAL TRANSMITTER AND RECEIVER IN THE OPTICAL WIRELESS COMMUNICATION SYSTEM



(57) Abstract: Packaging method and device for fabrication of an optical transmitter and receiver in the optical wireless communication system, that there is no necessary for moving or arrangement of a laser diode, photo diode or/and lens of transmitter and receiver, are provided. So that the optical wireless transmitter, receiver and transceiver, which are standardized to have simple structure and uniform divergence angle due to fixing the laser diode, photo diode or/and lens, are provided. The method for fabrication of an optical transmitter and receiver in the present invention includes a step for moving the laser diode and photo diode against the lens in order to have a desirable divergence angle for the transmitter and maximum sensitivity for the receiver; and a step for fixing the lens, laser diode and photo diode.



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

**PACKAGING METHOD FOR FABRICATON OF THE OPTICAL TRANSMITTER
AND RECEIVER IN THE OPTICAL WIRELESS COMMUNICATION SYSTEM**

[Technical Field]

5 The present invention relates to a packaging device and method for fabricating a transmitter and a receiver in an optical wireless communication system. More particularly, the invention relates to a packaging method for fabricating a transmitter, a receiver and a transceiver in an optical
10 wireless communication system, which moves a photo diode and a laser diode against a lens and permanently fixes the photo diode and laser diode such that there is eliminated a need for a device of moving or arranging the lens, photo diode and laser diode in order to allow the transmitter to have a
15 desirable divergence angle and to allow the receiver to have maximum sensitivity.

[Background Art]

20 While a general optical wired communication system transmits optical signals using optical fibers, an optical wireless communication system transmits optical signals through free space without using optical fibers. Accordingly, the optical wireless communication system is economical because there is no need to lay the optical fibers under the
25 ground. Furthermore, in the case of the optical wireless communication system, an ultra-high speed optical data link can be installed easily and rapidly and cost of maintenance is inexpensive.

30 In the optical wireless communication system using no optical fiber, however, a laser beam output from one of two transceivers constructing a link must be directly input to

the other transceiver without having any help or guide of a medium. Accordingly, the direction of the transceivers, a divergence angle of light output from a transceiver and sensitivity of a receiver become very important factors in
5 the optical wireless communication system.

A transmitter and a receiver of a conventional optical wireless communication system employ a method of mechanically driving a laser diode and a photo diode or a transmitter lens and a receiver lens such that optical axes of the transmitter
10 and receiver are aligned and a divergence angle of light and sensitivity of the receiver are controlled. The transmitter and receiver of the conventional optical wireless communication system use the mechanical driving method because of the following reasons.

15 Firstly, light output from the transmitter of the optical wireless communication system should diverge to some degree. The degree of divergence should be appropriately decided in consideration of a variation in the arrangement of the transmitter with time and a loss of laser beam in the air.
20 In general, the divergence angle used in the optical wireless communication system is very small (at most 2mrad) and the degree of divergence is sensitively varied with a distance between the transmitter lens and the laser diode. Accordingly, to decide an appropriate divergence angle of the optical
25 wireless communication system, it is required that the divergence angle be approximately controlled in a close range and then accurately controlled when the system is actually installed. This needs a device for accurately moving the transmitter lens or laser diode.

30 Secondly, the optical wireless communication system should have high receiving sensitivity in order to obtain

high power budget. To this end, lights condensed by the receiver lens must be input to the active region of the photo diode as much as possible. Since the diameter of the active region is less than several tens of micrometers, it is preferable that the photo diode is correctly located on the focus of the receiver lens. Accordingly, it is the most ideal to arrange the correct position of the photo diode when the system is installed in order to obtain maximum receiving sensitivity.

10 Thirdly, when a long-distance link of several kilometers is constructed using the transmitter and receiver of the optical wireless communication system, the receiver generally uses a lens or a concave mirror with a large diameter in order to receive as much laser beams as possible. 15 However, the lens or mirror with a large diameter has a long focal distance so that even a minute variation in the angle of the receiver considerably affects receiving sensitivity. Thus, when a long-distance link is constructed using an optical wireless communication transceiver having a 20 transmitter and a receiver, which are combined with each other to operate cooperatively, the optical axes of the transmitter and receiver must be level with each other. However, it is difficult to level the optical axes of the transmitter and receiver with each other in advance in the 25 construction of a long-distance link of several kilometers.

Fourthly, in the case of long-distance link, there occurs a phenomenon, i.e., beam bending, wondering and scintillation in which the path of a laser beam output from the transmitter is varied with time due to environmental 30 factors. To correct the varied path, a variation in the path of the laser beam should be detected to actively track the

transmitter. In this case, the position of the laser diode is changed or the transmitter itself is tilted. Thus, an automatic aligning device for the laser diode or transmitter is required. Particularly, when an optical wireless communication module having a transmitter and a receiver, which are not respectively arranged but combined with each other, is used, the receiving sensitivity of the receiver is affected while the transmitter is actively tracked if the receiver and the transmitter are moved together. This may cause a problem in power budge and, under certain circumstances, brings about a problem in active tracking.

Accordingly, in terms of stability and effectiveness of the link, the lens, laser diode and photo diode of the transmitter and receiver have been mechanically driven to obtain desirable divergence angle and receiving sensitivity and align the optical axes of the transmitter and receiver.

However, in the system in which the laser diode and photo diode or lenses of the transmitter and receiver are mechanically operated, a locking and arrangement device may become loose with time. This may cause a problem in stability of the system. Furthermore, the cost of the system is increased because the mechanical operation is complicated. Moreover, standardization is difficult so that difficulties are anticipated in the case of mass production of the system. In addition, the cost of the optical wireless communication system is increased because the structures of the transmitter and receiver become complicated and a driver cannot be removed while a link is constructed for active tracking of the transceiver.

As described above, the conventional optical wireless communication transceiver increases the cost of the optical

wireless communication system because the transmitter and receiver are respectively arranged and thus the structure and arrangement algorithm of the transceiver are complicated.

5 [Disclosure of Invention]

Accordingly, an object of the present invention is to provide a packaging method for fabricating a transmitter and a receiver of a short-distance optical wireless communication system in which a laser diode, a photo diode, a transmitter
10 lens and a receiver lens are not mechanically moved or arranged but permanently fixed.

To accomplish the object, the present invention provides a device for measuring the divergence angle of the transmitter and a packaging device and method for controlling
15 the divergence angle of the transmitter and sensitivity of the receiver on a single test bed using the measuring device and then permanently fixing the divergence angle and sensitivity.

The divergence angle is controlled by moving the laser
20 diode to an appropriate position while the transmitter lens is fixed. In this case, the distance between the transmitter lens and the laser diode is the most important. The sensitivity of the receiver can be controlled by moving the photo diode to an appropriate position while the receiver
25 lens is fixed. Here, the distance between the receiver lens and the photo diode, and the location of the photo diode on the optical axis of the receiver lens are also important. Accordingly, the present invention fabricates a transmitter block and a receiver block having appropriate accuracy, and
30 then respectively attaches the transmitter lens and the receiver lens to the transmitter block and the receiver block.

Subsequently, the present invention finely arranges the laser diode and the photo diode and bonds the laser diode and the photo diode using various packaging methods used for fabricating optical devices, such as UV epoxy and laser
5 welding.

The device for measuring the divergence angle according to the present invention includes a charge coupled device (CCD) camera for observing the shape of light, a transparent graduation ruler for confirming the size of laser beam, and
10 means for moving the CCD camera and the transparent graduation ruler perpendicularly to an optical axis. Preferably, the CCD camera can be connected to a monitor to observe the intensity and shape of laser beam.

The transparent graduation ruler is attached to the
15 front portion of the CCD camera such that the transparent graduation ruler serves as the basis for measuring the size of laser beam. The moving means includes a rail. The rail locates the CCD camera at a specific point on the optical axis all the time and, when the optical axes of the
20 transmitter and receiver are arranged to be level with each other, moves the CCD camera such that the CCD camera does not become an obstacle. The rail is located keeping a predetermined distance from the optical axis of the transmitter such that the divergence angle can be calculated
25 from the size of laser beam measured at the position of the rail.

In case of infrared band laser beam, a CCD camera for visible rays and an infrared sensing card to which the transparent graduation ruler is attached can replace an
30 expensive CCD camera for infrared rays.

The packaging method for fabricating a transmitter and

a receiver of an optical wireless communication system includes a first step of appropriately arranging large-aperture folding mirrors such that the distance between a collimating lens of the transmitter and a condensing lens of the receiver becomes the maximum; a second step of mounting a transmitter block to which a transmitter lens is attached and a receiver block to which a receiver lens is attached, on a fixed table, and operating a laser diode and a photo diode, respectively located in front of the transmitter block and receiver block, using a 6-axis high-precision aligner; a third step of measuring the divergence angle and shape of a laser beam emitted from the operated laser diode using a divergence angle measuring device to appropriately control the position of the laser diode, and monitoring the signal intensity of the photo diode to appropriately control the position of the photo diode such that sensitivity of the receiver becomes the maximum; and a fourth step of fixing the laser diode and the photo diode arranged through the position control step.

20 In a short-distance link of less than 200 through 300m, a laser beam path is barely affected by environmental factors such as turbulence, as opposed to a long-distance link. Thus, an inexpensive transmitter and receiver can be fabricated using the above-described packaging method.

25 Another object of the present invention is to provide a packaging device and method for fabricating an optical wireless communication transceiver in which a transmitter and a receiver are combined with each other such that the transmitter and the receiver do not need to be arranged respectively.

30

To accomplish the object, the present invention also

provides a device for measuring horizontality of the optical axes of transmitting and receiving parts and a device for measuring the divergence angle of laser beam. In addition, the present invention provides a packaging method for making
5 the optical axes of the transmitting and receiving parts be level with each other and controlling the divergence angle of laser beam using the devices.

The device for measuring horizontality of the optical axes of the transmitting and receiving parts includes a stand
10 having two holes distant from each other by a predetermined distance, and a circular plate to which a laser sensing card having a hole with a predetermined size at the center is attached.

The two holes of the stand function as female screws
15 and the circular plate functions as a male screw such that the circular plate can be fit into each hole or removed from the hole if necessary. The distance between the two holes of the stand is equal to that between the optical axes of the transmitter and receiver. The size of the hole of the
20 circular plate is decided based on the divergence angle of the laser beam output from the transmitter. At least two stands in which the circular plate is fitted are needed. It is judged whether the optical axes of the transmitter and receiver are level with each other from the shape of light at
25 the outside of the hole of the circular plate.

When the wavelength band of a used laser is the infrared band, an infrared sensing card is used as the laser sensing card. When the wavelength band of a used laser is the visible ray band, the circular plate is painted white without
30 using the laser sensing card.

The device for measuring the divergence angle of a

laser beam is identical to the aforementioned divergence angle measuring device.

A packaging method for fabricating an optical wireless communication transceiver includes a first step of
5 appropriately arranging a predetermined number of large-aperture folding mirrors such that the distance between a collimating lens of the transmitter and a condensing lens of the receiver becomes the maximum; a second step of setting at
10 least two optical axis horizontality measuring devices on an optical path on which the folding mirrors are arranged to prepare the measurement of alignment of the optical axes of the transmitter and receiver; a third step of mounting a transceiver block to which a transmitter lens and a receiver lens are attached, on a fixed table, operating a laser diode
15 and a photo diode located in front of the transceiver block using a 6-axis high-precision aligner, and aligning the optical axes of the transceiver using the optical axis horizontality measuring devices; a fourth step of measuring the divergence angle and shape of a laser beam emitted from
20 the operated laser diode using a divergence angle measuring device to appropriately control the position of the laser diode, and monitoring the signal intensity of the photo diode to appropriately control the position of the photo diode such that sensitivity of the receiver becomes the maximum; and a
25 fifth step of fixing the laser diode and the photo diode arranged through the position control step.

When the number of folding mirrors used in the first step is increased, the distance between the transmitter lens and the receiver lens is also increased and thus accuracy of
30 the divergence angle and horizontality is increased. However, too many folding mirrors increase aberration of laser beam

and noises. Thus, an appropriate number of folding mirrors are required.

The packaging method may further include the step of controlling the quantity of irradiated ultraviolet rays while
5 observing a variation in the arrangement state of the laser diode and photo diode using the divergence angle measuring device to prevent the arrangement state of the laser diode and photo diode from being changed due to shrinking of the epoxy when the laser diode and the photo diode are fixed
10 using the UV epoxy in the fifth step.

The packaging method arranges the laser diode of the transmitter or the photo diode of the receiver at a predetermined position and packages the transmitter and receiver such that the position of the arranged laser diode
15 or photo diode is permanently fixed.

In the packaging method, the arrangement of the laser diode of the transmitter and the photo diode of the receiver includes optical axis alignment.

In the packaging method, the divergence angle of the
20 transmitter is measured using the divergence angle measuring device and the laser diode is arranged such that the laser diode has an appropriate divergence angle.

A transmitter driving plate and a receiver driving plate are respectively connected to legs of the laser diode
25 and photo diode of the half-finished optical wireless communication transceiver (or optical wireless communication transceiver head) fabricated through the above-described packaging method and packaged to accomplish the finished optical wireless communication transceiver.

30

[Brief Description of the Drawings]

Further objects and advantages of the invention can be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

5 FIG. 1 illustrates a device of measuring horizontality of the optical axes of a transmitter and a receiver according to an embodiment of the present invention;

10 FIG. 2 illustrates a device of measuring the divergence angle of laser beam output from a transmitter according to an embodiment of the present invention;

 FIG. 3a illustrates the construction for a packaging process for fabricating an optical wireless communication transceiver according to an embodiment of the present invention;

15 FIG. 3b is a flow chart of the packaging process for fabricating the optical wireless communication transceiver according to an embodiment of the present invention;

20 FIG. 4 illustrates a general head in an optical wireless communication transceiver according to an embodiment of the present invention;

 FIG. 5a illustrates a bi-directional head in an optical wireless communication transceiver according to an embodiment of the present invention; and

25 FIG. 5b illustrates the construction for a packaging process for fabricating the bi-directional head according to an embodiment of the present invention.

[Best Mode for Carrying Out the Invention]

30 The present invention will now be described in detail in connection with preferred embodiments with reference to the accompanying drawings.

In a preferred embodiment of the present invention, a laser beam with an infrared band wavelength, especially, 1300nm or 1550nm, is used. The reason for this is that laser diodes of the wavelength band of 1300nm or 1550nm are
5 commercially available and inexpensive. Furthermore, light of this wavelength band much less affects the eye than visible rays.

The present invention proposes a packaging method that does not mechanically move or arrange any of a laser diode, a
10 photo diode, a transmitter lens and a receiver lens in an optical wireless communication system but permanently fixes the laser diode, photo diode, transmitter lens and receiver lens. Accordingly, the present invention can simplify the structure of a transceiver of the optical wireless
15 communication system and fabricate standardized products having a uniform divergence angle to facilitate mass production.

In case of an optical wireless communication transceiver in which a transmitter and a receiver are
20 combined with each other, the optical axes of the transmitter and receiver are leveled in advance such that the receiver is automatically arranged when the transmitter is arranged. Thus, an aligner is less used and the structure of the aligner is simplified.

25 Packaging of the transmitter and the receiver of an optical wireless communication system is similar to that of the transceiver of the optical wireless communication system so that only a device and method of packaging the transceiver having a transmitter and a receiver, which are combined with
30 each other, are described in embodiments of the present invention.

The present invention provides a device for measuring horizontality of the optical axis of the transceiver and a device for measuring the divergence angle of laser beam as a device for measuring horizontality of the optical axes of the transmitter and receiver and the divergence angle of laser beam.

The structure and function of the device for measuring horizontality of the optical axis of the transceiver will now be explained first. The structure of the device is illustrated in FIG. 1.

The optical axis horizontality measuring device 100 includes a stand 110 having two holes 111 at which taps 112 are respectively formed, a base plate 120 for fixing the stand onto a vibration isolating table, and an infrared sensing plate 130 having a hole. The infrared sensing plate is fit into each hole of the stand. The two holes 111 of the stand 110 respectively have the taps 112 in the form of female screw such that the infrared sensing plate 130 can be fit into each hole 111 of the stand 110. The distance between the two holes 111 is identical to that between the optical axes of the transmitter and the receiver. The base plate 120 connected with the stand 110 has slots 121 such that the base plate 120 is fixed onto the vibration isolating table using the slots 121.

An infrared sensing card having a predetermined hole 131 is attached to the front portion of the infrared sensing plate 130 such that the size and shape of a laser beam output from the transmitter are compared with the hole 131. The back of the infrared sensing plate 130 is processed into a male screw 132 such that the infrared sensing plate 130 can be fit into the hole 111 of the stand 110 or removed from the hole

111 more easily.

The optical axis horizontality measuring device of the present invention measures horizontality of the optical axis through the following process. Assuming that two optical
5 wireless communication transceivers are arranged facing each other.

First of all, two horizontality measuring devices are located on the optical axes of the transceivers. When a laser beam output from one of the two transceivers deviates from
10 the optical axis of the transceiver, the laser beam swerves from the hole 131 of the infrared sensing plate of the first horizontality measuring device, that is the horizontality measuring device located near the transceiver, and thus one side of the hole 131 is brightened. Accordingly, the
15 direction and degree of deviation of the laser beam can be found.

Then, the laser diode is arranged such that a laser beam input to the first horizontality measuring device exactly passes through the center of the hole 131. Here, the
20 laser beam may swerve from the second horizontality measuring device. In this case, the tilt of the laser diode is controlled and then the laser diode is horizontally moved such that the laser beam can pass through the hole of the infrared sensing plate of the second horizontality measuring
25 device. If the laser beam simultaneously passes through the centers of the holes of the two horizontality measuring devices, the opposite transceiver is arranged in the similar manner. When the two transceivers have been arranged, the optical axes of the transmitting and receiving parts of each
30 transceiver are level with each other. The accuracy of the arrangement depends on the distance between the two

transceivers, that is, the distance between the two horizontality measuring devices.

Consequently, the optical axis horizontality measuring device according to the present invention can find out a
5 degree of swerving of the optical axis by detecting light deviated from the hole 131 of the infrared sensing plate. Thus, it is possible to easily judge whether the optical axes of the transmitter and receiver are level with each other. Furthermore, a degree of divergence of light with respect to
10 distance can be easily approximately judged.

The device for measuring the divergence angle of a laser beam according to an embodiment of the present invention will now be explained. The divergence angle measuring device 200 is shown in FIG. 2.

15 The divergence angle measuring device 200 includes a CCD camera 210 having an infrared sensing card 212 to which a transparent graduation plate 213 on which a graduation ruler is printed is attached, a three-axis aligner 220 that can be operated on three axes perpendicular to one another, a rail
20 240 for moving the divergence angle measuring device, and a base plate 230 mounted on the rail 240.

The CCD camera 210 is a camera having a sensing range of the visible ray band, which is cheaper than a camera having a sensing range of the infrared band. The infrared
25 sensing card 212 is fixed to the front portion of the CCD camera 210 using a holder 211. The graduation plate 213 is attached to the infrared sensing plate 212 such that the size of the laser beam, which is output from the transmitter and input to the infrared sensing card 121, can be quantitatively
30 judged.

The three-axis aligner 220 finely moves the CCD camera

210 to a desired position such that the laser beam output from the transmitter can be read more conveniently and accurately using the graduation ruler. When the divergence angle measuring device 200 is not used, the three-axis aligner 220 is moved using transfer means such as the rail 240 to a position irrespective of an optical path such that the three-axis aligner 220 does not obstruct the measurement of optical axis horizontality or receiving sensitivity.

The divergence angle measuring device of the present invention can measure the size and shape of a laser beam. If the distance between the transmitter and a specific position is known, the size of laser beam at the specific position is accurately measured, and the size of laser beam at the position of the transmitter is known, the divergence angle of the transmitter can be known.

The optical axis horizontality measuring device 100 is used to align the optical axes of the transmitter and receiver to be level with each other, and the divergence angle measuring device 200 is used to measure the divergence angle of laser beam to fix the divergence angle to a desired value. A packaging method using the devices according to an embodiment of the present invention will now be explained with reference to FIGS. 3a and 3b.

(1) Folding mirrors 350, 360 and 380 having an aperture larger than that of a laser beam are installed on a vibration isolating table such that the distance between a collimating lens 311 of a transmitter and a condensing lens 312 of a receiver becomes longer than at least 10m in the step S310.

(2) A transceiver block 310 to which a transmitter lens and a receiver lens are attached is fixed, and then a laser diode (not shown) is located in front of the receiver lens in

the step S320. Here, the laser diode and a photo diode are attached to an appropriately fabricated holder. The holder is fixed to a 6-axis high-precision aligner (not shown) such that the holder can be finely moved.

5 (3) At least two optical axis horizontality measuring devices 330 and 340 and a laser beam divergence angle measuring device 320 are located on an optical path in order to measure optical axis horizontality between the transmitter and receiver and the divergence angle in the step S330.

10 (4) The laser diode and the photo diode are simultaneously arranged using the 6-axis high-precision aligner to align the optical axes and divergence angle in the step (S340). The process of aligning the optical axes and divergence angle will now be explained in detail.

15 The divergence angle of the laser beam output from the transceiver is approximately arranged, and then the laser diode is moved in the direction perpendicular to the optical axes or the tilt of the laser diode is changed using the aligner to measure optical axis horizontality while the
20 optical axis horizontality measuring device is observed. When the optical axes of the transmitter and receiver become level with each other, the infrared sensing plate of the optical axis horizontality measuring device is removed and the divergence angle measuring device is moved to the receiver
25 using the rail. Then, the position of the CCD camera is controlled using the three-axis aligner such that light observed through the divergence angle measuring device is easily read, and then the laser diode is moved to the optical axis direction such that the size of the laser beam becomes a
30 predetermined value. Subsequently, the photo diode is moved in the optical axis direction and the direction perpendicular

to the optical axis to find the point at which the intensity of a received optical signal is the maximum level.

(5) The arranged holder of the laser diode and photo diode is fixed using UV epoxy or a laser welding device in
5 the step S350.

In general, fixing points of the holder are decided such that four points disposed outside the holder are symmetrical. When the UV epoxy is used, a variation in the position of laser beam, generated when ultraviolet rays are
10 irradiated, is observed using the divergence angle measuring device and the quantity of ultraviolet rays irradiated on a fixing point opposite to the point where the variation is generated is increased to minimize an arrangement error due to deformation of epoxy generated when the epoxy is hardened.

(6) A transmitter driving plate and a receiver driving
15 plate are respectively connected to the laser diode and the photo diode and packaged to implement the transceiver having the transmitter and receiver, which are level with each other, and a predetermined divergence angle of the transmitter.

20 The optical axes of the transmitter and receiver and the divergence angle of the transceiver fabricated through the above-described process are standardized according to predetermined rules. Thus, the receiver is automatically aligned when the transmitter is aligned. Furthermore, the
25 transmitter does not require a divergence angle control function because the transceiver having a divergence angle fixed in advance according to a link distance and purpose can be mass-produced.

The head of the optical wireless communication
30 transceiver fabricated using the aforementioned packaging method can have a general head form in which the transmitter

lens and the receiver lens are respectively located at different positions and a bi-directional head form in which the transmitter and receiver share a single lens.

The general head 400 is illustrated in FIG. 4.
5 Referring to FIG. 4, the transmitter and the receiver use respective lenses. The general head 400 includes a main body 410 to which a diode holder 420 is attached, a diode holder 420 for holding a laser diode or a photo diode, a laser diode or photo diode 430, and a lens 440.

10 A process of fabricating the general head 400 according to an embodiment of the present invention will now be explained.

Two lenses 440 are attached to the main body 410 using epoxy. Then, the diode holder 420 to which the laser diode or
15 photo diode is fixed is attached to the main body 410 using the above-described packaging method of the present invention. Here, the diode holder 420 is attached to the main body 410 using epoxy or laser welding 450.

The bi-directional head 500 is illustrated in FIG. 5a.
20 Referring to FIG. 5a, laser diodes with different wavelengths are used for transceivers facing each other and dichronic mirrors are used to separate lights having different wavelengths such that each transceiver can be constructed using a single lens.

25 The bi-directional head 500 includes a lens 550, a dichronic mirror 511, a main body 510 to which a diode holder 520 is attached, the diode holder 520 for holding a laser diode or a photo diode, a laser diode 530, and a photo diode 540. The lens 550 is anti-reflection-coated for the laser
30 diodes 530 and 570 with different wavelengths used for the transceivers facing each other. The dichronic mirror 511 must

reflect a laser beam emitted from the laser diode 530.

While a process of fabricating the bi-directional head 500 according to the present invention is identical to the process of fabricating the general head 400, the process of
5 fabricating the bi-directional head can manufacture two transceiver heads through one-time packaging process.

Since the number of lenses used for the bi-directional head is smaller than that of lenses used for the general head, the bi-directional head can reduce the size and weight of the
10 transceiver for the same lens size. This can simplify the structure of an aligner used for an optical wireless communication and decrease the volume of a motor to thereby reduce the manufacturing cost of the optical wireless communication system.

15

[Industrial Applicability]

As described above, in the transmitter and the receiver of the optical wireless communication system fabricated using the packaging method of the present invention, components are
20 not moved and thus mechanical operations are simplified and product cost is remarkably reduced. Furthermore, standardization and mass production of the transmitter and the receiver can be achieved.

Moreover, in case of the transceiver of the optical
25 wireless communication system, optical axis horizontality of the transmitter and the receiver is measured on a single test bed and then the transceiver is fabricated. Thus, the arrangement process is simplified and the number of aligners is reduced by half. Furthermore, the aligner can be removed
30 after arrangement and thus the structure of the aligner is simplified. This enables the construction of an inexpensive

optical wireless communication system.

While the present invention has been described with reference to the particular illustrative embodiments, it is not to be restricted by the embodiments but only by the
5 appended claims. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope and spirit of the present invention.

What Is Claimed Is:

1. A device for measuring horizontality of optical axes of a transmitter and a receiver of an optical wireless
5 communication system, comprising:

a stand having two holes distant from each other by a predetermined distance;

a base plate for fixing the stand to a predetermined vibration isolating table; and

10 a laser sensing plate fit into each hole of the stand, the laser sensing plate having a laser sensing card attached to the front portion thereof, for comparing the size and shape of a laser beam output from the transmitter with the holes of the stand.

15

2. The device as claimed in claim 1, wherein each of the holes of the stand has a tap in the form of a female screw and the back portion of the laser sensing plate is machined into a male screw such that the laser sensing plate
20 is fit into the hole of the stand or separated from the hole.

3. The device as claimed in claim 1, wherein the base plate has at least two slots through which the base plate is fixed onto the vibration isolating table.

25

4. The device as claimed in claim 1, wherein the distance between the centers of the two holes of the stand corresponds to that between the optical axes of the transmitter and receiver.

30

5. The device as claimed in claim 1 or 2, wherein

the laser sensing plate is an infrared sensing plate and the laser sensing card is an infrared sensing card.

6. A device for measuring the divergence angle of a
5 laser beam, comprising:

a CCD camera having a transparent graduation ruler attached to the front end thereof, the CCD camera serving as a basis for measuring the size of the laser beam;

a three-axis aligner operated on three axes
10 perpendicular to the CCD camera; and

a base plate located under the three-axis aligner, the base plate including a movable member capable of being freely moved to a position irrespective of an optical path.

7. The device as claimed in claim 6, further
15 comprising a rail provided under the base plate, wherein the movable member included in the base plate can be mounted on the rail.

8. The device as claimed in claim 6, wherein the CCD
20 camera is a CCD camera for visible rays including an infrared sensing card to which a transparent graduation plate on which a graduation ruler is printed is attached.

9. A packaging method for fabricating a transmitter
25 and a receiver of an optical wireless communication system, comprising the steps of:

appropriately arranging large-aperture folding mirrors such that the distance between a collimating lens of the
30 transmitter and a condensing lens of the receiver becomes the maximum;

mounting a transmitter block to which a transmitter lens is attached and a receiver block to which a receiver lens is attached on a fixed table, and operating a laser diode and a photo diode, respectively located in front of the transmitter block and receiver block, using a 6-axis high-precision aligner;

measuring the divergence angle and shape of a laser beam emitted from the operated laser diode using a divergence angle measuring device to appropriately control the position of the laser diode, and monitoring the signal intensity of the photo diode to appropriately control the position of the photo diode such that sensitivity of the receiver becomes the maximum; and

fixing the laser diode and the photo diode arranged through the position control step.

10. The packaging method as claimed in claim 9, wherein the laser diode and the photo diode are fixed using UV epoxy or a laser welding device.

11. The packaging method as claimed in claim 9, wherein the position control of the laser diode is performed using the divergence angle measuring device of any one of claims 6 to 8.

12. A packaging method for fabricating an optical wireless communication transceiver in which a transmitter and a receiver are combined with each other, comprising the steps of:

appropriately arranging a predetermined number of large-aperture folding mirrors such that the distance between

a collimating lens of the transmitter and a condensing lens of the receiver becomes the maximum;

setting at least two optical axis horizontality measuring devices on an optical path on which the folding
5 mirrors are arranged to prepare the measurement of alignment of the optical axes of the transmitter and receiver;

mounting a transceiver block to which a transmitter lens and a receiver lens are attached on a fixed table, operating a laser diode and a photo diode located in front of
10 the transceiver block using a 6-axis high-precision aligner, and aligning the optical axes of the transceiver using the optical axis horizontality measuring devices;

measuring the divergence angle and shape of a laser beam emitted from the operated laser diode using a divergence
15 angle measuring device to appropriately control the position of the laser diode, and monitoring the signal intensity of the photo diode to appropriately control the position of the photo diode such that sensitivity of the receiver becomes the maximum; and

20 fixing the laser diode and the photo diode arranged through the position control step.

13. The packaging method as claimed in claim 12, wherein the laser diode and the photo diode are fixed using
25 UV epoxy or a laser welding device.

14. The packaging method as claimed in claim 13, further comprising the step of observing a variation in the arrangement state of the laser diode and photo diode using
30 the divergence angle measuring device when the laser diode and the photo diode are fixed using the UV epoxy to prevent

the arrangement state of the laser diode and photo diode from being changed due to shrinking of the epoxy.

15. The packaging method as claimed in claim 12,
5 wherein the optical axis horizontality measuring devices is the optical axis horizontality measuring device of any one of claims 1 to 5.

16. The packaging method as claimed in claim 12,
10 wherein the divergence angle measuring device is the divergence angle measuring device of any one of claims 6 to 8.

17. A method of packaging a transmitter and/or a receiver of an optical wireless communication system, the method comprises the steps of:

15 arranging a laser diode of the transmitter or a photo diode of the receiver at a predetermined position; and

packagig the transmitter or the receiver such that the arranged position of the laser diode or photo diode is permanently fixed.

20

18. The packaging method as claimed in claim 17, wherein the arrangement of the laser diode of the transmitter or the photo diode of the receiver includes optical axis alignment, and the transmitter and the receiver are combined
25 into a single transceiver module.

19. The packaging method as claimed in claim 17 or 18, wherein the arranged position of the laser diode and/or photo diode is permanently fixed using UV epoxy or a laser welding
30 method.

20. The packaging method as claimed in claim 17 or 18, wherein the laser diode is arranged such that the divergence angle of the transmitter is measured using the divergence angle measuring device of any one of claims 6 to 8 and the
5 laser diode is arranged to have an appropriate divergence angle.

21. A transmitter and a receiver of an optical wireless communication system using the packing method of any
10 one of claims 17 to 20.

[Drawings]

Fig. 1

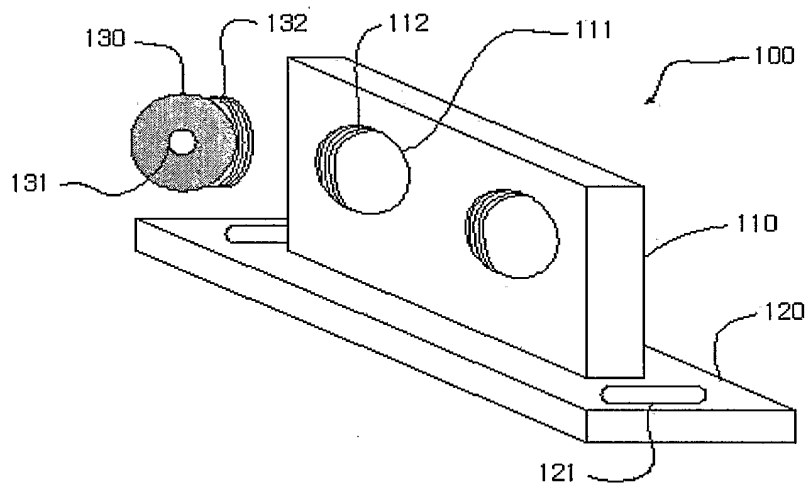


Fig. 2

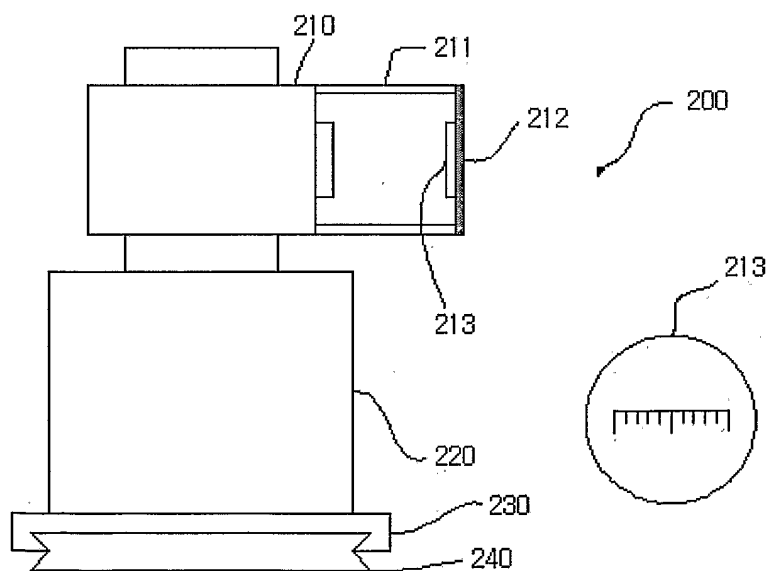


Fig. 3a

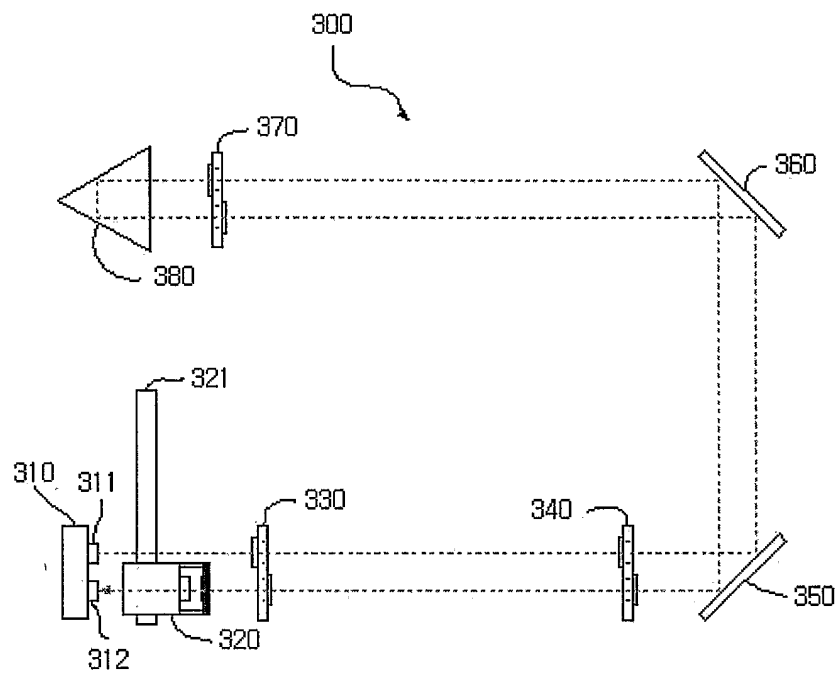


Fig. 3b

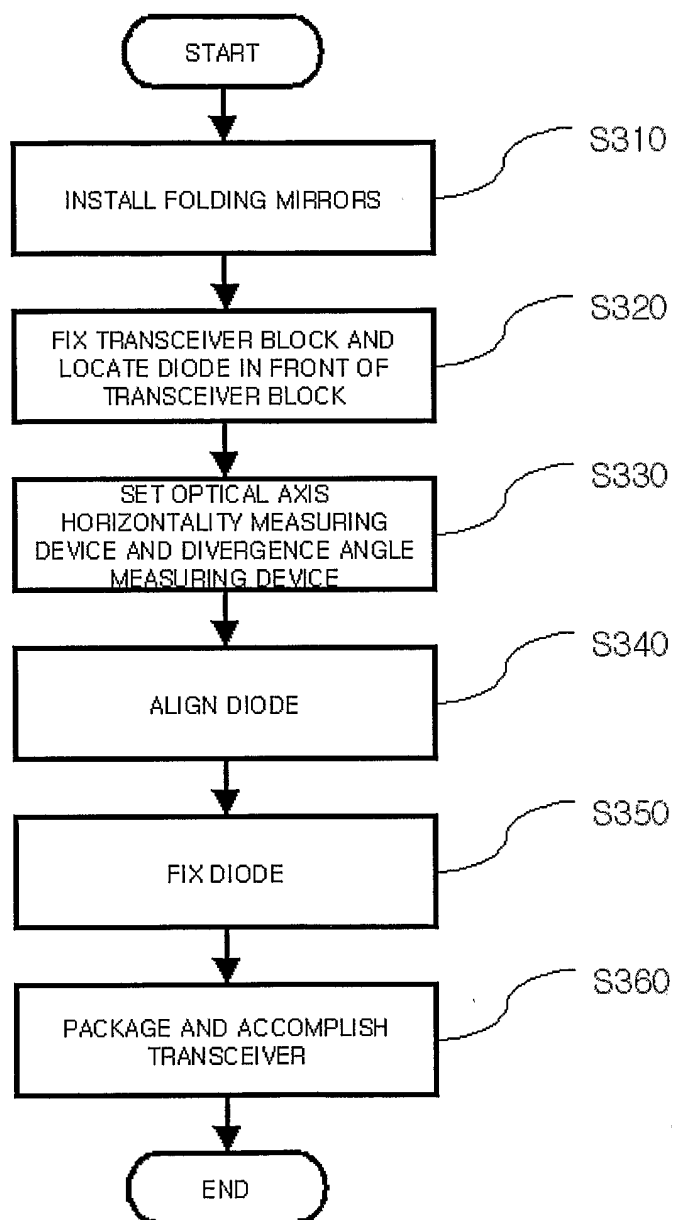


Fig. 4

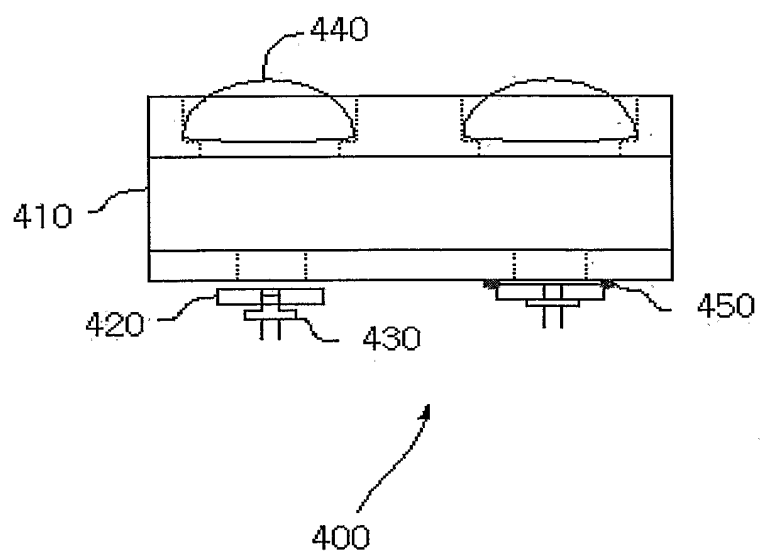


Fig. 5a

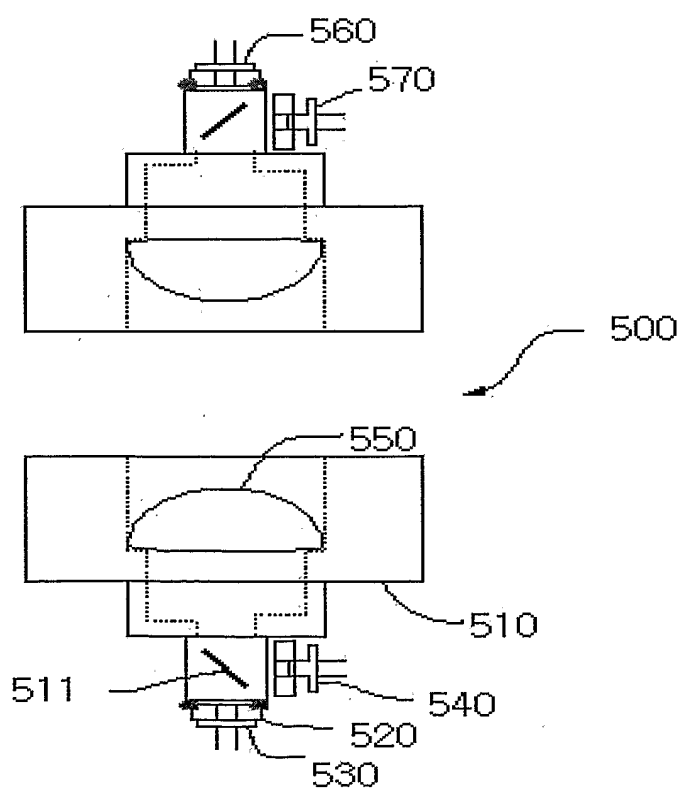


Fig. 5b

