

Development of a Pediatric Laparoscopic Training and Skills Assessment Simulator

Biomedical & Electrical Engineering

Atallah Madi, Esraa Alaa Aldeen, Huda Sheikh, Youssef Megahed

Group #27

1. BACKGROUND

What is pediatric laparoscopy?

- Minimally invasive surgical technique
- Small incisions (0.5-1 cm)
- For diagnosis or removal
- Reduced pain and recovery time
- Limited space and margin for error

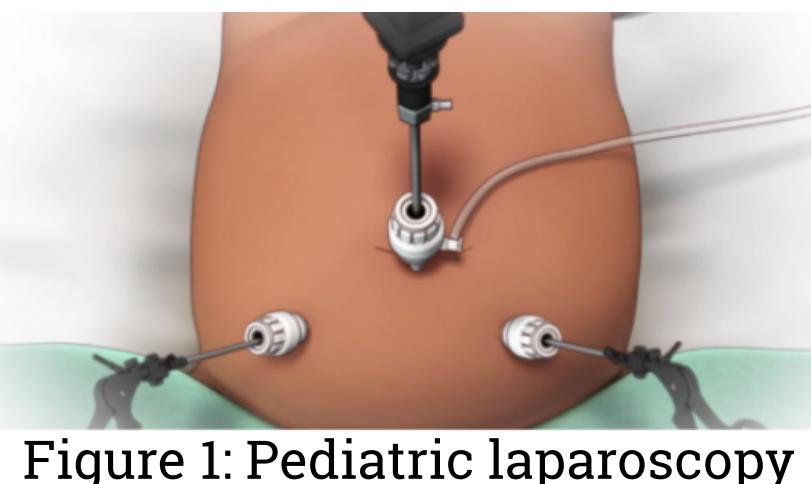


Figure 1: Pediatric laparoscopy

TOOLS IN PEDIATRIC LAPAROSCOPY

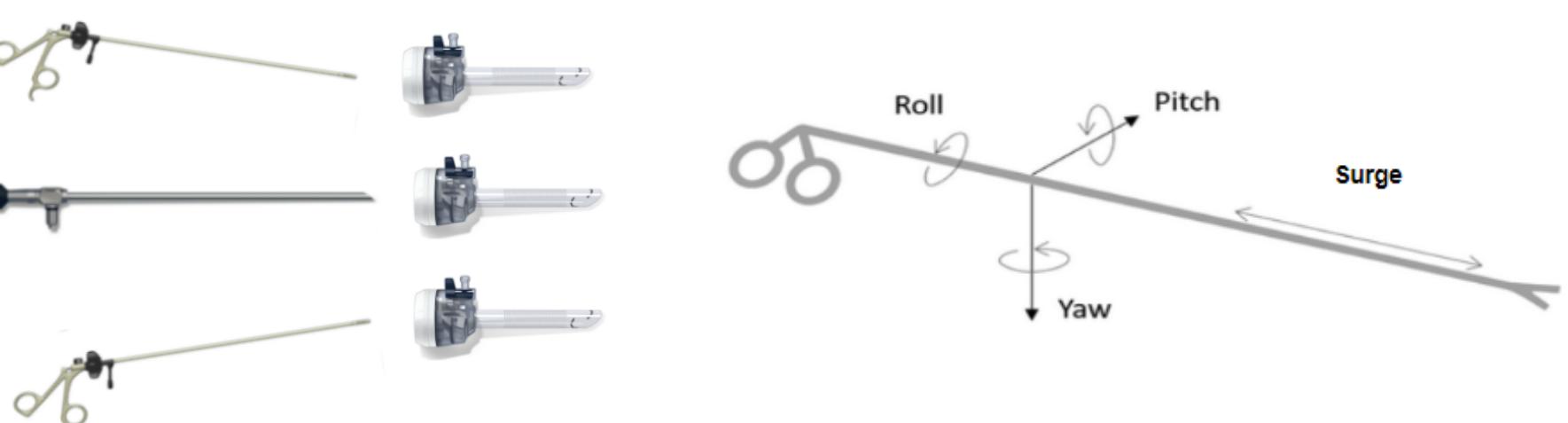


Figure 2: Tools used in pediatric laparoscopy

LAPAROSCOPIC TASKS

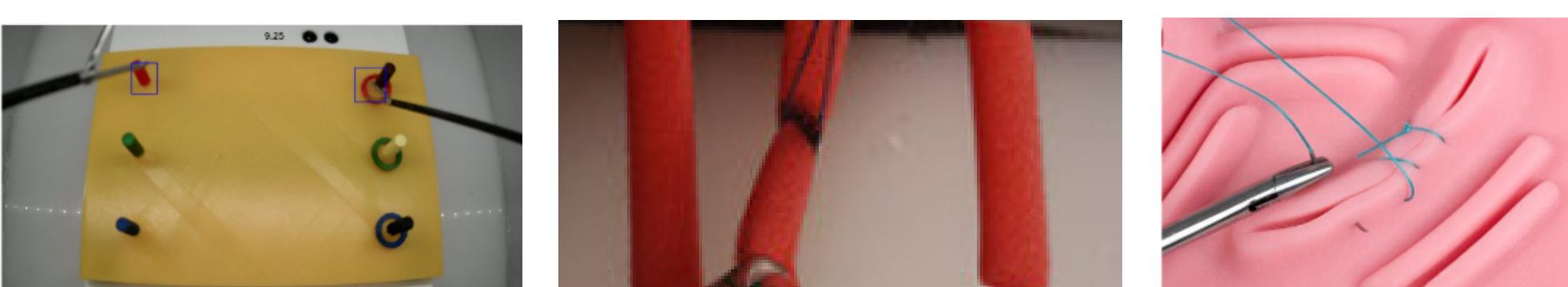


Figure 3: Peg transfer (left), ligating loop (middle), suturing (right)

2. PROBLEM STATEMENT

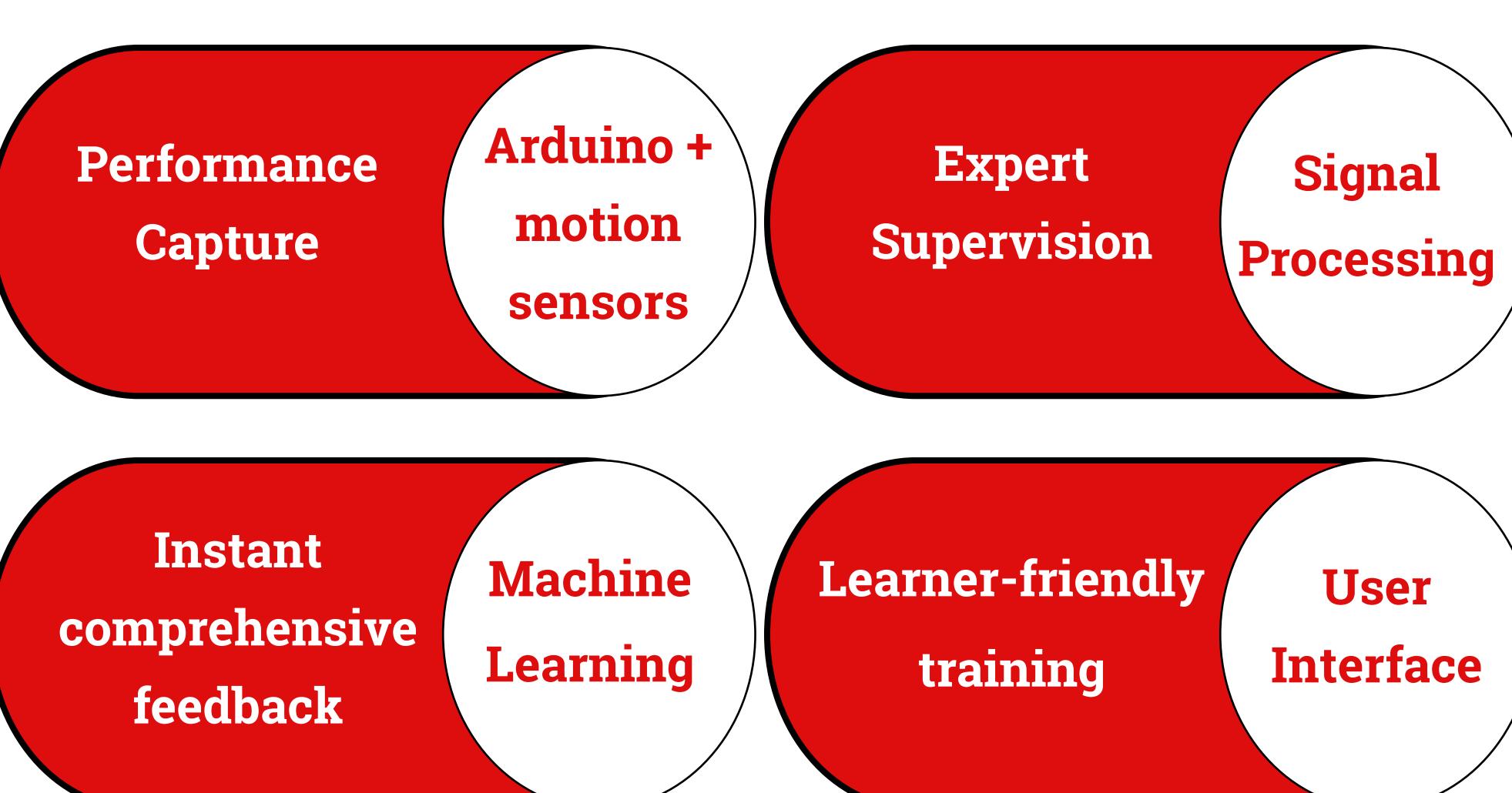
Current pediatric laparoscopic training simulators:

- Lack sufficient tracking methods
- Need expert supervision
- Offer limited instant feedback



Figure 4: Surgical simulator

3. DESIGN SOLUTION



PEDIATRIC LAPAROSCOPIC SIMULATOR



Figure 5: Our pediatric laparoscopic surgical simulator

AUGMENTED REALITY ENVIRONMENT

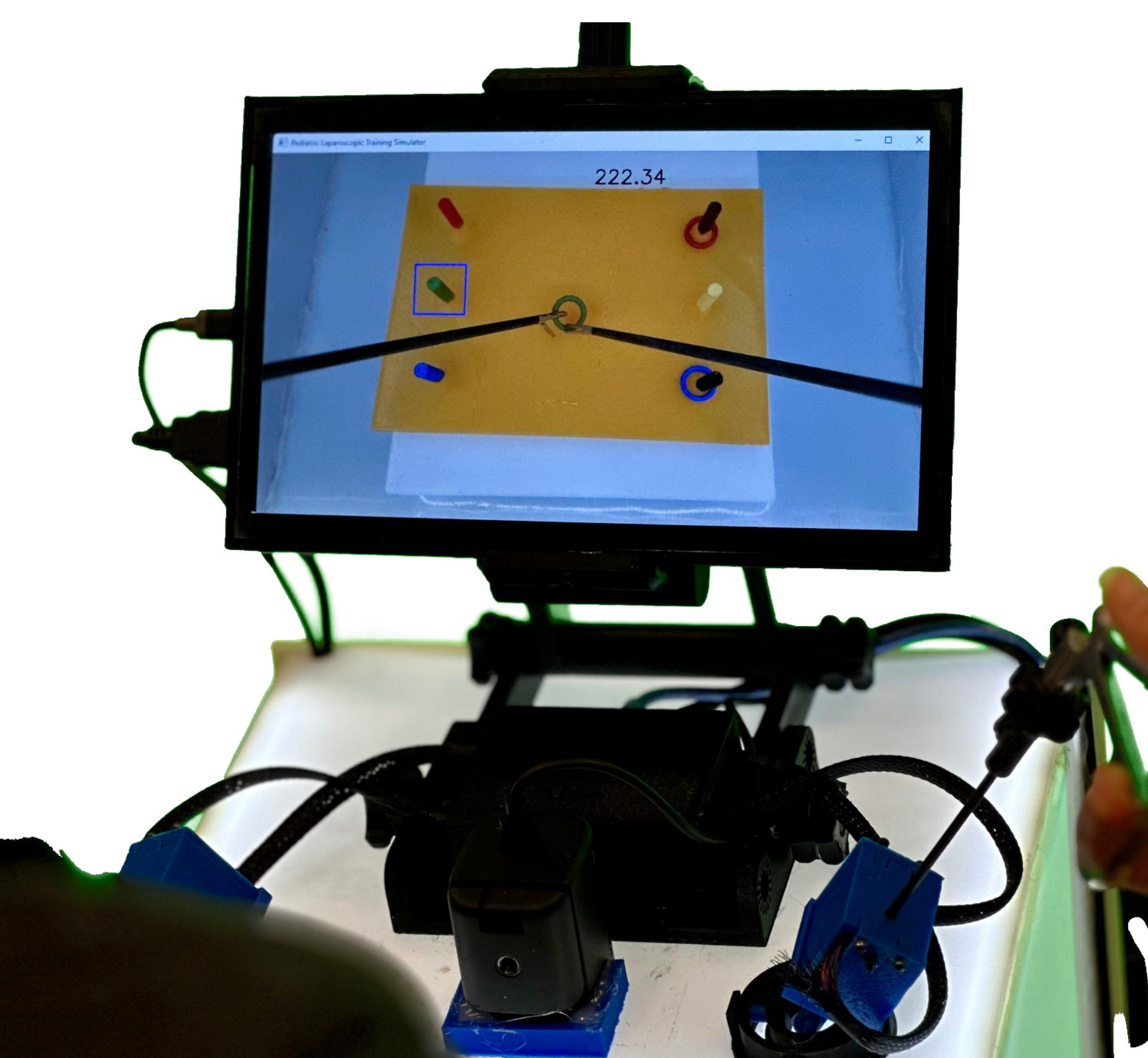
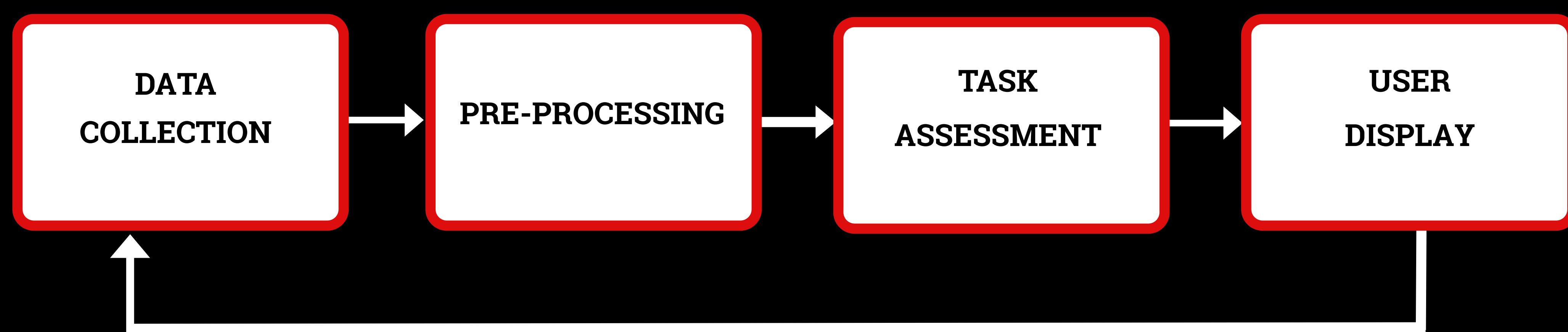


Figure 6: Performing a task on the laparoscopic simulator

4. OUR DESIGN FLOW



DATA COLLECTION

Gyroscopes, Load Cells, Accel.

I2C, SPI

Microcontroller

Raw Data

Save Reading

Conversion

PRE-PROCESSING

Gesture Recognition Pipeline

Gestures Modelling

Dataset

Training set

Testing set

Labelled Images

used by

Model for Feature Localization

Generated Feature Maps for Gesture Classification

Gesture Classification and Detection

Performance Evaluation

TASK ASSESSMENT

STEP BY STEP

1 Align Data

2 Normalize Data

3 Process Windows

4 Video Processing

5 Calculate DTW Distances

6 Identify Weak Performance

7 Present Insights

8 Generate Feedback

9 Model for Feature Localization

D = $\frac{\sum_{i=1}^k d(i)}{\sum_{i=1}^k k}$ > Mean + Standard Deviation (across all windows)

USER DISPLAY

Voice-assisted navigation

Login/registration menu

Enhanced feedback displays

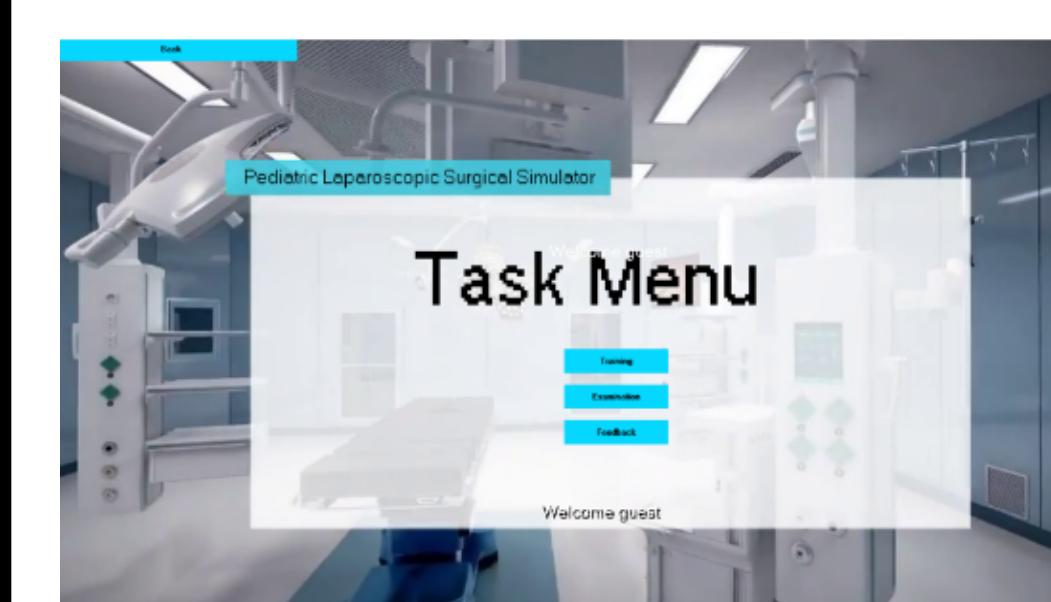


Figure 7: The user interface

5. RESULTS

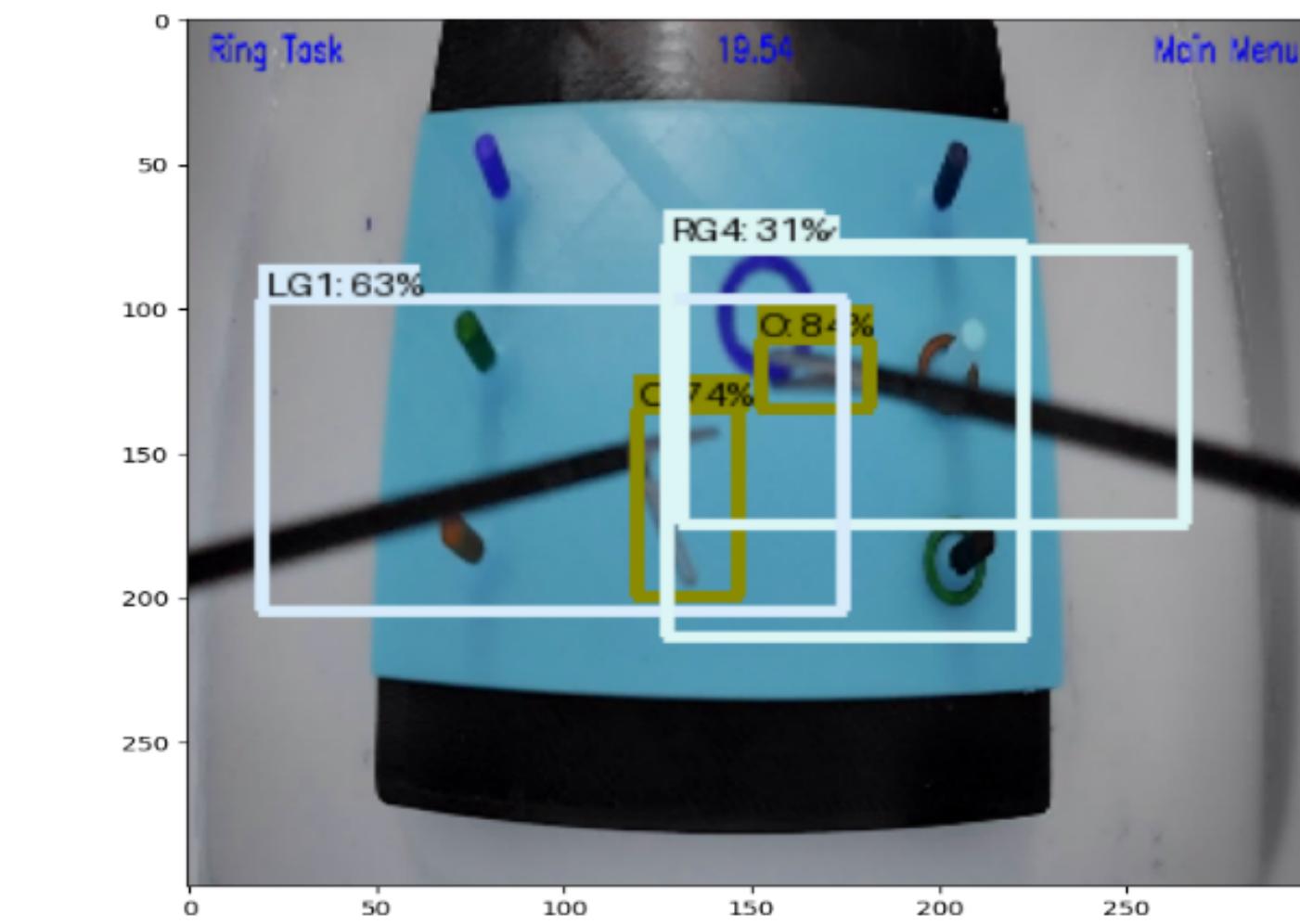
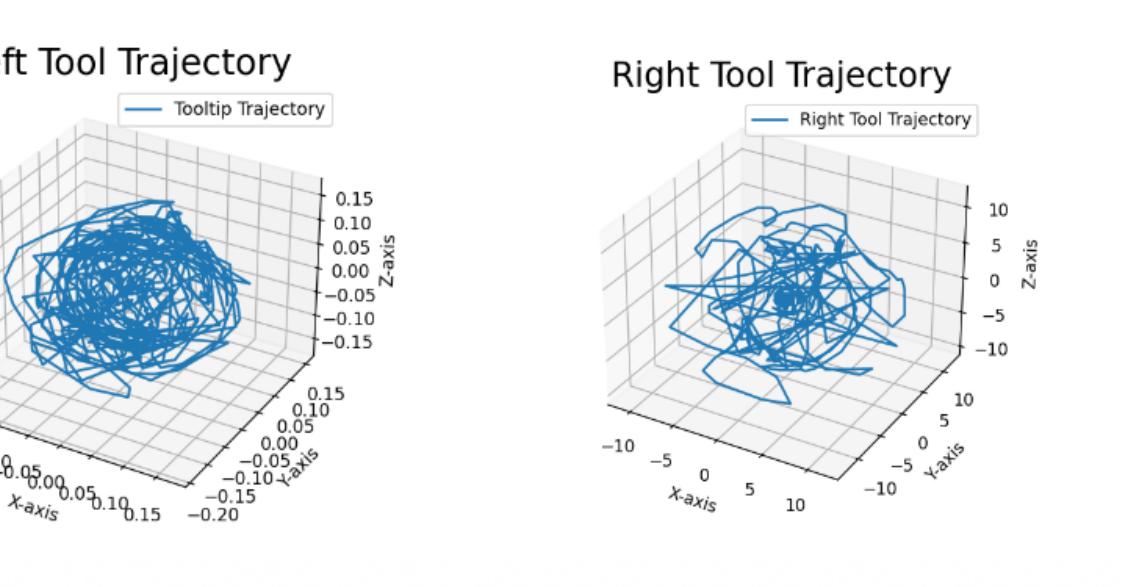
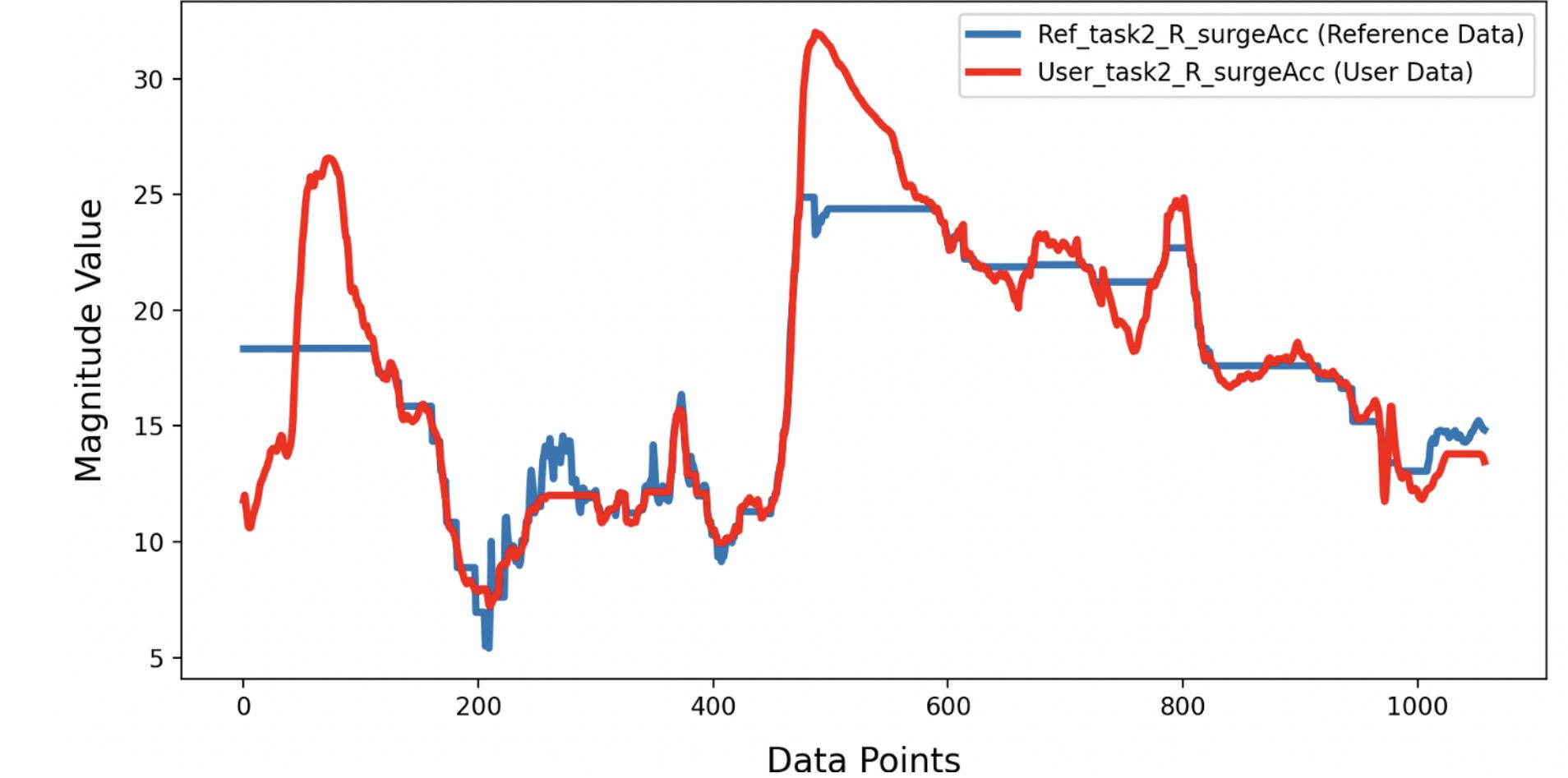


Figure 8: Gesture recognition model for left and right gestures



Left Tool Trajectory

Right Tool Trajectory



Aligned_task2_R surgeAcc

Ref_task2_R surgeAcc (Reference Data)

User_data (User Data)

Figure 9: Visual feedback (bottom) and tool trajectory (top)

6. IMPROVEMENTS

Visual aid for feedback

Improving gesture recognition model

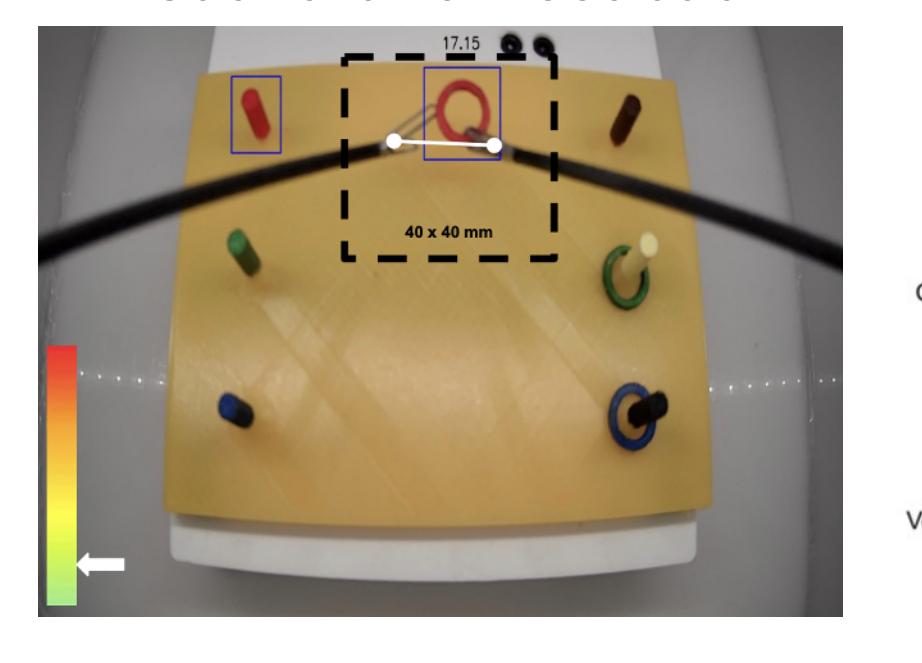


Figure 10: Instant visual feedback

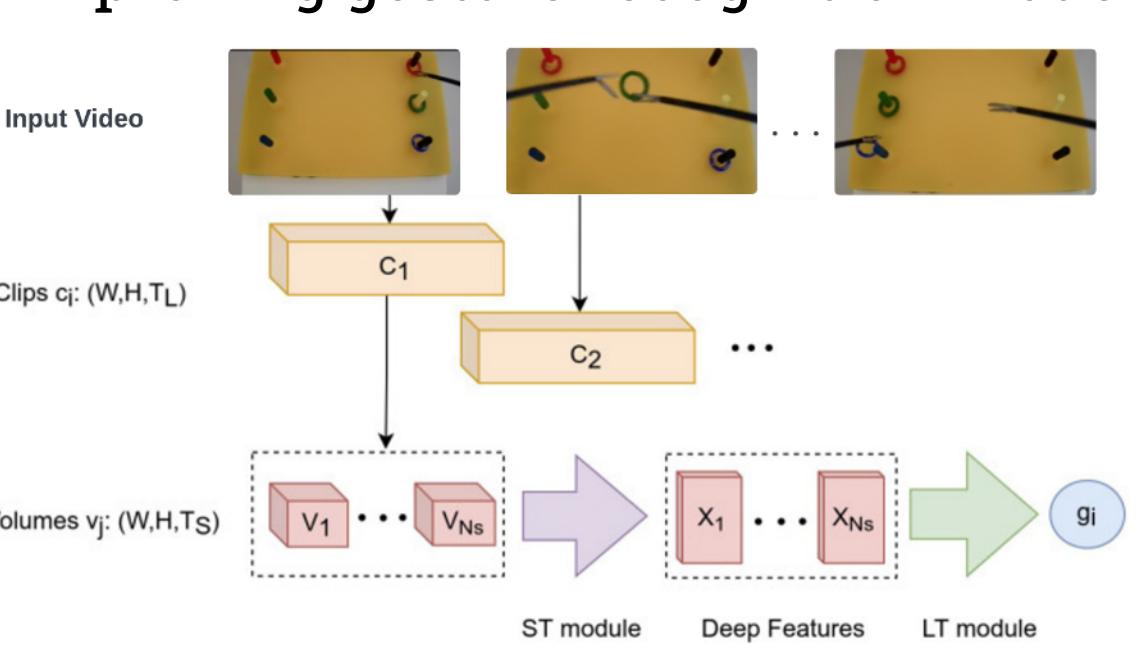


Figure 11: Model diagram

7. CONCLUSIONS

- Offers better approach to pediatric laparoscopic training
- Enhances skill development
- Provides user-friendly interface
- Eliminates the need for expert supervision

ACKNOWLEDGMENTS

We sincerely thank Professor Carlos Rossa for his pivotal mentorship, and Drs. Ahmed Nasr (CHEO) and Georges Azzie (SickKids) for their critical clinical insights, all of which were key to our project's success.

CHEO