Presenting: Kenzie Germanson

iPhone Virtual Reality Model for Microsurgery

BME 200/300

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Clients: Dr. Ellen Shaffrey and Dr. Samuel Poore

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Presenting: Kenzie Germanson

Background - Microscopes

Surgical Microscope

- Very high resolution
- Depth perception
- Expensive
- Uncommon

iPhone

- High resolution
- Minimal depth perception
- Less expensive
- Commonly accessible

Background - Past Designs

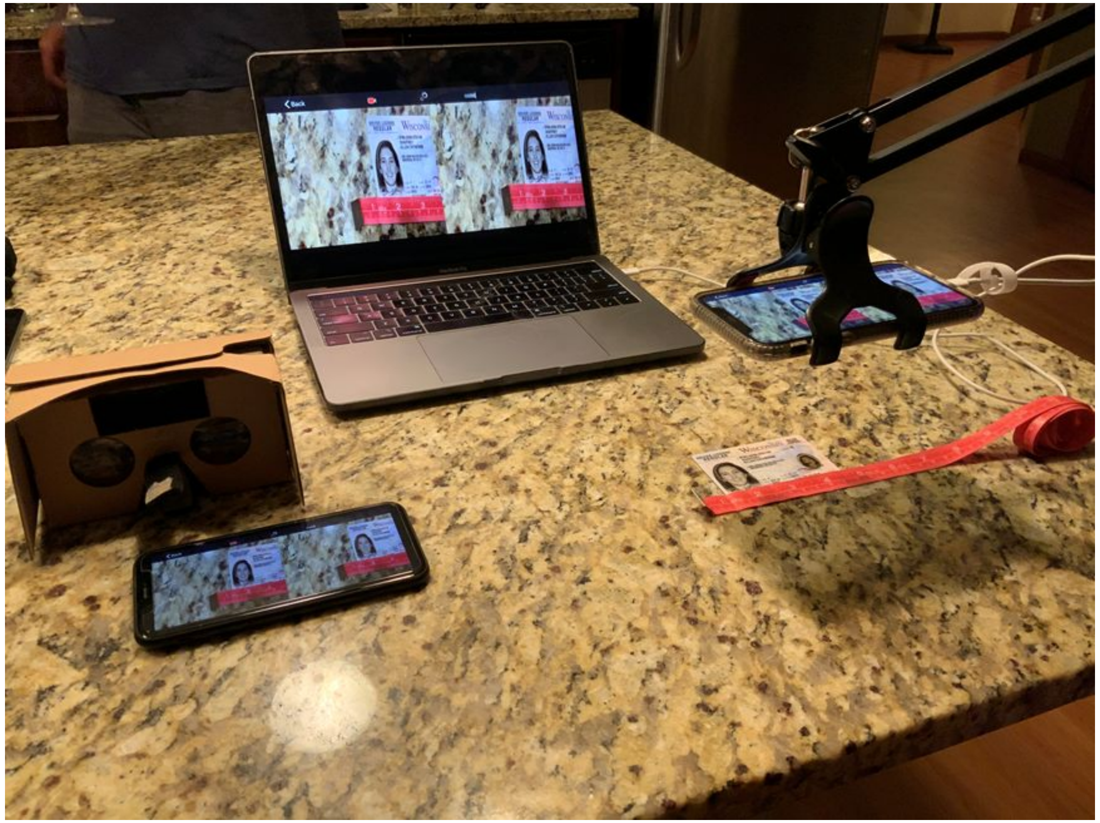

__Figure 1.__ Client's Google Cardboard design to increase depth and accessibility. Photo provided by clients.

Google Cardboard

- Accessible
- Streamable
- Depth
- Major delay
- Unadjustable

Previous BME Group

- Program development
- Major delay
- Lacks depth

Presenting: Nicholas Jacobson

Competing Designs (Nicholas)

- Orbeye 4K 3D Orbital Camera System
  - 26x magnification
  - Stereoscopic camera and display
  - Removes the constraints of an optical microscope [1]

Figure 2. *Orbeye 4K 3D Orbital Camera System*

- Mitaka MM51
  - Optical Microscope
  - Non-stereoscopic display for viewing subject
  - More restrictive for the surgeon [2]

Figure 3. *Mitaka MM51 Optical Microscope*

Presenting: Nicholas Jacobson

Problem Statement

- Design a cost-effective microsurgical training system that utilizes a smartphone camera and outputs a stereoscopic image.
    - Current imaging technologies are expensive
    - Not readily available for a large amount of trainees
    - Unable to be brought home for practice

Presenting: Mitchell Benyukhis

PDS Summary

Design Requirements

- Mounted on a adjustable stand
- Light Weight; < 4.5 kg
- Transmit video footage from camera to a stereoscopic display

Performance Requirements

- Creates image with high zoom and resolution to see sutures (0.070 mm in diameter) clearly [3]
- Streaming resolution of at least 10.2 megapixels
- Stream delay of no more than 0.5 seconds

Splitting Lens Design

- Uses a single smartphone
- Two lenses at different positions
- Customized viewing options
  - Polarized
  - VR
  - Monitor
- Eliminate duplicate view (FOV)

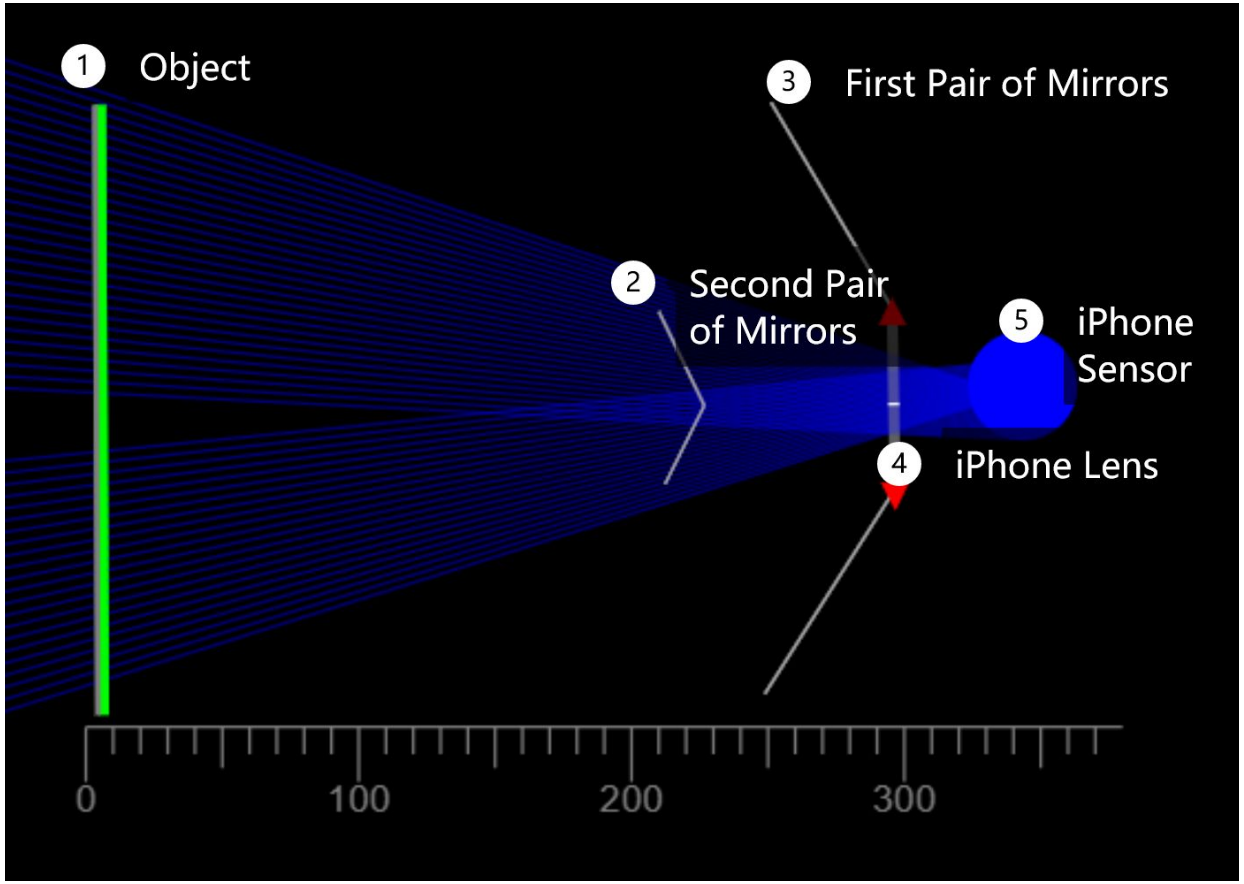

Figure 4. *The light will reach (3) first pair of mirrors then to the second pair (2), and being reflected to the smartphone lens (4). The position and dimensions of the components are not in scale and are subject to change.*

Complimentary Multi-Bandpass Filter (CMBF)

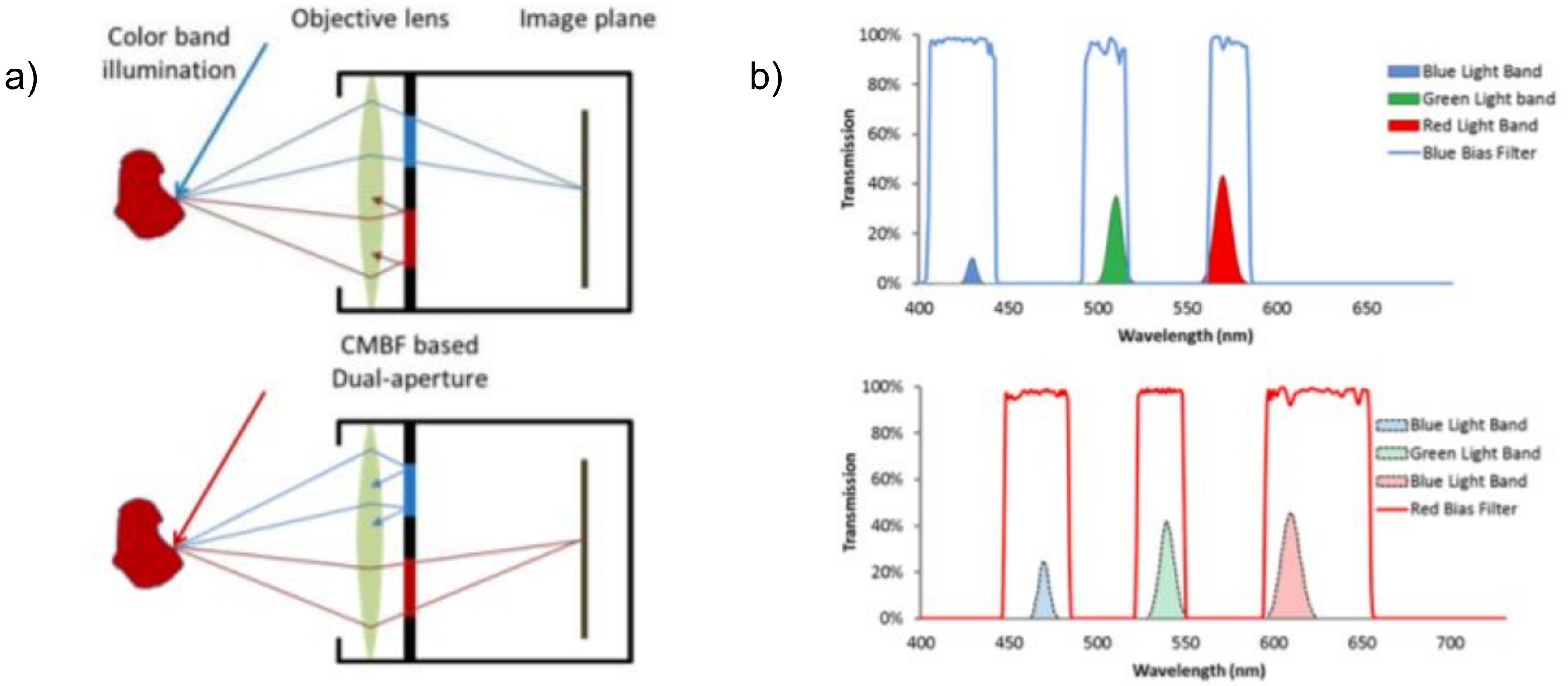

Figure 5: (a) A pair of complementary bandpass filters placed at the dual-aperture single objective lens. The scheme describes the two viewpoints made by the complementary bandpass filters. (b) An actual spectral plot of a pair of complementary triple-band bandpass filters purchased commercially off-the-shelf. The bell curves are light bands selected by a tunable filter from a broadband light. Figures adapted from Bae *et al*. [5]

Efficient Algorithm

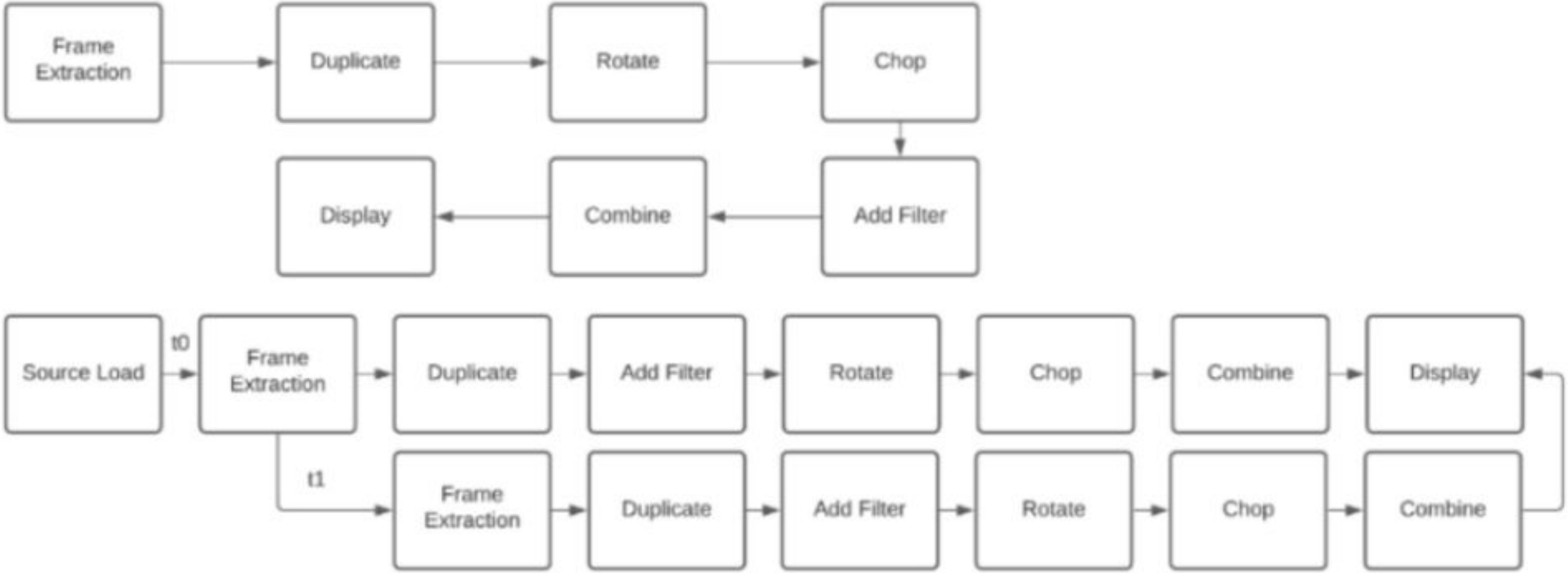

Figure 6: (Top) Original algorithm developed by the previous team. (Bottom) Proposed algorithm to enhance efficiency

Presenting: Haochen Wang

Design Matrix

Criteria		Splitting Lens Design		Complementary Multi-Bandpass Filter (CMBF)		Efficient Algorithm Design	
	Weight	Raw Score	Score	Raw Score	Score	Raw Score	Score
Effectiveness (Time Lag)	25	5/5	25	5/5	25	2/5	10
Quality (Optical Quality)	20	3/5	12	4.5/5	18	3/5	12
Ease of Use	20	5/5	20	4/5	16	5/5	20
Cost	15	3/5	9	2/5	6	5/5	15
Safety	10	4/5	8	4/5	8	5/5	10
Ease of Fabrication	5	4/5	4	1/5	1	5/5	5
Durability	5	4/5	4	2/5	2	5/5	5
Total	100	28/35	82	23.5/35	76	30/35	77

Table 1: Design matrix of proposed designs. The criteria assigned with a full score are highlighted in yellow. And the highest total score is highlighted in green.

Future Work

- Depth-Perception
  - Cost Effective
  - Malleable to change
- Small render lag time
- Distance between lenses for binocular vision
- Maintain steadiness
- Determine value of zoom for best resolution and visibility of suture

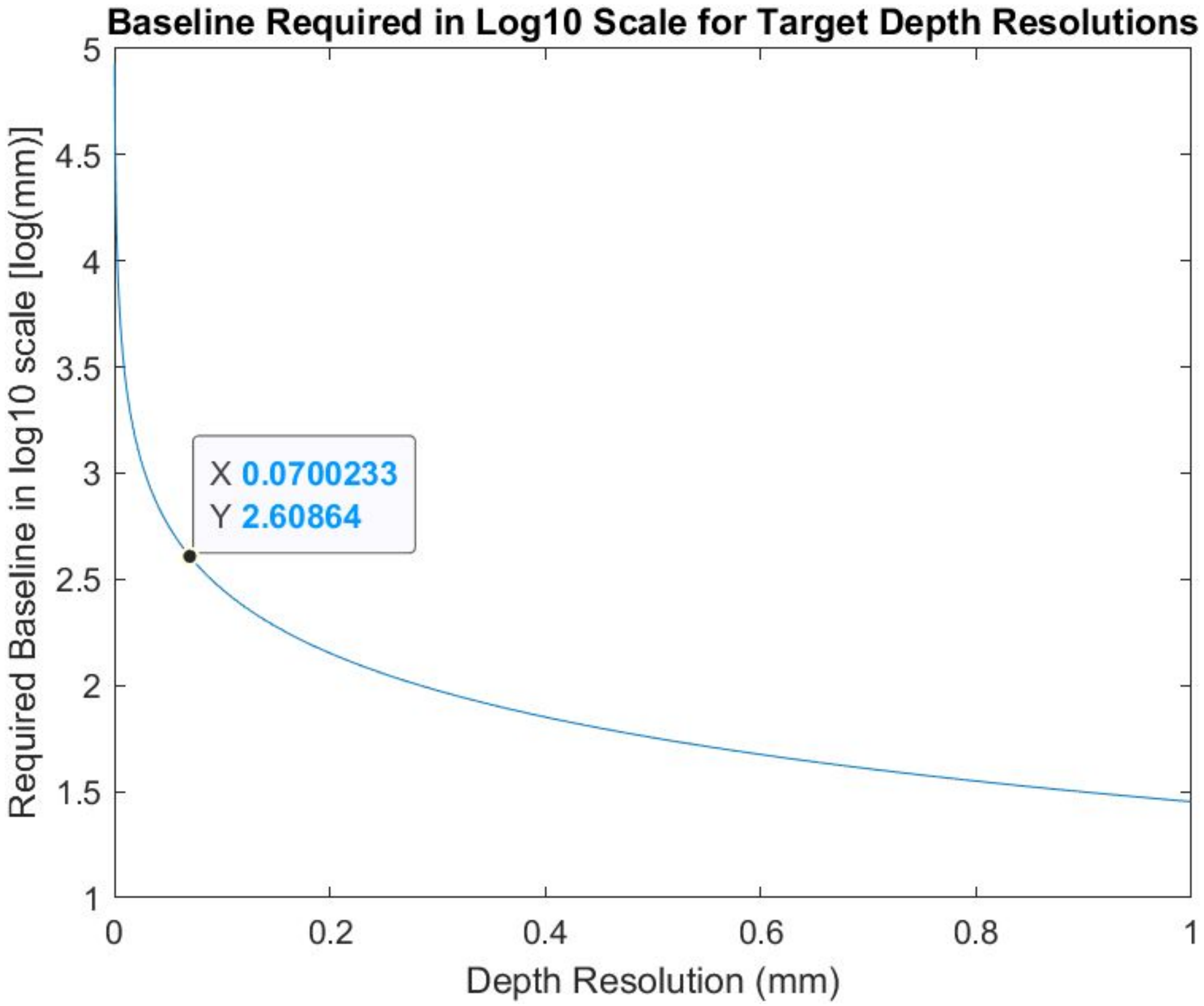

Figure 7: The baseline required (in a log10 scale) for target depth resolution. The diameter of the suture (minimal detectable size) is marked on the graph. The resulting baseline is 406 mm for the configuration Mathematical model adapted from Seal et al. *[6].*

Presenting: Henry Plamondon

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Presenting: Henry Plamondon

References

[1]“ORBEYE 4K 3D Digital Video Microscope | Olympus Medical Systems,” *www.olympus.co.uk*. https://www.olympus.co.uk/medical/en/Products-and-solutions/Medical-specialities/Neurosurgery/ORBEYE.html [accessed Oct. 15, 2021].

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