Optical Surgical Navigation: A Promising Low-cost Alternative

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Background

- Computer-assisted surgery provides real-time guidance to surgeons during minimally invasive procedures

    - Allows surgeon to see instrument positions relative to preoperative imaging
    - High precision → improves success of surgery

Background

- In recent years, surgical navigation has become a promising alternative to augment traditional procedures
    - Neurosurgery
    - Orthopedic surgery
    - Maxillofacial surgery

Current Solutions

NuVasive

Navigation is dependent on infrared, spherical markers
- Relies on smart imaging through a digital screen to track trajectories
- Cost: $360,000 - $500,000

Surgalign

Navigation is dependent on infrared, spherical markers
- Augmented reality screen to detect trajectories
- FDA cleared, no price listed

Talke Biomedical Lab Approach

We aim to design a surgical navigation system that is:
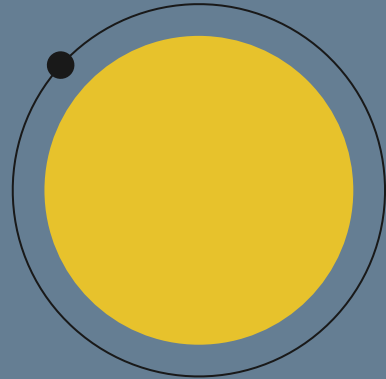 Cost-effective
 Radiation-exposure limiting
 Accurate
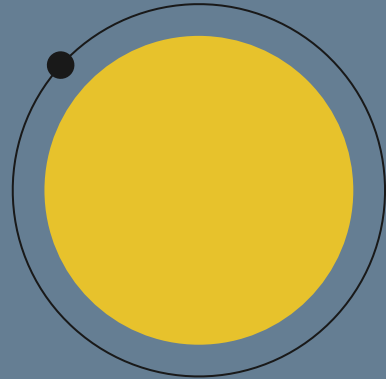
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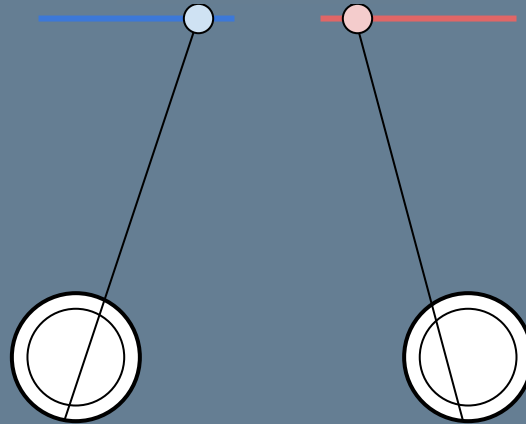- Radiation-exposure limiting
- Accurate

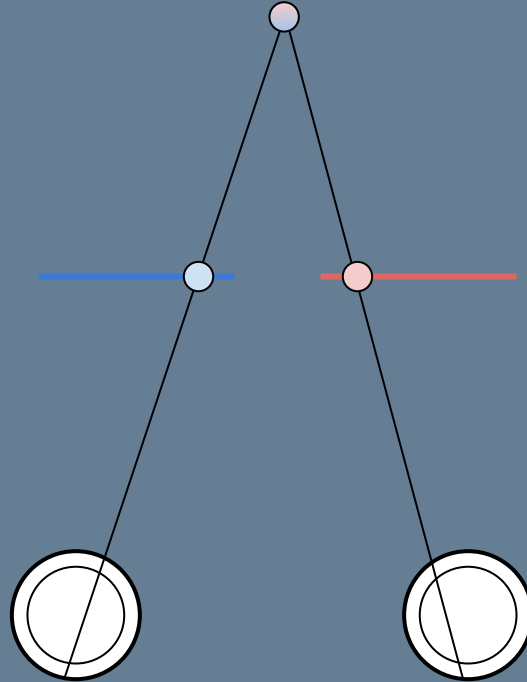Current proposition: optical tracking using stereoscopic vision
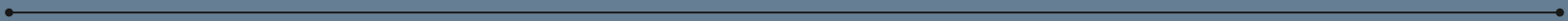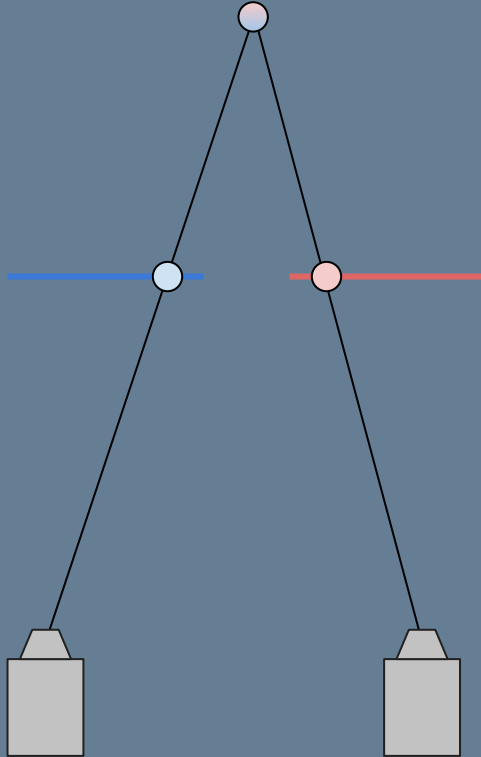
Stereoscopic Vision – In Concept

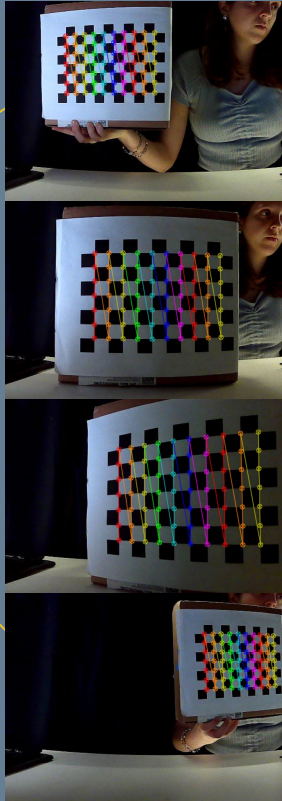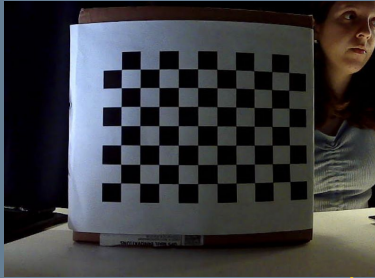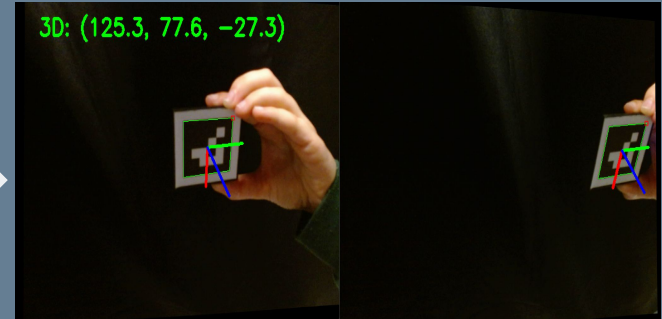# Stereoscopic Vision – In Concept

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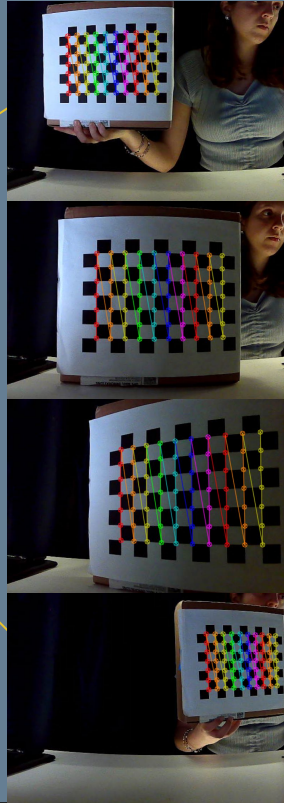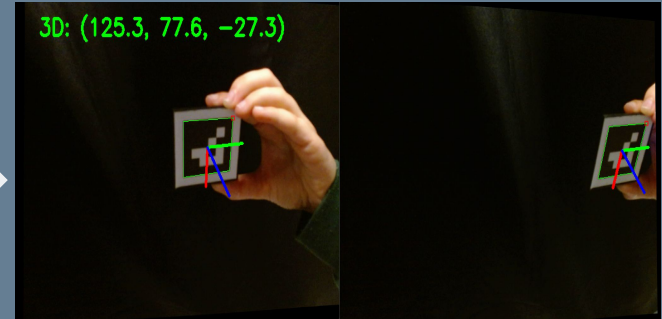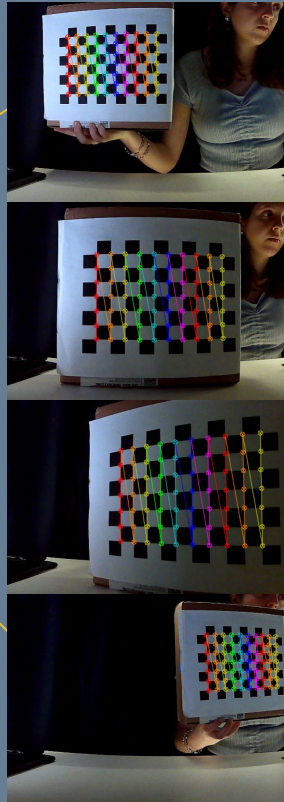
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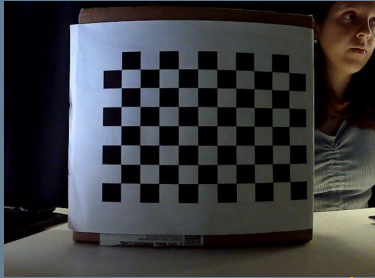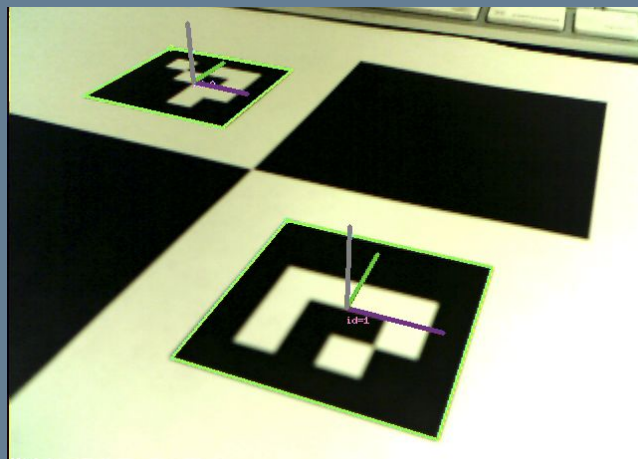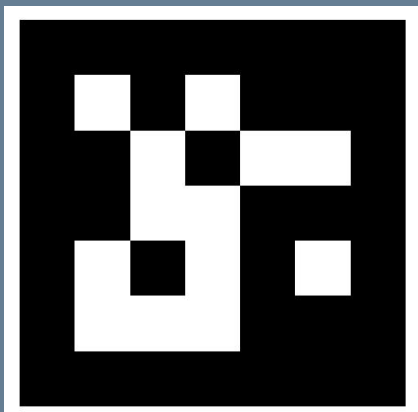# Stereoscopic Vision – In Practice

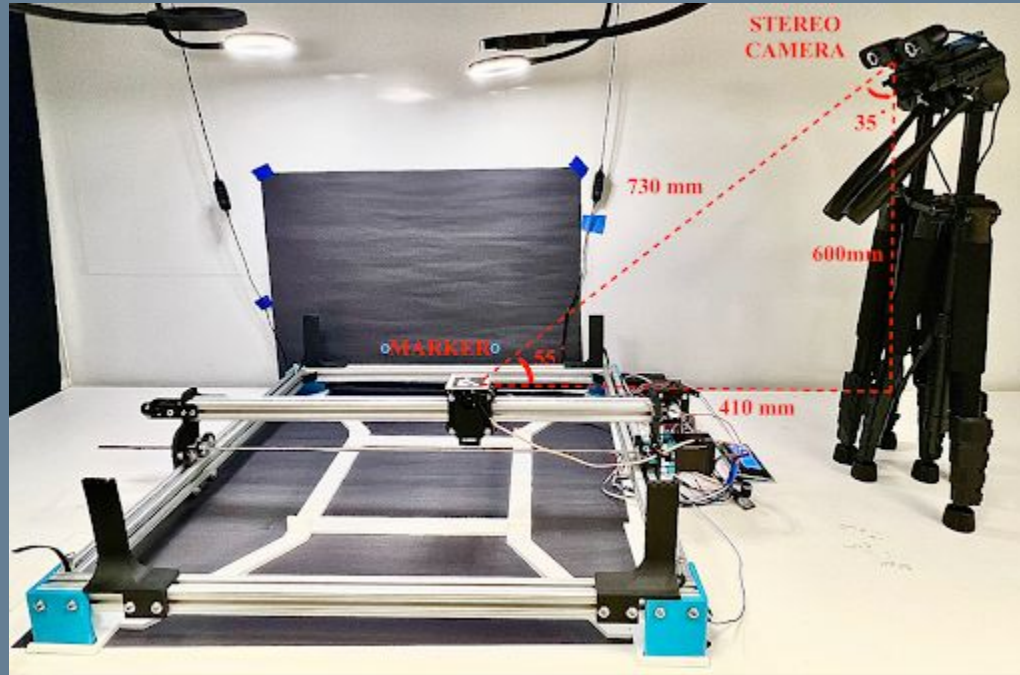# Stereoscopic Vision – In Practice

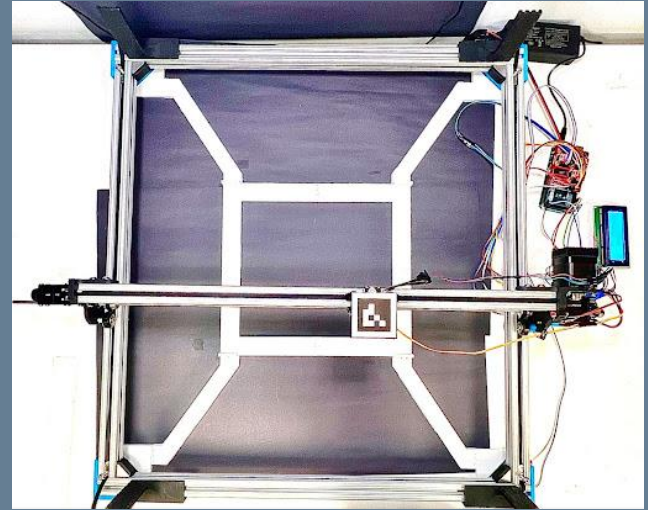# Stereoscopic Vision – In Practice

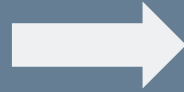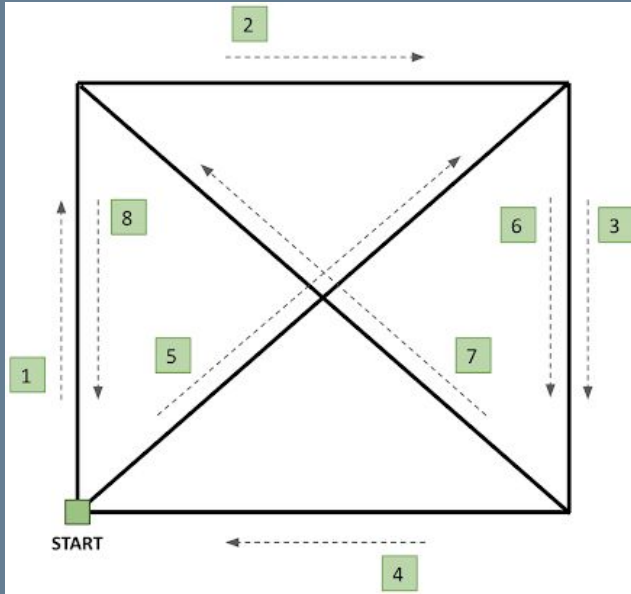# Stereoscopic Vision – In Practice

ArUco Markers

Positioning Platform

Design-validation

Experiments
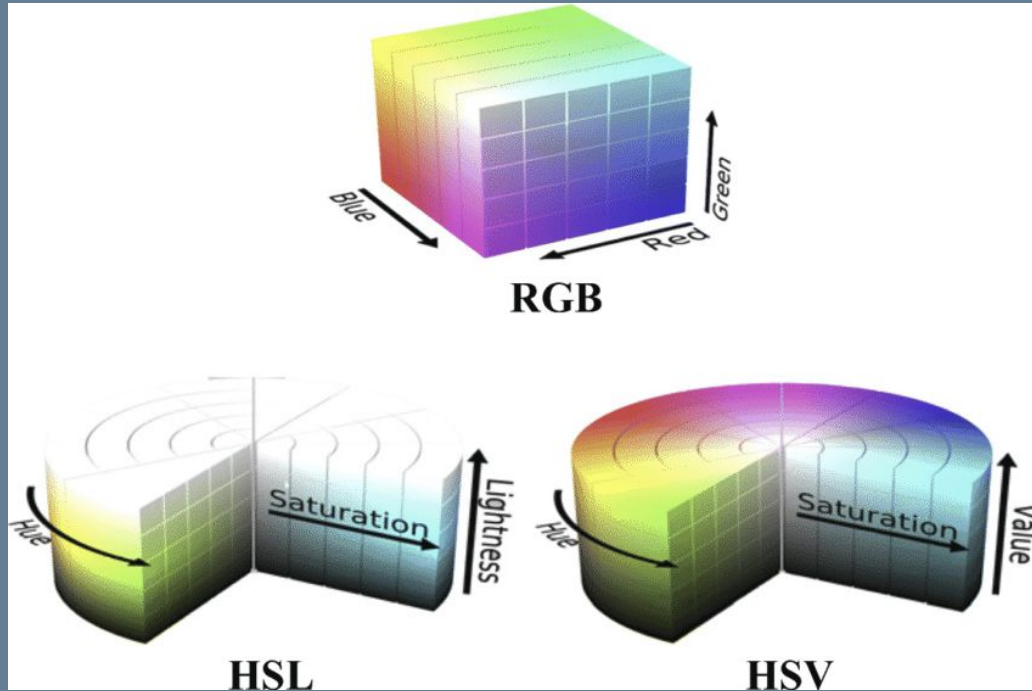
Experiments

TABLE 1: DETECTION PERCENTAGE (%) OF FOUR COLORED MARKERS IN RGB, HSL AND HSV COLOR SPACES.

Color Space	Color			
	White	Pink	Yellow	Orange
RGB	99.7	98.1	97.1	99.5
HSL	99.5	81.3	89.7	87.0
HSV	97.5	73.5	78.4	80.6

TABLE 2: MARKER TRACKING AVERAGE ERROR (MM) OF FOUR COLORED MARKERS IN RGB, HSL, AND HSV.

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RGB	5.48	5.62	12.35	5.39
HSL	5.38	6.80	5.96	6.26
HSV	5.61	6.98	6.17	5.88

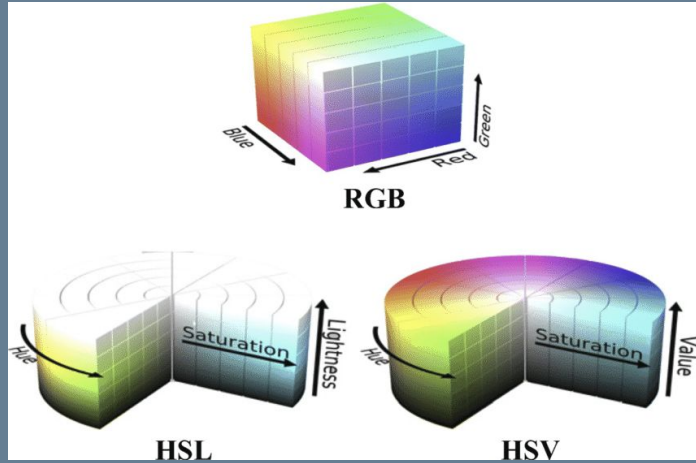**TABLE 1: DETECTION PERCENTAGE (%) OF FOUR COLORED MARKERS IN RGB, HSL AND HSV COLOR SPACES.**

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Discussion

- Our surgical navigation system is promising:

  - 5 mm of error is higher than needed for clinical use but has potential to be reduced with higher quality cameras

- Affordable:

  - We spent around 40 dollars on two web cameras

- Minimally invasive:

  - Only requires external cameras and ArUco markers
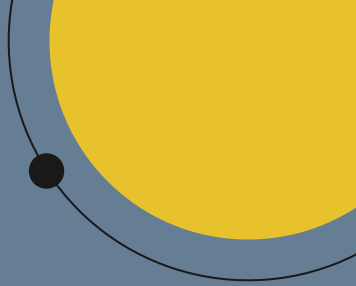
Future Work

- Increase the quality of cameras used in order to increase the accuracy of the system

- Integrate a multi-camera system

- Transition to adhesive markers
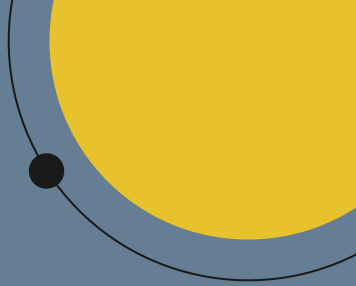
Thank you!

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