Gesture Controls for Raven Robot

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Group 7

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CIS Project Mission

Implement Gesture Controls for Raven Robot

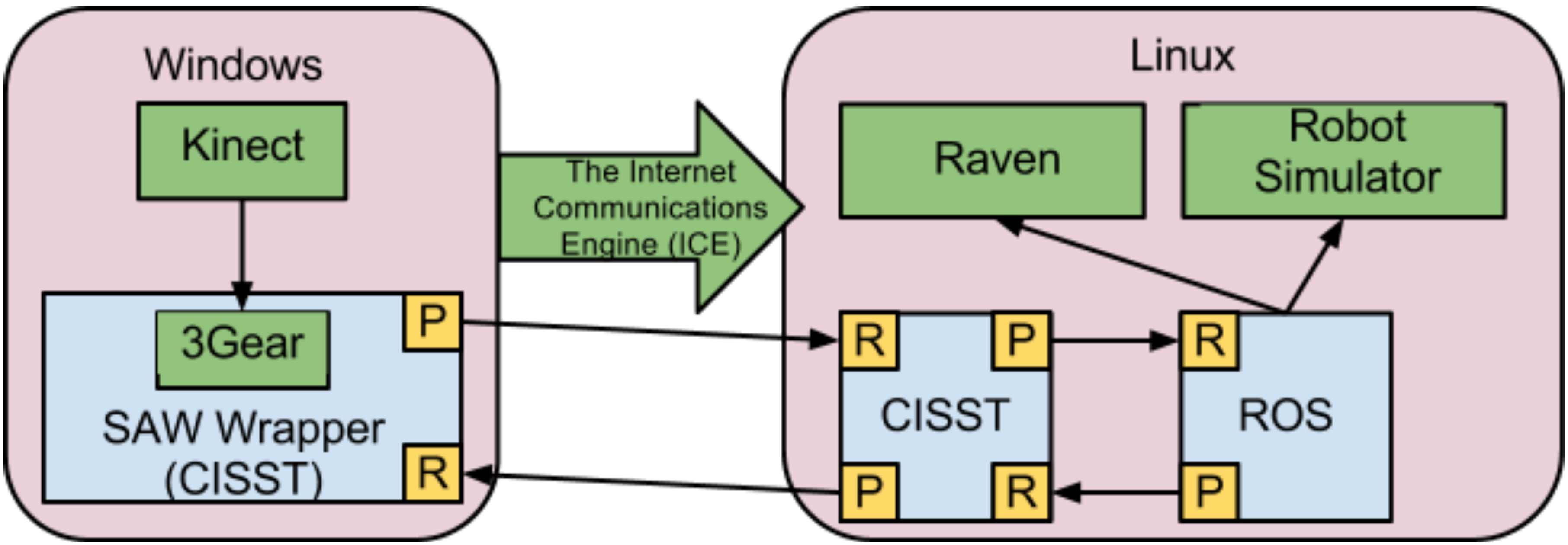
Image courtesy of 3Gear

image courtesy of popular mechanics

CIS Project Mission

ERC | CISST

Integrate 3Gear system, CISST, ROS, and Raven



Paper Selection

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Implementation and Evaluation of a Gesture-Based Input Method in Robotic Surgery

Purpose: Implement and evaluate a gesture-based input for a surgery robot; explore usability for commanding frequently-used automated or semi-automated surgical actions.

Relevance to my project: Gives background on surgical robot input; explores one type of gesture-based input.

Authors:

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Presented:

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Summary of Problem

- Too many surgical actions!
  - Primary input/tool control
  - Additional arms
  - Camera control
  - Automated tasks
  - Additional commands
- Current input devices are inadequate
  - Distraction from operative situ
  - Cognitive burden and mental stress
  - Training effort
  - Not well-integrated into surgical workflow

Summary

- Integrate **haptic gesture control** for some **surgical commands**

- **Test** against **menu input** for speed, accuracy, and **user experience**

Key Results

Compared to menu inputs, gesture inputs were:

- Faster
- More prone to error (10.42% vs. 5.21% error for menu inputs)
- More "useable"

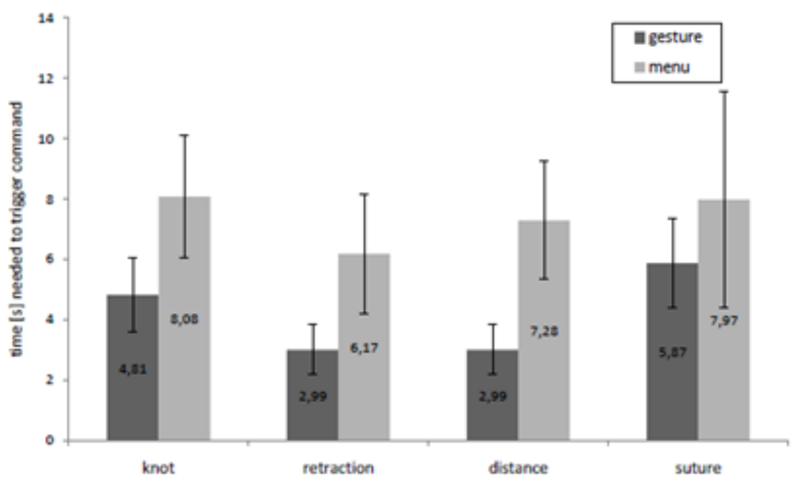

Fig. 7. Times needed to trigger an action: Gesture-based vs. menu.

Significance

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- **Preliminary results** show **feasibility** of gesture-based input methods for robot-assisted surgery
- **Authors' analysis** of the **usability** of current input methods gives a **framework** for **our project**

Technical Background

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Endoscopic Partial-Autonomous Robot (EndoPar) controlled by two Phantom haptic displays

Fig. 1. Hardware setup: Ceiling mounted robots with surgical instruments

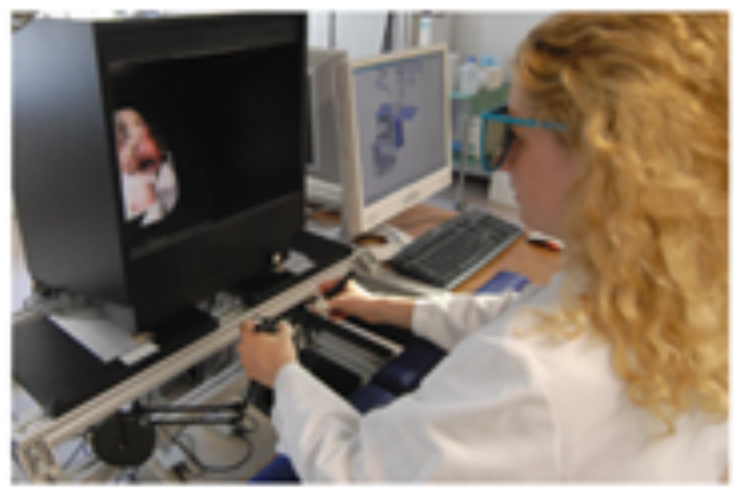
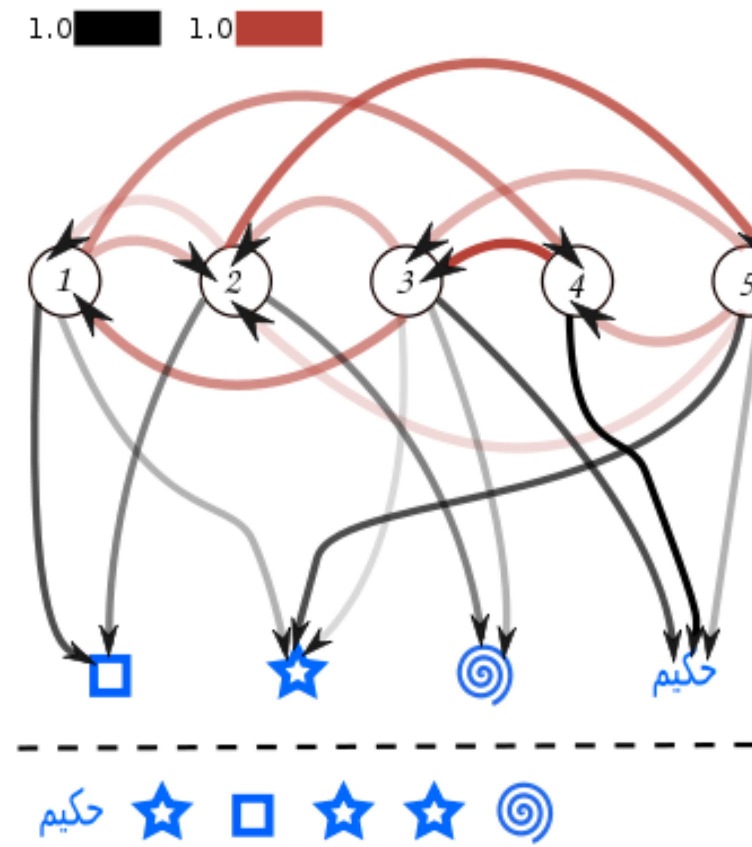


Fig. 2. Master console with Phantom™ devices and 3D screen

Technical Background

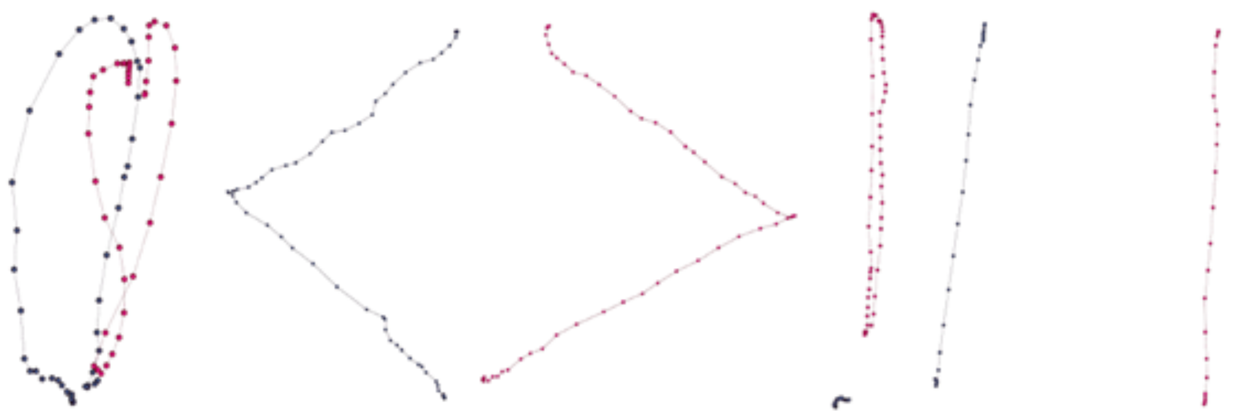
Hidden Markov Model identifies gestures

- directional change of each instrument's trajectory
- directional change of one instrument with respect to the second instrument
- velocity of each instrument
- distance between the two instruments
- temporal change of distance between two instruments
- state (open or closed) of each gripper



Preliminary Experiment

- Preliminary study: 22 participants performed 2 different gestures for 9 pre-selected surgical functions
- Authors chose the 4 most consistent and highly rated functions to conduct their main experiment
- This ensured that they used the most intuitive gestures



(a) (b) (c) (d)

Fig. 6. **Trajectories of gesture instances**: The blue lines indicate the left instrument, the red ones show the right instrument. Fig. 6(a) shows an instance of the "knot-tying" gesture, Fig. 6(b) shows the gesture for "suturing", Fig. 6(c) shows the gesture that initializes the "distance measuring". The picture is rotated 90° counterclockwise to save space. The gesture depicted in Fig. 6(d) would initialize the retraction of the 3rd robot arm to supply the surgeon with new material (e.g., threads).

Main Experiment

- 24 participants
  - 2x4 ((input mode) x (surgical action)) conditions
- Measured accuracy and speed

modality	knot	retraction	distance	suture	∅
gesture	95.83%	75.0%	100.0%	87.5%	89.58%
menu	95.83%	91.67%	95.83%	95.83%	94.79%

- Surveyed for user experience
  - pragmatic quality
  - attractiveness
  - hedonic quality-stimulation
  - hedonic quality-identity

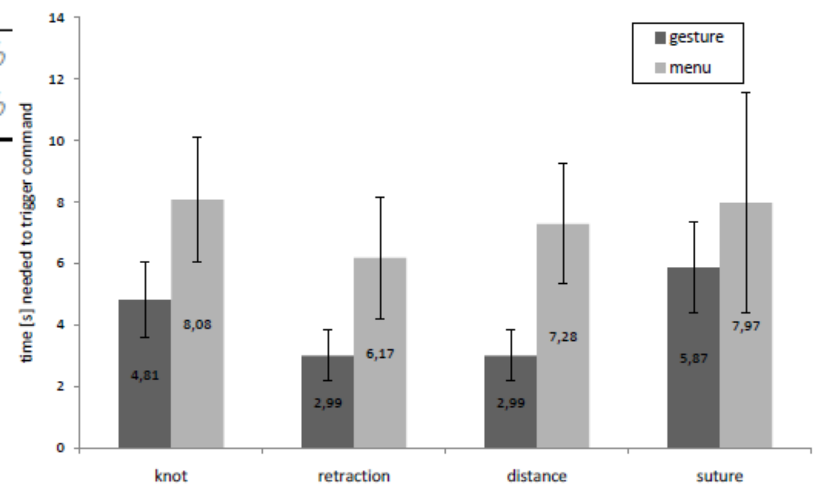


Fig. 7. Times needed to trigger an action: Gesture-based vs. menu.

Authors' Conclusions

Discussion/Issues:

- Main instruments not decoupled when performing gesture inputs
- Did not explore the effects of training
- User experience ratings are biased towards novel, exciting technology

Conclusion: Much further study is needed, but results show haptic gesturing to be a good addition (but not replacement) to input, offering more speed to execute surgical commands

Positive Points

- Detailed evaluation of study's motivation
- Thoughtfully implemented gesture-based input
- Thorough analysis of experiment's limitations, acknowledging many areas of further study needed

Negative Points

- HMM poorly explained
- No mention of ongoing or potential work in other types of gesture inputs
- No discussion of how to implement less intuitive commands
- User experience measures did not answer the usability problems posed at the beginning of the study
- Voice recognition seems appropriate for their problem/system

My Conclusions

- Preliminary findings are optimistic for gesture-based inputs
- Our project's input method is very different and admittedly less thought out in terms of intuitive input
    - Main goal is the proof-of-concept of integration of the CISST and ROS libraries with 3Gear and Raven systems.
    - This should make experimenting with input devices simpler.
    - 3Gear and other input devices must consider usability; the authors outline the issues well (but need some help measuring effectiveness).

Thank you!

Questions?