Dual Handheld and Video Otoscope

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Abstract

Otoscope is a device for looking inside of an ear canal, and can be categorized into two types: handheld and video. Instructor guidance when teaching otoscope techniques for animals poses a challenge. The challenge arises with each type of the otoscope as they both don't allow synchronous feedback to instructors. An otoscope was designed to include key features from both the handheld and video otoscope to address client requirements.

Motivation

- Veterinary student poses a safety concern to the animal during examinations as their technique and fluency using the otoscope.
- A device that provides a simple approach will benefit students during examinations as they will be guided by instructors afar.
- Aspects of this device can be transferred to use on humans.

Problem Statement

The current designs of handheld otoscopes for animal practice do not allow video transfer to a distant view compared to a video otoscope, which is practiced differently in simulations. The goal is to design a handheld otoscope with video capabilities to allow student-performed examinations to be visualized to the faculty for assessments.

Background Research

- A dog's ear is composed of distinct structures that veterinarians classify into the outer, middle, and inner ear [1].
- A beam splitter is utilized to direct incident light, allowing a portion to pass through to the lens while reflecting at a 45-degree angle towards the camera [2].
- A color accuracy in cameras can be measured using metrics like Delta E (ΔE) for color difference, and influenced by factors such as white balance, saturation, color gamut, sensor characteristics, lens quality, lighting conditions, and calibration. [3]

Design Specifications

- The otoscope resembles features of a traditional otoscope (using lenses) and a video otoscope (ability for distant view).
- External light source that is bright to view the inner ear canal
- Wireless connection to external device for video viewing
- Maintain below budget
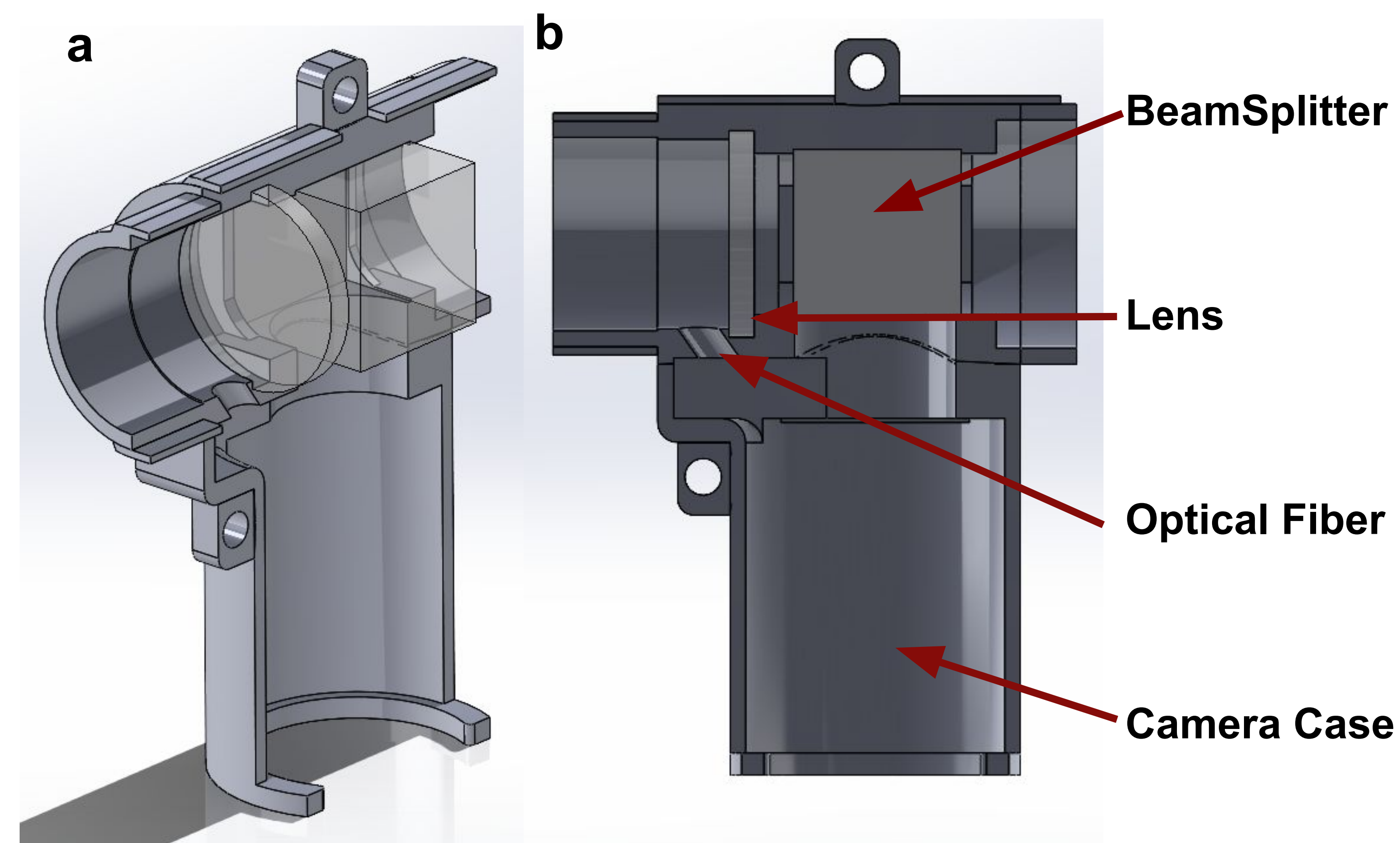- Structurally similar to the current traditional otoscope model

Final Design

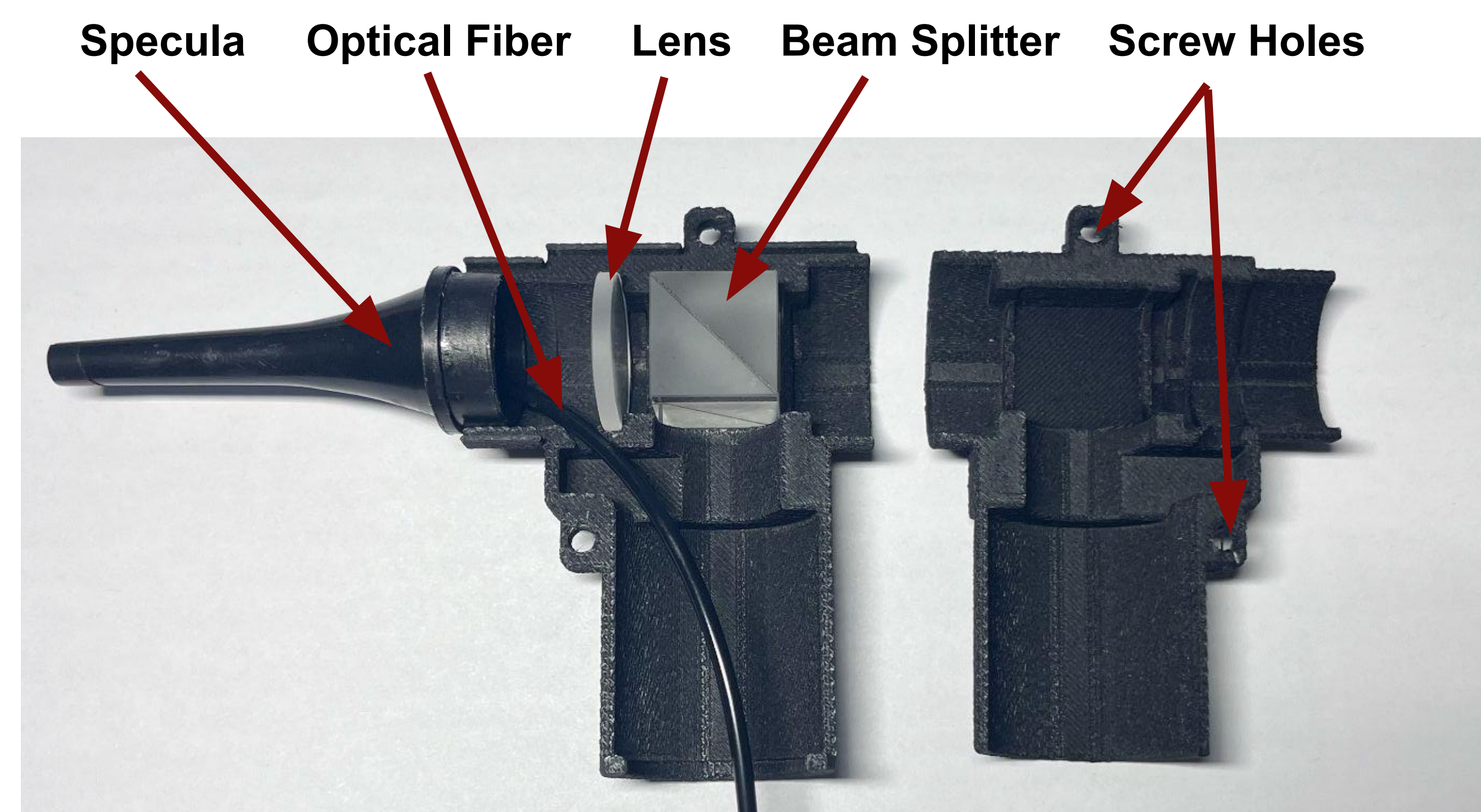Figure 1 - Inside view of Otoscope Model. a) 3D view, b) side view

Labels: BeamSplitter, Lens, Optical Fiber, Camera Case

Labels: Specula, Optical Fiber, Lens, Beam Splitter, Screw Holes

Figure 2 - Prototype Otoscope Casing Without Camera

Material Costs

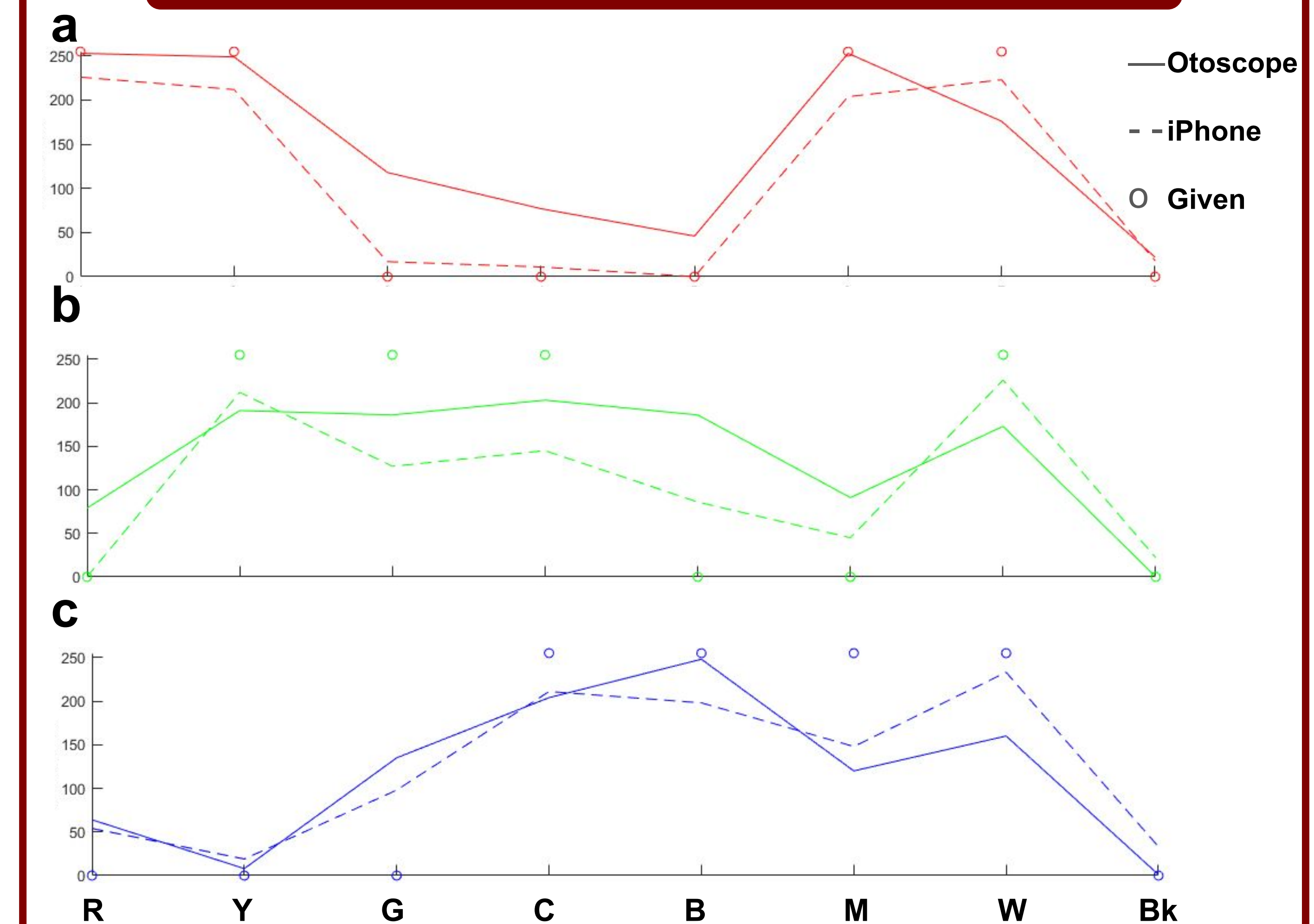|	
Light Components	$ 46.56
Camera	$ 39.99
Previously Owned Materials Beam Splitter, Lens	$ 143.99
3D Printing and Fabrication Costs	$ 7.99
Total	**$ 238.53**

Testing

Figure 3- Color Testing Results. a) R-value, b) G-value, c) B-value. Legend: R-Red Y-Yellow G-Green C-Cyan B-Blue M-Magenta W-White Bk-Black. Yaxis- RGB value from 0-255
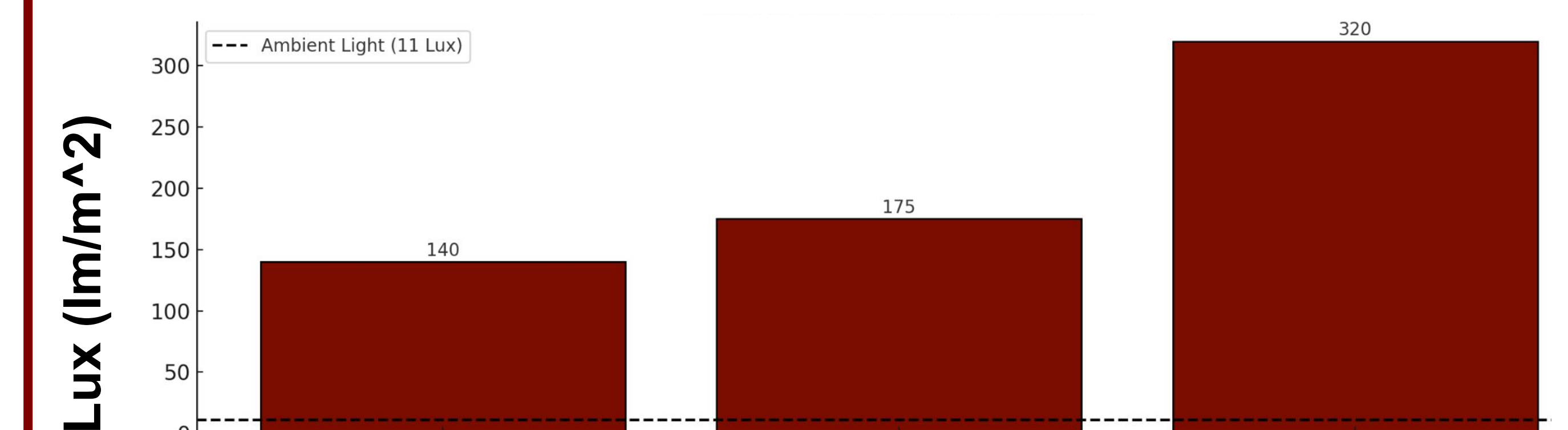

Figure 4- Illumination Source Brightness Testing Results. From left to right: 2023 Design, Traditional Otoscope, new otoscope design

Future Work & Discussion

- Upgrade to a higher-resolution camera for clearer wireless imaging.
- Add a lens to increase the focal length.
- Replace the optical fiber with a cuttable version.
- Improve structural rigidity to prevent damage from drops.

Acknowledgements & References

[1] "Examining and medicating the ears of a dog," Veterinary Teaching Hospital. https://hospital.vetmed.wsu.edu/2022/01/04/examining-and-medicating-the-ears-of-a-dog/
[2] D. R. Paschotta, "Beam Splitters," www.rp-photonics.com. https://www.rp-photonics.com/beam_splitters.html (accessed Nov. 27, 2023).
[3] Prabu KumarPrabu is the Chief Technology Officer and Head of Camera Products at e-con Systems, "What is color accuracy? how to measure color accuracy? - e-con systems," e, https://www.e-consystems.com/blog/camera/technology/what-is-color-accuracy-how-to-measure-color-accuracy/ (accessed Dec. 3, 2024).