Gaze Tracking Enabled Automatic Robot Error Detection

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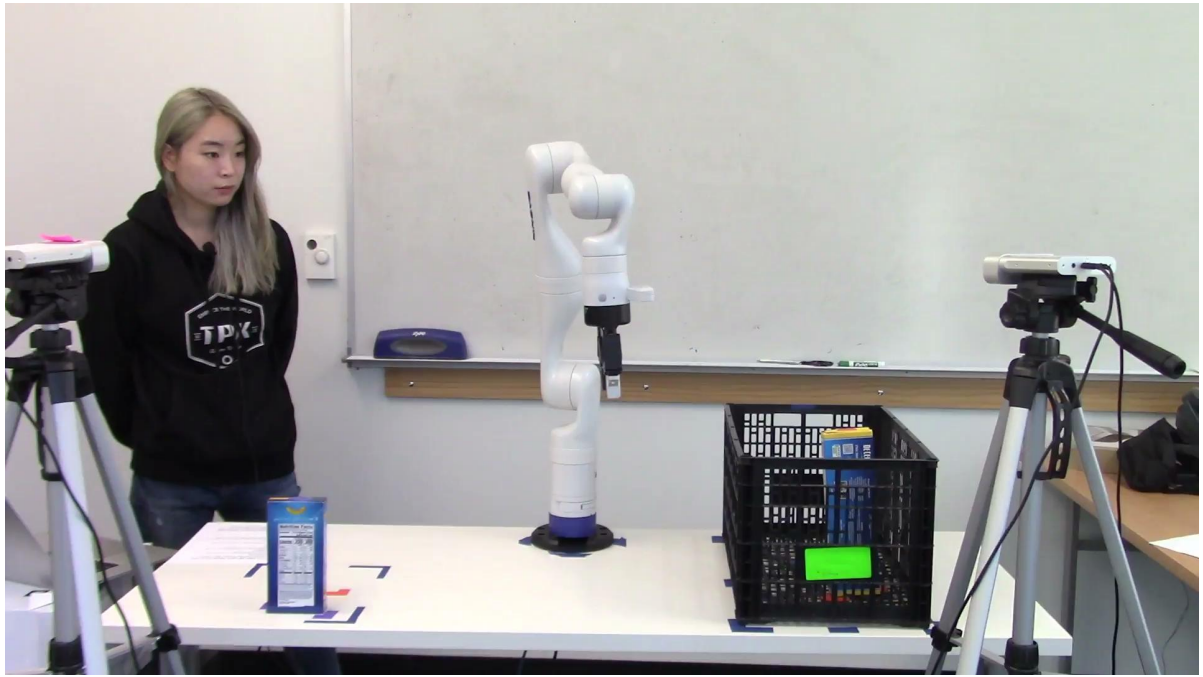
Project Review

Background: Robot Errors

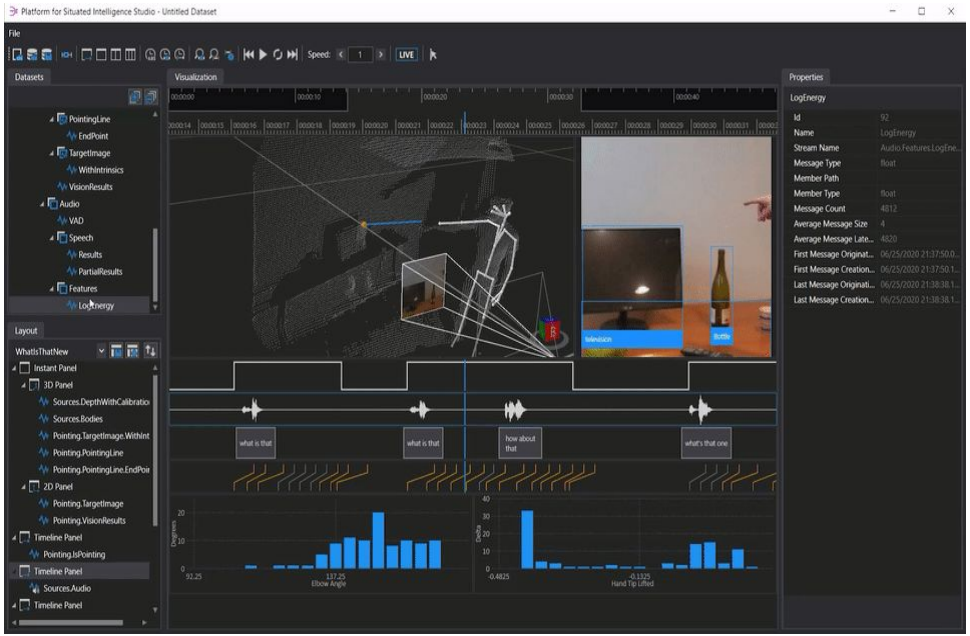
- Robots make mistakes; people react socially to physical interaction errors
- Errors are subjective to task or user, resulting in a variety of reactions



[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

Updated Deliverables

Minimum:	● User Study Results and Analysis of Data
Expected:	● Integrate gaze tracker component into PSI for real-time error detection
Maximum:	● ML Algorithm that automatically detects errors using gaze data

Updated Timeline

Description	February				March				April				May	
Reading Preliminary Papers			■	■	■	■								
Learn PSI				■	■	■	■							
Write Gaze Tracker Component										■	■			
Test Gaze Tracker Component										■	■			
Prep For User Study						■	■	■	■	■				
User Study									■	■				
Test Out ML Algorithms											■	■		
Create Poster											■	■		
Present Poster													■	

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	*In Progress*
Gaze Tracker Component Tested	4/1/22	*In Progress*
User Study Prep Completed	4/1/22	*In Progress*
●Questionnaire Created	3/19/22	**Completed**
~~●Tutorial Created~~	~~3/19/22~~	~~*N/A*~~
●IRB Approval	3/1/22	**Completed**
●Participant Recruitment Process Started	3/27/22	*In Progress*
User Study Conducted	4/9/22	*In Progress*
●Pilot Study Conducted	4/1/22 | New: 4/15/22	*In Progress*
●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

- Aronson, R. M., & Admoni, H. (2010). *Gaze for Error Detection During Human-Robot Shared Manipulation*. https://www.semanticscholar.org/paper/Gaze-for-Error-Detection-During-Human-Robot-Shared-Aronson/390e9ac2e0a4162339a9a7e8bdb9c372bdcea659
- 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
- Honig, S., & Oron-Gilad, T. (2018). Understanding and Resolving Failures in Human-Robot Interaction: Literature Review and Model Development. *Frontiers in Psychology*, *9*. https://www.frontiersin.org/article/10.3389/fpsyg.2018.00861
- 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