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Self-Contained Testable AR Glasses Sub-Module

Geoff Gudgeon

Jaehong Choi

Matthew Valente

daniel effinger

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ABSTRACT

Designers of AR glasses are faced with packaging challenges. Packaging constraints may force optical components to be aligned at the top level of assembly or some sort of final alignment may be required at the highest level. This causes the display to not be testable or sealed until the device is almost fully assembled. This disclosure describes a fully self-contained testable module that includes an entire see-through stack and integrated display for augmented reality glasses. The module is sealed from the environment, preserving the performance as it is shipped and integrated into the AR glasses, and delivered to the customer. AR glasses with a fully testable module as described herein are modular, which makes them easier to repair and upgrade. If necessary due to issues at higher level assembly or with returned units, the module can be replaced independent of other components. The modular design also allows for flexibility with respect to supply management.

KEYWORDS

- Augmented reality (AR)
- AR glasses
- AR eyewear
- AR headset
- Display module
- Modular glasses
- Modular eyewear

BACKGROUND

Designers of AR glasses are faced with packaging challenges. Packaging constraints may force optical components to be aligned at the top level of assembly or some sort of final alignment may be required at the highest level. This causes the display to not be testable or sealed until the device is almost fully assembled. The optical capabilities of the manufacturer therefore need to be sophisticated in order to build such AR displays. The remainder of the AR glasses assembly may not require any optical experience at all.

Aligning the optics at a high assembly level may be a problem if there are any issues with the display since the entire device may need to be taken apart and individual components may need replacement. For example, the display and optical components need to be carefully aligned to optimize the AR display performance and to ensure that the user's view is not distorted. Furthermore, the display and optical components need to be protected from damage during assembly and shipping of the device. Further, it is desirable for AR glasses to look and feel like traditional eyewear. To achieve this, any modularity must be hidden from the user with seamless integration to frames. These problems can be solved if the AR display is a self-contained fully functional module that can be fully assembled, tested, and stocked to install at the higher level assembly.

DESCRIPTION

This disclosure describes a fully self-contained testable module that includes an entire see-through stack and integrated display for augmented reality glasses.

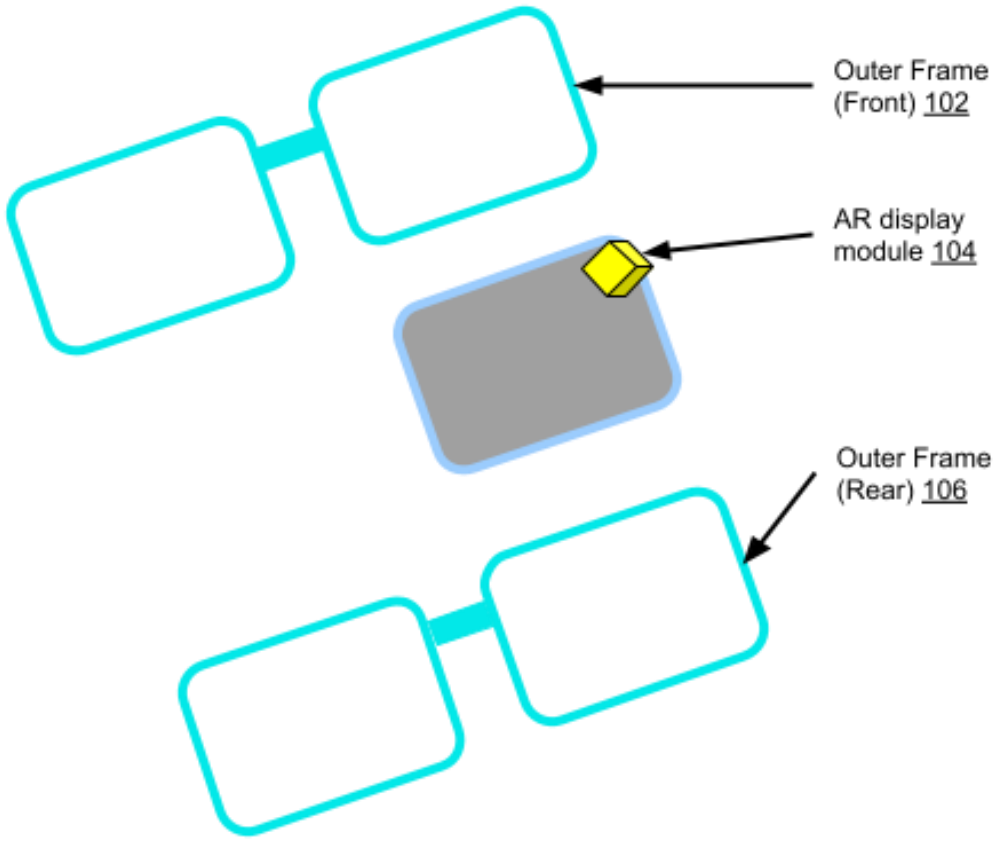

Fig. 1: Accommodating AR sub-module into frames (exploded view)

Fig. 1 illustrates an exploded view of accommodating an AR sub-module into an eyewear frame. The eyewear has a conventional outer frame at the front (102). The AR display module (104) is behind the front outer frame. The assembly is completed by the rear outer frame (106). The module can be assembled, aligned, and tested by an optics alignment specialist before being integrated at a higher level. The module is fully functional and sealed from the environment. Display calibration and acceptance testing can be conducted at this module level such that issues are found early in the build and there is much less manufacturing complexity at the top level assembly. This allows for the AR glasses manufacturer at the top level to have less optics specialization and sophistication. The module includes a display, an optical system, and ophthalmic lenses.

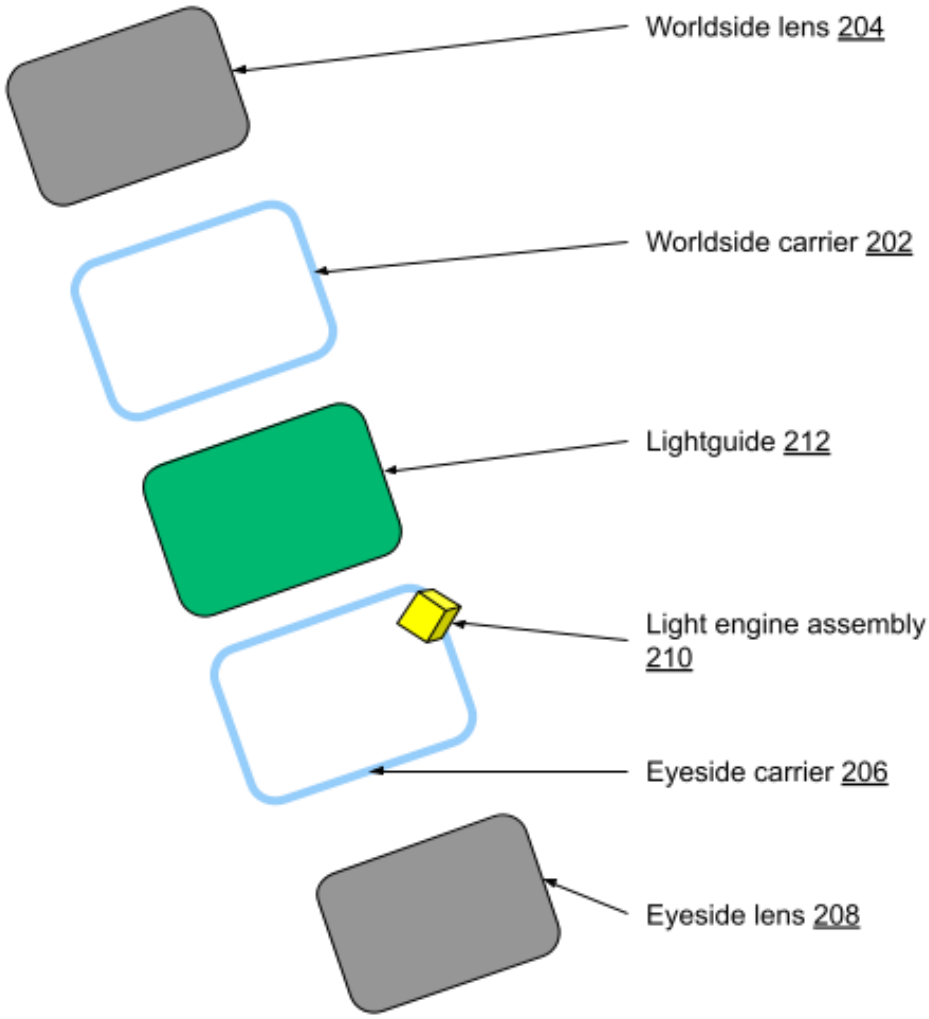

Fig. 2: Exploded view of AR module

Fig. 2 shows an exploded view of the AR module. The worldside carrier (202) is the part of the frame that is farthest away from the wearer. The worldside carrier houses the worldside lens (204). On the other side of the frame, the eyeside carrier (206) houses the eyeside lens (208). The light engine assembly (210) is housed adjacent to the eyeside carrier. The lightguide (212) is positioned between the worldside and eyeside carriers.

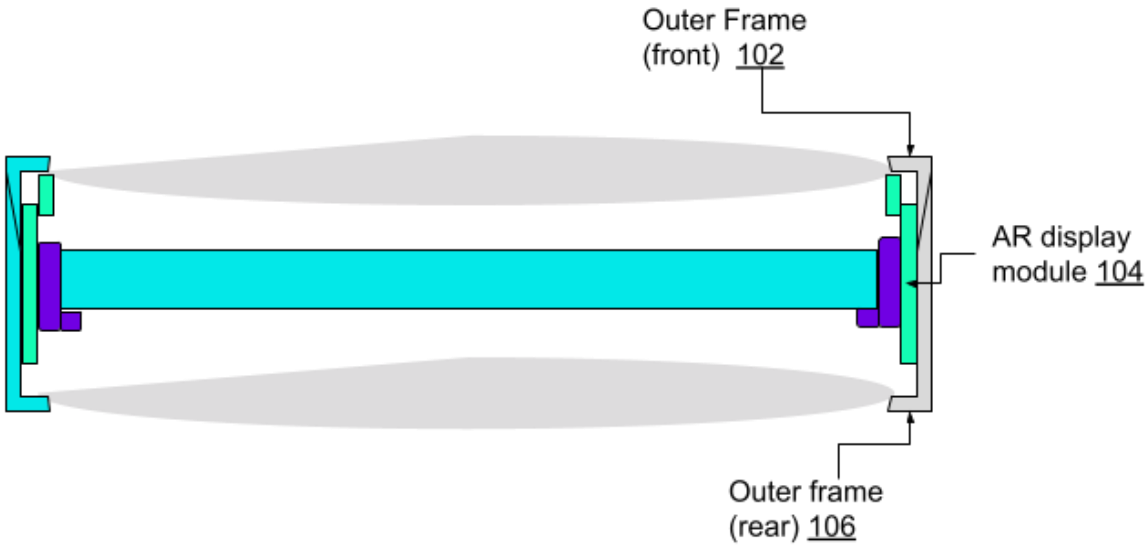

Fig. 3: Cross-section view of AR display module with frames

Fig. 3 shows a cross-section view of the AR display module with frames. The front frame (102) houses the AR display module (104), bookended by the rear frame (106). The module is fully self-contained and testable such that it can be tested without being integrated into a top level AR glasses assembly. This allows for the module to be tested thoroughly and to identify any issues early in the build process. The module is also sealed from the environment - it is protected from dust, moisture, and other contaminants, preserving the performance as-measured as it is shipped and integrated and delivered to the customer. This makes the module durable and reliable.

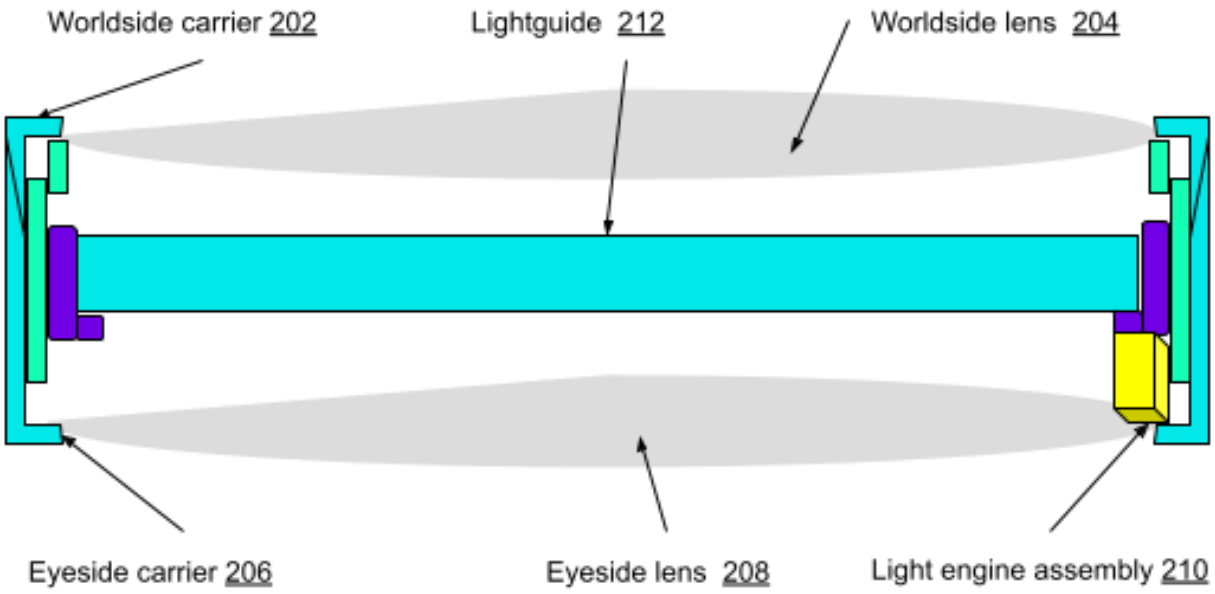

Fig. 4: Cross-section of AR display module

Fig. 4 illustrates a cross section of the AR display module. The worldside carrier (202) has the worldside lens (204) attached to it. The eyeside carrier (206) houses the eyeside lens (208). The light engine assembly (210) is affixed onto the carrier. The lightguide (212) is in between the eyeside and the worldside lens. Display calibration can be conducted at this module level. The display can be calibrated, and the data saved with the unit to ensure smooth integration to the higher level assembly. AR glasses with a fully testable module as described herein are modular, which makes them easier to repair and upgrade.

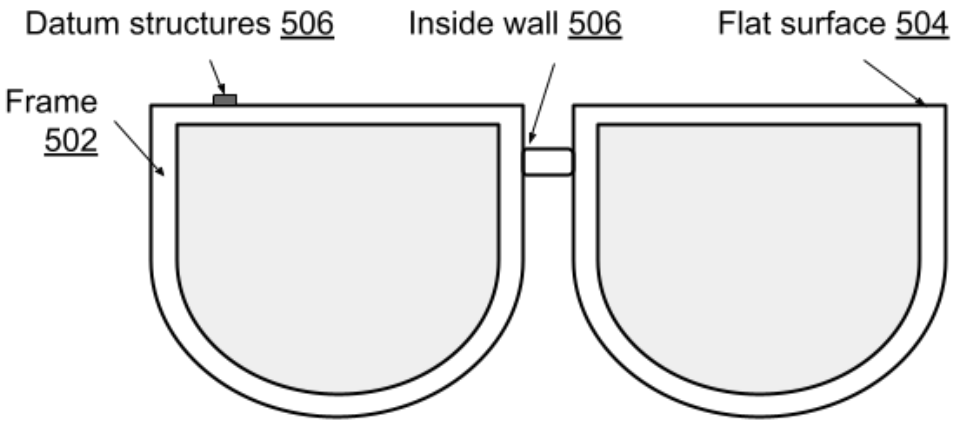

Fig. 5: AR display module interface

Fig. 5 illustrates the module interface of the AR display module. The entire module is housed in the frame (502) of the eyewear. The module is housed behind the flat surface (504) and has a series of datum structures (506) located next to the inside wall (508). This set of datums allows for repeatable installation and alignment into the front frame of the AR glasses. The same datum and installation method is used to install the display at the sub-module level for display acceptance and calibration. This allows for seamless integration of the module into the frames with similar performance at the top level and modular level.

The modular AR glasses as described herein have a number of benefits. For example, the modular design allows for flexibility with respect to supply management. The module can be sourced from an optics specialist while the higher level assembly can be sourced from a generalist manufacturer. Further, since the display is fully functional at the module level, early determination of display performance is possible, with pass/fail criteria being met or otherwise at an early stage. This allows for lower costs of yield issues. Also, calibration is possible at the level of a module, since the module manufacturer has ownership of build, performance, and calibration.

Since the module is fully sealed, it is robust. It can therefore be stocked, shipped, handled, installed, and delivered to customers without impacting performance. Consequently, the module manufacturer can maintain high cleanliness standards and the higher level manufacturer can have less stringent requirements. If necessary due to issues at higher level assembly or with returned units, the module can be replaced independent of other components.

CONCLUSION

This disclosure describes a fully self-contained testable module that includes an entire see-through stack and integrated display for augmented reality glasses. The module is sealed from the environment, preserving the performance as it is shipped and integrated into the AR glasses, and delivered to the customer. AR glasses with a fully testable module as described herein are modular, which makes them easier to repair and upgrade. If necessary due to issues at higher level assembly or with returned units, the module can be replaced independent of other components. The modular design also allows for flexibility with respect to supply management.

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