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Inventor(s)	Murthy; Banuprakash et al.

BRACKET ASSEMBLY FOR VEHICLE CAMERA MONITOR SYSTEMS

Abstract

A camera monitor system (CMS) for a vehicle includes a wing including a housing configured to be secured to the vehicle, and a camera assembly having a camera mounted to the wing with a bracket assembly. The camera may include an image capture unit configured to provide a desired field of view of the vehicle. A display may depict at least a portion of the field of view. A controller may be in communication with the camera and the display. The bracket assembly may include first, second, and third brackets configured for adjustment of the camera with respect to first, second, and third dimensions.

Inventors: **Murthy; Banuprakash (Novi, MI), Irfhana; Fathima (Lake Orion, MI)**

Applicant: **Stoneridge Electronics AB** (Solna, SE)

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Background/Summary

BACKGROUND

[0001] Mirror replacement systems, and camera systems for supplementing mirror views, are utilized in commercial vehicles to enhance the ability of a vehicle operator to see a surrounding environment. Camera monitor systems (CMS) utilize one or more cameras disposed about the vehicle to provide an enhanced field of view to a vehicle operator on one or more displays located in the vehicle cabin. In some examples, mirror replacement systems within the CMS can cover a larger field of view than a conventional mirror, or can include views that are not fully obtainable via a conventional mirror.

[0002] The cameras are installed in a fixed position to provide desired fields of view, for example, legally prescribed views according to regulation. Camera position is calibrated and set upon installation of the camera arm or wing onto the vehicle. Camera positioning between different vehicles may need to be different due to the installed position of the camera wing. Each camera's field of view may also change may change during vehicle operation due to the camera wing being bumped or the vehicle becoming damaged.

SUMMARY

[0003] In some aspects, the embodiments described herein relate to a camera monitor system (CMS) for a vehicle, including: a wing including a housing configured to be secured to the vehicle, and a camera assembly having a camera mounted to the wing with a bracket assembly. The camera may include an image capture unit configured to provide a desired field of view of the vehicle. A display may depict at least a portion of the field of view. A controller may be in communication with the camera and the display. The bracket assembly may include first, second, and third brackets configured for adjustment of the camera with respect to first, second, and third dimensions.

[0004] In a further example of the foregoing, the first, second, and third brackets are positioned in a nested configuration, the camera is mounted to the third bracket, and the first bracket operatively mounted to the housing.

[0005] In a further example of any of the foregoing, the first, second, and third brackets are connected serially, the second bracket interconnected between the first and third brackets.

[0006] In a further example of any of the foregoing, the first bracket is adjustably supported with first fasteners by a base for movement in first dimension, the base affixed to the housing.

[0007] In a further example of any of the foregoing, the second bracket is adjustably supported with second fasteners by the first bracket for movement in the second dimension.

[0008] In a further example of any of the foregoing, the third bracket is adjustably supported with third fasteners by the second bracket for pivoting in the third dimension.

[0009] In a further example of any of the foregoing, the first dimension is roll, the second dimension is pitch, and the third dimension is yaw.

[0010] In a further example of any of the foregoing, the first bracket is adjustably supported with first fasteners by a base for movement in first dimension, and each of the base, the first bracket, and the second bracket includes an opening for wiring of the camera to extend through.

[0011] In a further example of any of the foregoing, one of the base, the first bracket, the second bracket, and the third bracket includes a dial, and an adjacent one of the one of the base, the first bracket, the second bracket, and the third bracket to the one of the base, the first bracket, the second bracket, and the third bracket includes an indicator next to the dial, a relative position of the indicator to the dial being indicative of a position in a corresponding camera dimension provided by the one the first bracket, the second bracket, and the third bracket.

[0012] In a further example of any of the foregoing, the first bracket includes the dial, and the base includes the indicator positioned to indicate a position of the camera in the first dimension.

[0013] A method of adjusting a camera monitor system in a vehicle, the method may include adjusting a position of a camera disposed in a wing including a housing configured to be secured to the vehicle. The adjusting may include moving a first bracket relative to a base to a desired position

in a first dimension, moving a second bracket relative to the first bracket to a desired position in a second dimension, and moving a third bracket relative to the second bracket to a desired position in a third dimension, the camera mounted to the third bracket.
[0014] In a further example of any of the foregoing, the first dimension is roll, the second dimension is pitch, and the third dimension is yaw.
[0015] In a further example of any of the foregoing, the method includes determining a change in vehicle position in at least one of a yaw, pitch, and roll directions, wherein the adjusting is based on the determined change.
[0016] In a further example of any of the foregoing, after the adjusting, the cover is secured to the wing.
[0017] In a further example of any of the foregoing, the method includes, before the adjusting step, removing a portion of the wing to access at least one of the base, the first bracket, the second bracket, and the third bracket.
[0018] In a further example of any of the foregoing, the method includes, before the adjusting step, unlocking at least one of the base, the first bracket, the second bracket, and the third bracket.
[0019] In a further example of any of the foregoing, the unlocking step includes loosening at least one fastener.
[0020] In a further example of any of the foregoing, the method includes locking the first bracket in position with a fastener.
[0021] In some aspects, the techniques described herein relate to a method, wherein the first bracket, the second bracket, and the third bracket are connected serially and positioned in a nested configuration, with the second bracket interconnected between the first and third brackets.
[0022] In a further example of any of the foregoing,, the first dimension is roll, the second dimension is pitch, and the third dimension is yaw, and the method includes determining a change in vehicle position in at least one of a yaw, pitch, and roll directions, wherein the adjusting is based on the determined change.
[0023] These and other features may be best understood from the following specification and drawings, the following of which is a brief description.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0024] FIG. **1**A is a schematic front view of a commercial truck with a camera monitor system (CMS) used to provide at least Class II and Class IV views.
[0025] FIG. **1**B is a schematic top elevational view of a commercial truck with a camera mirror system providing Class II, Class IV, Class V, Class VI and Class VIII views.
[0026] FIG. **2** is a schematic illustration of an interior of a vehicle cab and the CMS system.
[0027] FIG. **3** illustrates an example wing.
[0028] FIG. **4** illustrates an interior view of the example wing of FIG. **3**.
[0029] FIG. **5**A schematically illustrates the adjustable engagement between the base and first bracket in the roll direction.
[0030] FIG. **5**B illustrates another view of the example bracket assembly.
[0031] FIG. **6** illustrates an example base.
[0032] FIG. **7** illustrates an example first bracket.
[0033] FIG. **8** schematically illustrates the adjustable engagement between the first bracket and second bracket in the pitch direction.
[0034] FIG. **9** illustrates the example first bracket.
[0035] FIG. **10** illustrates the example second bracket.
[0036] FIG. **11** schematically illustrates the adjustable engagement between the second bracket and

third bracket in the yaw direction.
[0037] FIG. **12** illustrates an example second bracket.
[0038] FIG. **13** illustrates an example third bracket.
[0039] FIG. **14** illustrates another view of the example second bracket.
[0040] FIG. **15** illustrates an example indicator and dial.
[0041] FIG. **16** illustrates an example support bracket.
[0042] FIG. **17** illustrates another view of the example support bracket.
[0043] FIG. **18** illustrates an example cover portion for an example wing.

DETAILED DESCRIPTION

[0044] A schematic view of a commercial vehicle **10** is illustrated in FIGS. **1**A and **1**B. FIG. **2** is a schematic top perspective view of the vehicle **10** cabin including displays and interior cameras. The vehicle **10** includes a vehicle cab or tractor **12** for pulling a trailer **14**. It should be understood that the vehicle cab **12** and/or trailer **14** may be any configuration. Although a commercial truck is contemplated in this disclosure, the invention may also be applied to other types of vehicles. The vehicle **10** incorporates a camera monitor system (CMS) **15** (FIG. **2**) that has driver and passenger side camera arms **16***a*, **16***b* (generally, "camera arm **16**" or "wing") mounted to the outside of the vehicle cab **12**. If desired, the camera arms **16***a*, **16***b* may include conventional mirrors integrated with them as well, although the CMS **15** can be used to entirely replace mirrors. In additional examples, each side can include multiple camera arms, each arm housing one or more cameras and/or mirrors.
[0045] Each of the camera arms **16***a*, **16***b* includes a base that is secured to, for example, the cab **12**. A pivoting arm is supported by the base and may articulate relative thereto. Fixed wings may also be used. At least one rearward facing camera **20***a*, **20***b* is arranged respectively within camera arms. The exterior cameras **20***a*, **20***b* each have an image capture unit that capture an exterior field of view FOVEX**1**, FOVEX**2** that each include at least one of the Class II and Class IV views (FIG. **1**B), which are legal prescribed views in the commercial trucking industry. It is desirable to capture at least a portion of the trailer **14** in the field of view, for example, the side and/or end of the trailer, throughout vehicle operation. Multiple cameras also may be used in each camera arm **16***a*, **16***b* to provide these views, if desired. Class II and Class IV views are defined in European R46 legislation, for example, and the United States and other countries have similar drive visibility requirements for commercial trucks, for example, SAE J3155. Any reference to a "Class" view is not intended to be limiting, but is intended as exemplary for the type of view provided to a display by a particular camera. Each arm **16***a*, **16***b* may also provide a housing that encloses electronics that are configured to provide various features of the CMS **15**.
[0046] First and second video displays **18***a*, **18***b* are arranged on each of the driver and passenger sides within the vehicle cab **12** on or near the A-pillars **19***a*, **19***b* to display Class II (narrow angle view) and Class IV (wide angle view) views (e.g., Class II depicted above Class IV in a portrait-style configuration) on its respective side of the vehicle **10**, which provide rear facing side views along the vehicle **10** (e.g., portions of the trailer) that are captured by the exterior cameras **20***a*, **20***b*.
[0047] If video of Class V and/or Class VI views are also desired, a camera housing **16***c* and camera **20***c* may be arranged at or near the front of the vehicle **10** to provide those views (FIG. **1**B). A third display **18***c* arranged within the cab **12** near the top center of the windshield can be used to display the Class V and Class VI views, which are toward the front of the vehicle **10**, to the driver. The displays **18***a*, **18***b*, **18***c* face a driver region **24** within the cabin **22** where an operator is seated on a driver seat **26**. The location, size and field(s) of view streamed to any particular display may vary from the configurations described in this disclosure and still incorporate the disclosed invention.
[0048] If video of Class VIII views is desired, camera housings can be disposed at the sides and rear of the vehicle **10** to provide fields of view including some or all of the Class VIII zones of the vehicle **10**. As illustrated, the Class VIII view includes views immediately surrounding the trailer,

and in the rear proximity of the vehicle including the rear of the trailer. In one example, a view of the rear proximity of the vehicle is generated by a rear facing camera disposed at the rear of the vehicle, and can include both the immediate rear proximity and a traditional rear view (e.g. a view extending rearward to the horizon, as may be generated by a rear view mirror in vehicles without a trailer). In such examples, the third display **18***c* can include one or more frames displaying the Class VIII views. Alternatively, additional displays can be added near the first, second and third displays **18***a*, **18***b*, **18***c* (generally, "display **18**") and provide a display dedicated to providing a Class VIII view.

[0049] In some cases, the Class VIII view is generated using a trailer mounted camera **30**. The trailer mounted camera **20***d* is a rear facing camera which provides a field of view behind the trailer. This rear view can be provided to one of the displays **18***a*, **18***b* and/or another display **18***c* within the vehicle cabin **22** as a rear view mirror replacement or as a rear view mirror supplement. This view is particularly beneficial as the trailer **14** may block some, or all, views provided by a conventional rear view mirror.

[0050] The CMS **15** is also configured to utilize the images from the cameras **20***a*, **20***b*, **20***c*, **20***d* (generally, "camera **20**") as well as images from other cameras that may be disposed about the vehicle or in communication with the vehicle to determine features of the vehicle, identify objects, and facilitate driver assistance features such as display overlays and semi-automated driver assistance systems.

[0051] These features and functions of the CMS **15** are used to implement multiple CMS **15** systems that aid in operation of the vehicle. It should be noted that a controller **30** (FIG. **2**) for the CMS **15** can be used to implement the various functionalities disclosed in this application. The controller **30**, which is in communication with the displays **18** and cameras **20**, may include one or more discrete units. For example, a centralized architecture may have a common controller arranged in the vehicle **10**, while a decentralized architecture may use a controller provided in each of the displays **18**, for example. Moreover, a portion of the controller **30** may be provided in the vehicle **10**, while another portion of the controller **30** may be located elsewhere, for example, the camera arms **16**. In another example, a master-slave display configuration may be used where one display includes the controller **30** while the other display receives the commands from the controller **30**.

[0052] In terms of hardware architecture, such a controller can include a processor, memory (e.g., memory **31**, FIG. **2**), and one or more input and/or output (I/O) device interface(s) that are communicatively coupled via a local interface. The local interface can include, for example but not limited to, one or more buses and/or other wired or wireless connections. The local interface may have additional elements, which are omitted for simplicity, such as controllers, buffers (caches), drivers, repeaters, and receivers to enable communications. Further, the local interface may include address, control, and/or data connections to enable appropriate communications among the aforementioned components.

[0053] The controller **30** may be a hardware device for executing software, particularly software stored in memory (e.g., memory **31**, FIG. **2**). The controller **30** can be a custom made or commercially available processor, a central processing unit (CPU), an auxiliary processor among several processors associated with the controller, a semiconductor-based microprocessor (in the form of a microchip or chip set) or generally any device for executing software instructions.

[0054] The memory **31** can include any one or combination of volatile memory elements (e.g., random access memory (RAM, such as DRAM, SRAM, SDRAM, VRAM, etc.)) and/or nonvolatile memory elements (e.g., ROM, hard drive, tape, CD-ROM, etc.). Moreover, the memory **31** may incorporate electronic, magnetic, optical, and/or other types of storage media. The memory **31** can also have a distributed architecture, where various components are situated remotely from one another, but can be accessed by the processor.

[0055] The software in the memory **31** may include one or more separate programs, each of which

includes an ordered listing of executable instructions for implementing logical functions. A system component embodied as software may also be construed as a source program, executable program (object code), script, or any other entity comprising a set of instructions to be performed. When constructed as a source program, the program is translated via a compiler, assembler, interpreter, or the like, which may or may not be included within the memory **31**.

[0056] The disclosed input and output devices that may be coupled to system I/O interface(s) may include input devices, for example but not limited to, a keyboard, mouse, scanner, microphone, camera, mobile device, proximity device, etc. Further, the output devices, for example but not limited to, a printer, display, etc. Finally, the input and output devices may further include devices that communicate both as inputs and outputs, for instance but not limited to, a modulator/demodulator (modem; for accessing another device, system, or network), a radio frequency (RF) or other transceiver, a telephonic interface, a bridge, a router, etc.

[0057] When the controller **30** is in operation, the processor can be configured to execute software stored within the memory **31**, to communicate data to and from the memory **31**, and to generally control operations of the computing device pursuant to the software. Software in memory **31**, in whole or in part, is read by the processor, perhaps buffered within the processor, and then executed.

[0058] FIG. **3** illustrates an example wing **16** of the example CMS **15**. A camera assembly is mounted to the wing **16** through an adjustable bracket assembly **38** (not shown; see later Figures) and includes a camera **20** with an image capture unit configured to provide a desired field of view of the vehicle to which the wing **16** is attached. As shown, the example wing **16** includes a housing **40** secured to the vehicle and providing an opening **42** through which the camera **20** can capture one or more images. Although a camera **20** is the object adjustable by the example bracket assemblies and method disclosed herein, other objects, including other vehicle sensors, may benefit from this disclosure.

[0059] Applicant has identified that it may be desirable to adjust objects such as vehicle cameras **20** in various dimensions such as for calibration, precision, or to compensate for vehicle position changes. The systems and methods disclosed herein may benefit non-vehicular applications as well.

[0060] FIG. **4** illustrates the interior of the example wing **16** of FIG. **3**, including the example bracket assembly **38** internal to the housing **40** and including a base **44**, a first bracket **46**, a second bracket **48**, and a third bracket **56** for pivotable adjustment of the camera **20** with respect to three dimensions. In some implementations, the adjustment of the various components in the bracket assembly **38** described herein may be pivotable adjustment. A cover portion **41** (see FIG. **3**) of the housing **40** may be removed to access the bracket assembly **38**. In some examples, the cover portion **41** is installed in a sealed manner and/or removed by one or more snap-fit connection points **43** (FIG. **18**). In some disclosed examples the three dimensions are the yaw, pitch, and roll dimensions. The base **44** may be affixed to the housing **40**. The bracket assembly **38** may be formed of plastic. The bracket assembly **38** may be formed of thermoplastic. The bracket assembly **38** may be formed of Polycarbonate-acrylonitrile butadiene styrene (PC-ABS).

[0061] As will be explained further, the example first bracket **46** is adjustably supported with the base **44** for movement in the roll dimension **50**. The example second bracket **48** is adjustably supported with the first bracket **46** for movement in the pitch dimension **52**. The example third bracket **56** is adjustably supported with the second bracket **48** for movement in the yaw dimension **54**, and the camera **20** (See FIG. **11**) is mounted to the third bracket **56**. The third bracket **56** may be integral with the camera **20** or be a separate component in some examples.

[0062] In some examples, as shown, the base **44**, first bracket **46**, second bracket **48**, and third bracket **56** are positioned in a nested configuration. The example first bracket **46** is nested within the base **44**, and the example second bracket **48** is nested within the first bracket **46**, and the example third bracket **56** is nested within the second bracket **48**. In some examples, as shown, the base **44**, first bracket **46**, second bracket **48**, and third bracket **56** may be connected serially. The second bracket **48** may be interconnected between the first bracket **46** and the third bracket **56**.

[0063] FIGS. **5**A and **5**B illustrate the adjustable engagement between the base **44** and the first bracket **46** in the roll direction **50**. The example base **44** includes a main body portion **58** and arms **60**A and **60**B extending from the main body portion **58**. The base **44** is fixed to a support bracket **61** at the arms **60**A and **60**B. The example second bracket **48** and third bracket **56** are nested between the arms **60**A and **60**B.

[0064] The main body portion **58** includes an opening **62**, and the first bracket **46** has a ring protrusion **64** that extends through, and is adjustable within, the opening **62** and circumscribes an opening **66**. Wiring **68** from the camera **20** may extend through the openings **62**, **66**. In the example, the roll axis AR extends through the openings **62**, **66**. In some examples, as shown, the roll axis AR is centered within the openings **62**, **66**. In some examples, as shown, the openings **62**, **66** are circular.

[0065] A roll indicator **71** may be provided on the main body portion **58** and positioned to indicate the roll position of the camera **20** on a roll dial **72** provided on the first bracket **46**. An example indicator **71** may be next to dial **72**, such as shown and described in more detail at FIG. **15**.

[0066] As the example base **44** is fixed to the support bracket **61** and the support bracket **61** is fixed within the housing **40**, the first bracket **46** is adjustable relative to the base **44** about the roll dimension to adjust the roll position of the camera **20**. When the first bracket **46** is adjusted in the roll dimension **50**, the second bracket **48**, third bracket **56**, and camera **20** move with the first bracket **46** such that the camera **20** roll position is adjusted.

[0067] The main body portion **58** may provide one or more slots **74** for receiving one or more fasteners **76** coupled to the first bracket **46** for adjustable support to secure the first bracket **46** at a desired roll position. In some examples, the one or more slots **74** may be sized and positioned to allow the fasteners **76** to move circumferentially within the slots **74** relative to the roll axis AR when the first bracket **46** is adjusted in the roll dimension **50** before being tightened at the desired roll position. In some examples, as shown, the slot **74** may be oblong with respect to its circumferential length. The example fasteners **76** may be bolts or screws in some examples, but a skilled person having the benefit of this disclosure would recognize that other fastener types may be utilized. The various fasteners disclosed herein may be loosened before adjustment and tightened after adjustment to secure the bracket assembly **38** in a desired position. The slots **74** may be positioned opposite the opening **62** from one another. Although two slots **74** are shown in the illustrative example, more or fewer slots may be utilized in some examples.

[0068] FIGS. **6** and **7** illustrate the example base **44** and first bracket **46**, respectively. The first bracket **46** includes one or more fastener openings **78** that are smaller than the slots **74**. The fastener openings **78** may be sized such that the fasteners **76** (not shown) may not move circumferentially within the fastener opening **78**. That is, when fasteners **76** are received within the slots **74** and fastener openings **78** but not yet tightened, the fasteners **76** can move circumferentially within the slots **74** but not the fastener openings **78**.

[0069] As illustrated schematically in FIG. **8**, the second bracket **48** is adjustable in the pitch dimension **52** relative to the first bracket **46**. As such, the second bracket **48** may be adjusted in the pitch dimension **52**, with the third bracket **56** and the camera **20** moving therewith for adjustment of the camera **20** to a desired pitch position.

[0070] With continued reference to FIG. **8**, FIGS. **9** and **10** illustrate the first bracket **46** and second bracket **48**, respectively. The first bracket **46** includes a main plate **80** and two wings **82** extending from the main plate **80**. The wings **82** may extend from opposite lateral ends of the main plate **80**. The wings **82** may be substantially perpendicular (±10 degrees) to the main plate **80**. The wings **82** provide apertures **84** for receiving posts **86** of the second bracket **48**. The posts **86** are centered on the pitch axis AP, which extends through the apertures **84**. The posts **86** are adjustable within the apertures **84** for adjusting of the second bracket **48** in the pitch dimension **52**.

[0071] One or more walls **88** may extend from the main plate **80**, providing a slot **90** for receiving a fastener **92** for adjustable support for securing the second bracket **48** in the desired pitch position.

The example slots **90** may be oblong and may be larger than openings **94** in the second bracket **48** that also receive the fasteners **92**. The slots **90** allow the fasteners **92** to move in the circumferential direction relative to the pitch axis AP within the slots **90** during pitch adjustment and before tightening of the fasteners **92**. The walls **88** may be substantially perpendicular (±10 degrees) to the main plate **80**. One wall **88** may extend from an upper portion of the main plate **80**, and a second wall **88** may extend from a lower portion of the main plate **80** opposite the upper portion.

[0072] The example wings **82** and walls **88** may extend from the plate **80** in a first direction, and the ring protrusion **70** (see FIG. **7**) may extend from the plate **80** in a second direction opposite the first direction. The example wings **82** are positioned between the arms **60**A, **60**B of the base **44**. The example wings **82** are opposite the opening **66** from one another. The wings **82** and the walls **88** may be substantially parallel (±10 degrees) to one another in some examples. The wings **82** and the walls **88** adjoin the main plate **80**.

[0073] The second bracket **48** includes a main body portion **96** providing an opening **98**, which may be circular in some examples, and the posts **86** extend from the main body portion **96** and are opposite the opening **98** from one another. The example posts **86** extend from the main body portion **96** in opposite directions. The opening **98** may be aligned with the opening **66** when assembled. With reference to FIG. **5**B, the camera wiring **68** may extend through the opening **98**.

[0074] As illustrated schematically in FIG. **11**, the third bracket **56** is adjustable in the yaw dimension **54** relative to the second bracket **48**. As such, the third bracket **56** may be adjusted in the yaw dimension **54**, with camera **20** being fixed to the third bracket **56** and moving therewith for adjustment of the camera **20** to a desired yaw position.

[0075] FIGS. **12** and **13** illustrate the second bracket **48** and the third bracket **56**, respectively. An upper support wall **100**A and a lower support wall **100**B extend from the main body portion **96** of the second bracket **48**. The upper support wall **100**A and lower support wall **100**B are opposite the opening **98** from one another. The yaw axis AY extends through the upper support wall **100**A and lower support wall **100**B. One or more fasteners **103** may be centered on the yaw axis AY and extend through one or both of the walls **100**A, **100**B. The upper support wall **100**A and lower support wall **100**B may be substantially parallel (±10 degrees) to one another.

[0076] The third bracket **56** may include one or more fastener openings **105** for receiving the fastener **103** for adjustable support, allowing the third bracket **56** to move relative to the fastener **103**. The third bracket **56** includes a camera opening **109** for receiving the camera **20**. The example opening **109** surrounds a lens portion **107** of the camera **20**. Although one fastener opening **105** is shown near the upper end, an additional fastener opening **105** may be provided near the lower end additionally or alternatively. The third bracket **56** may be nested between the support walls **100**A, **100**B as shown.

[0077] Referring back to FIG. **11**, a yaw indicator **111** may be provided on the upper support wall **100**A for indicating yaw position on a yaw dial **113** provided on the third bracket **56**.

[0078] As illustrated in FIG. **14**, a wall **112** adjoining the support wall **100**A and the main body portion **96** may provide a pitch dial **114** for the pitch position of the bracket assembly. The wall **112** may provide a fastener opening **94**. A pitch indicator **116** (see FIG. **11**) may be provided on the base for indicating pitch position on the pitch dial **114**.

[0079] FIG. **15** illustrates an example indicator **71**/**111**/**116** and dial **72**/**113**/**114**. The indicator **71**/**111**/**116** may include a tip **124** positioned to indicate on markers **126** on the dial. In some examples, at initial setup of the bracket assembly **38**, the tip **124** may be positioned at a center marker **126**A. The center marker **126**A may indicate a baseline position in the dimension. In some examples, adjacent markers **126** are spaced 1 degree from one another, and there are 5 markers on each side of the center marker **126**A. More or fewer markers **126** may be utilized. Other spacing increments may be utilized as well. As the bracket assembly is adjusted in one of the three dimensions described herein, the associated indicator **71**/**111**/**116** will indicate the position in that dimension on the associated dial **72**/**113**/**114**. In some examples, one may receive input that an

adjustment in one or more of the dimensions is needed, and can make the adjustment with the use of the indicators **71**/**111**/**116** and dials **72**/**113**/**114** and without the need for additional measurement devices.

[0080] FIGS. **16** and **17** illustrate the example support bracket **61**. The support bracket **61** includes a wall **119** that provides an opening **120** for the camera **20** to view through. Apertures **122** are provided on opposite sides of the opening **120**, to which the arms **60**A, **60**B (see FIG. **5**B) of the base **44** are fixed. Referring back to FIG. **5**B, the second bracket **48**, the main plate **80**, and the third bracket **56** may be provided between the main body portion **58** and the wall **119**.

[0081] A method of adjusting a camera monitor system **15** in a vehicle, according to the examples herein, may include adjusting a position of a camera **20** in a wing **16** secured to the vehicle. The adjusting may include moving a first bracket **46** relative to a base **44** to a desired position in a first dimension, moving a second bracket **48** relative to the first bracket **46** to a desired position in a second dimension, and moving a third bracket **56** relative to the second bracket **48** to a desired position in a third dimension, with the camera **20** mounted to the third bracket **56**.

[0082] An example method may further include determining a change in vehicle position in at least one of a yaw, pitch, and roll directions, and the adjusting is based on the determined change. The change may be determined relative to a vehicle coordinate system, such as vehicle coordinate system ISO 8855 in some examples. One or both of the wing and the camera may have one or more differences from the vehicle reference, and adjustments may be made based on those differences.

[0083] After the adjusting, an example method may include securing a cover to the wing. In some examples, the securing is achieved by way of one or more snap-fit connection points.

[0084] Before the adjusting step, an example method may include removing a portion of the wing **16** to access at least one of the third bracket **56**, the first bracket **46**, and the second bracket **48**. Before the adjusting step, an example method may include unlocking at least one of the third bracket **56**, the first bracket **46**, and the second bracket **48**. The unlocking step includes loosening at least one fastener. An example method may include locking a bracket in position with a fastener.

[0085] The example assemblies and methods disclosed help position and also measure the extrinsic position with variation for a number of degrees in each of the rotational axes, to accommodate for cabin configurations, build tolerances and over life time changes on the wing or physical structure with slight modification in the wing as a service or build option. Additional measurement devices may not be needed. The position of the camera can be adjusted to accommodate such changes instead of having to replace the entire wing.

[0086] Although the different examples are illustrated as having specific components, the examples of this disclosure are not limited to those particular combinations. It is possible to use some of the components or features from any of the embodiments in combination with features or components from any of the other embodiments.

[0087] The foregoing description shall be interpreted as illustrative and not in any limiting sense. A worker of ordinary skill in the art would understand that certain modifications could come within the scope of this disclosure. For these reasons, the following claims should be studied to determine the true scope and content of this disclosure.

Claims

1. A camera monitor system (CMS) for a vehicle, comprising: a wing including a housing configured to be secured to the vehicle; a camera assembly having a camera mounted to the wing with a bracket assembly, the camera including an image capture unit configured to provide a desired field of view of the vehicle; a display configured to depict at least a portion of the field of view; and a controller in communication with the camera and the display; wherein the bracket assembly comprises first, second, and third brackets configured for adjustment of the camera with respect to first, second, and third dimensions.

2. The system of claim 1, wherein the first, second, and third brackets are positioned in a nested configuration, the camera mounted to the third bracket, and the first bracket operatively mounted to the housing.
3. The system of claim 2, wherein the first, second, and third brackets are connected serially, the second bracket interconnected between the first and third brackets.
4. The system of claim 2, wherein the first bracket is adjustably supported with first fasteners by a base for movement in first dimension, the base affixed to the housing.
5. The system of claim 4, wherein the second bracket is adjustably supported with second fasteners by the first bracket for movement in the second dimension.
6. The system of claim 5, wherein the third bracket is adjustably supported with third fasteners by the second bracket for pivoting in the third dimension.
7. The system of claim 3, wherein the first dimension is roll, the second dimension is pitch, and the third dimension is yaw.
8. The system of claim 1, wherein the first bracket is adjustably supported with first fasteners by a base for movement in first dimension, and each of the base, the first bracket, and the second bracket includes an opening for wiring of the camera to extend through.
9. The system of claim 4, wherein one of the base, the first bracket, the second bracket, and the third bracket include a dial, and an adjacent one of the one of the base, the first bracket, the second bracket, and the third bracket to the one of the base, the first bracket, the second bracket, and the third bracket includes an indicator next to the dial, a relative position of the indicator to the dial being indicative of a position in a corresponding camera dimension provided by the one the first bracket, the second bracket, and the third bracket.
10. The system of claim 9, wherein the first bracket includes the dial, and the base includes the indicator positioned to indicate a position of the camera in the first dimension.
11. A method of adjusting a camera monitor system in a vehicle, the method comprising: adjusting a position of a camera disposed in a wing including a housing configured to be secured to the vehicle, the adjusting including: moving a first bracket relative to a base to a desired position in a first dimension; moving a second bracket relative to the first bracket to a desired position in a second dimension; and moving a third bracket relative to the second bracket to a desired position in a third dimension, the camera mounted to the third bracket.
12. The method of claim 11, wherein the first dimension is roll, the second dimension is pitch, and the third dimension is yaw.
13. The method of claim 12, the method comprising: determining a change in vehicle position in at least one of a yaw, pitch, and roll directions, wherein the adjusting is based on the determined change.
14. The method of claim 11, the method comprising: after the adjusting, securing a cover to the wing.
15. The method of claim 11, the method comprising: before the adjusting step, removing a portion of the wing to access at least one of the base, the first bracket, the second bracket, and the third bracket.
16. The method of claim 11, the method comprising, before the adjusting step, unlocking at least one of the base, the first bracket, the second bracket, and the third bracket.
17. The method of claim 16, wherein the unlocking step includes loosening at least one fastener.
18. The method of claim 11, the method comprising: locking the first bracket in position with a fastener.
19. The method of claim 11, wherein the first bracket, the second bracket, and the third bracket are connected serially and positioned in a nested configuration, with the second bracket interconnected between the first and third brackets.
20. The method of claim 19, wherein the first dimension is roll, the second dimension is pitch, and the third dimension is yaw, the method comprising: determining a change in vehicle position in at

least one of a yaw, pitch, and roll directions, wherein the adjusting is based on the determined change.