

Gaze Tracking Enabled Automatic Robot Error Detection

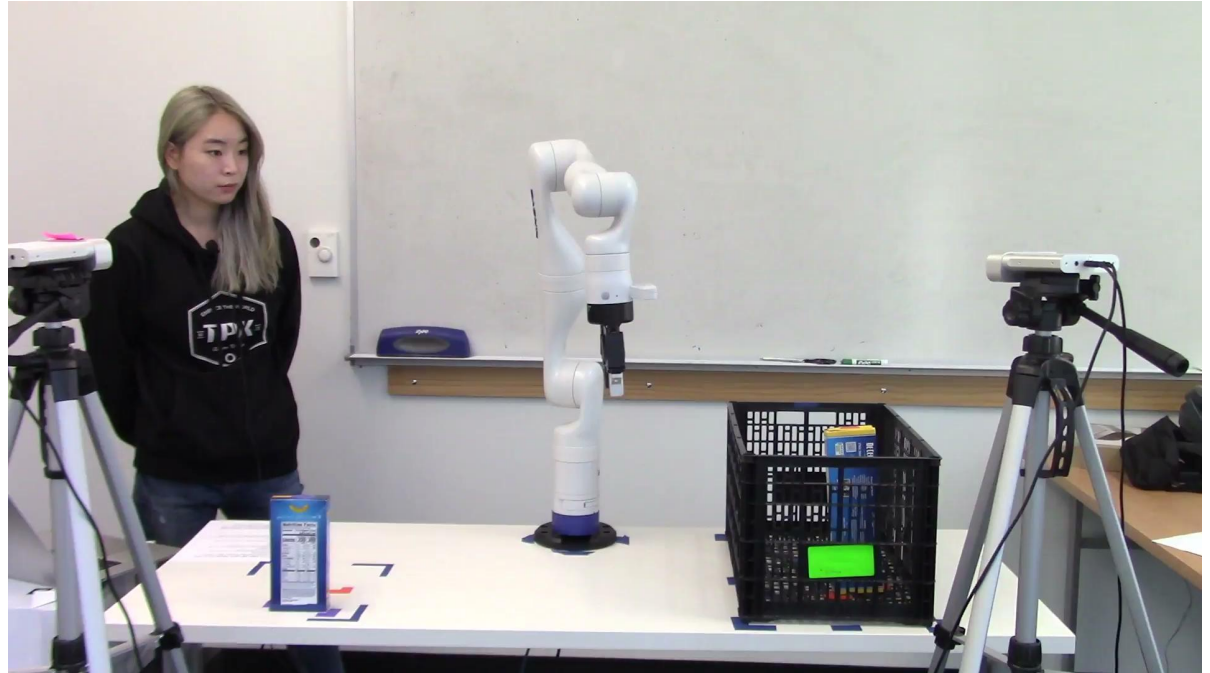
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Project Review

Background: Robot Errors

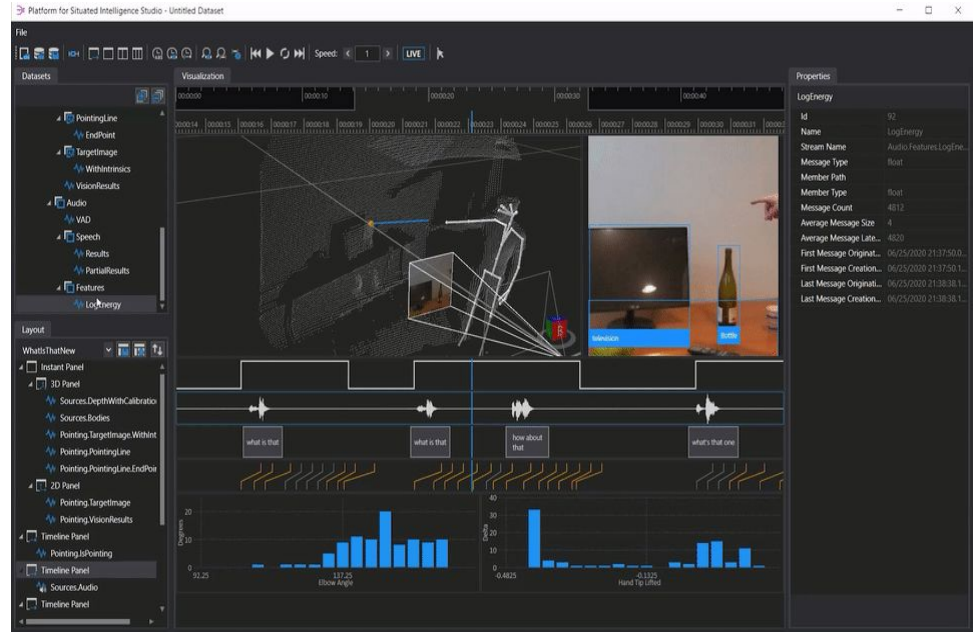
- Robots make mistakes; people react socially to physical interaction errors
- Errors are subjective to task or user, resulting in a variety of reactions



[Sample reaction from Stiber pilot study]

Background: Robot Error Detection

- Prior work by mentors using Microsoft PSI [Platform for Situated Intelligence]
- Human's reaction recorded in PSI system
- PSI Framework analyzes multimodal interactions and incorporates facial action units of a human's expression in response to robot error



<https://github.com/microsoft/psi/wiki/Brief-Introduction>

Project Aims

- Collect data to understand human gaze reactions associated with physical robotic error
- Add an additional component to the PSI system - mobile gaze tracker
- Create ML algorithm with data collection to automatically detect the robot error as it occurs

Overall Status

- Learning experience with gaze tracker and AR tags
- 3D localization of gaze within world coordinate system
- Updates to study design after initial pilot study test runs
- Collected and video coded initial user study pilot data

Video Coding Gaze Fixation

The screenshot displays a video coding application interface. The top window, titled "Data Viewer Controller", shows a table of gaze fixation data and a video player. The table lists gaze events with their corresponding robot actions and timestamps. The video player shows a scene with a robot arm and a table, with a red circle highlighting a specific area of interest.

robotAction	gazeFixation	voiceCommands
	(Tablet, 320-325)	
		3 00:02:23:095 00:02:27:1 (-<transcript>)
	107 00:02:26:163 00:02:26:492 (Robot Body, 326)	
	108 00:02:26:492 00:02:26:747 (Objects, 327)	
	109 00:02:26:747 00:02:26:802 (Cube, None)	
	110 00:02:26:802 00:02:26:839 (Eraser, 328)	
	111 00:02:26:839 00:02:27:204 (Cube, None)	

The video player shows a scene with a robot arm and a table. A red circle highlights a specific area of interest on the table. The video title is "c245503c_0.0-194.634.mp4".

The bottom window, titled "Data Viewer Controller", shows a control panel with various buttons and a timeline. The timeline displays a video track with a blue highlight and a red vertical line indicating the current time. The control panel includes buttons for "Add Data", "Point cell", "hide tracks", "set onset", "play", "set offset", "jump", "shuttle", "stop", "shuttle", "find", "jog", "pause", "jog", "enter", "new cell", "set prev offset", "set offset", and "new cell". The timeline also shows "Onset" and "Offset" markers.

00:02:26:842 @ 0x

Add Data

Point cell

hide tracks

set onset

play

set offset

jump

shuttle

stop

shuttle

find

jog

pause

jog

enter

new cell

set prev offset

set offset

new cell

Add Bookmark

Snap Region

Lock all

Enable Cell Highlighting

Enable Highlight and Focus

Clear Region

c245503c_0.0-194...
FPS: 29.83

Onset
00:02:59:284

Offset
00:03:05:379

Updated Deliverables

Minimum:	<ul style="list-style-type: none">● User Study Results and Analysis of Data
Expected:	<ul style="list-style-type: none">● Integrate gaze tracker component into PSI for real-time error detection
Maximum:	<ul style="list-style-type: none">● ML Algorithm that automatically detects errors using gaze data

Updated Milestones

Description	Expected Date Done By	Status
Preliminary Papers Read	3/1/22	Completed
PSI Learned	3/10/22	Completed
Gaze Tracker Component Written	3/19/22	<i>In Progress</i>
Gaze Tracker Component Tested	4/1/22	<i>In Progress</i>
User Study Prep Completed	4/1/22	<i>In Progress</i>
● Questionnaire Created	3/19/22	Completed
● Tutorial Created	3/19/22	<i>N/A</i>
● IRB Approval	3/1/22	Completed
● Participant Recruitment Process Started	3/27/22	<i>In Progress</i>
User Study Conducted	4/9/22	<i>In Progress</i>
● Pilot Study Conducted	4/1/22 New: 4/15/22	<i>In Progress</i>
● Half of participants completed study	4/2/22	Not Started
ML Algorithms Tested	4/16/22	Not Started
● Tested Possible Algorithm #1	4/2/22	Not Started
● Tested Possible Algorithm #2	4/9/22	Not Started
Poster Presentation / Report	5/5/22	Not Started

Updated Dependencies

Dependency	Contact	Solution	Alternative Plan	Completed
PSI Software	Maia Stiber	Online Github Instructions	N/A	Y
Computer (Windows)	Chien-Ming Huang	Lab Computer	Personal Windows Laptop	Y
Robot	Chien-Ming Huang	Use ICL Lab Kinova robot	N/A	Y
Cameras	N/A	Get cameras from lab	Personal Camera	Y
Room for User Study	Chien-Ming Huang	Malone 335	Talk to Chien-Ming Huang to find available room	Y
Participant Recruitment	Maia Stiber	Follow IRB protocol	N/A	In Progress
Data/Code Backup	N/A	Github/Drive	External HD	Y
IRB Approval	Chien-Ming Huang	Get added to IRB	N/A	Y
SD Card Reader	N/A	USB-C/HDMI/SD Card adapter	USB SD Card reader	Y

Questions

References

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- Stiber, M., & Huang, C.-M. (2020). Not All Errors Are Created Equal: Exploring Human Responses to Robot Errors with Varying Severity. *Companion Publication of the 2020 International Conference on Multimodal Interaction*, 97–101. <https://doi.org/10.1145/3395035.3425245>
- Kontogiorgos, D., Tran, M., Gustafson, J., & Soleymani, M. (2021). A Systematic Cross-Corpus Analysis of Human Reactions to Robot Conversational Failures. In *Proceedings of the 2021 International Conference on Multimodal Interaction* (pp. 112–120). Association for Computing Machinery. <https://doi.org/10.1145/3462244.3479887>
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- Aliasghari, P., Ghafurian, M., Nehaniv, C. L., & Dautenhahn, K. (2021). Effect of Domestic Trainee Robots' Errors on Human Teachers' Trust. *2021 30th IEEE International Conference on Robot Human Interactive Communication (RO-MAN)*, 81–88. <https://doi.org/10.1109/RO-MAN50785.2021.9515510>