Maximizing Agent Utility in Human-Robot Interaction Assembly Tasks

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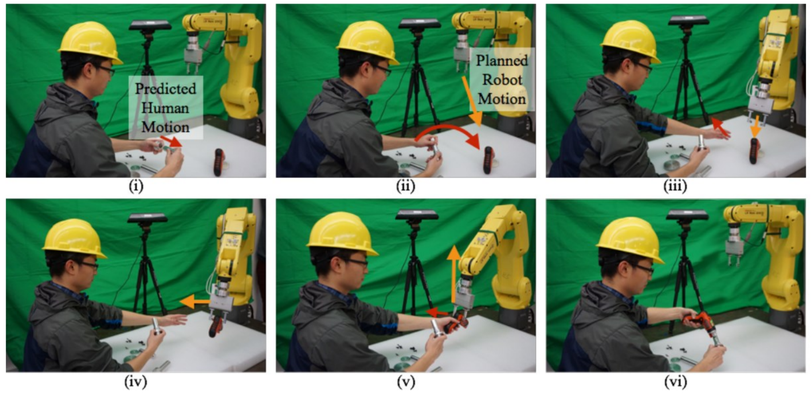
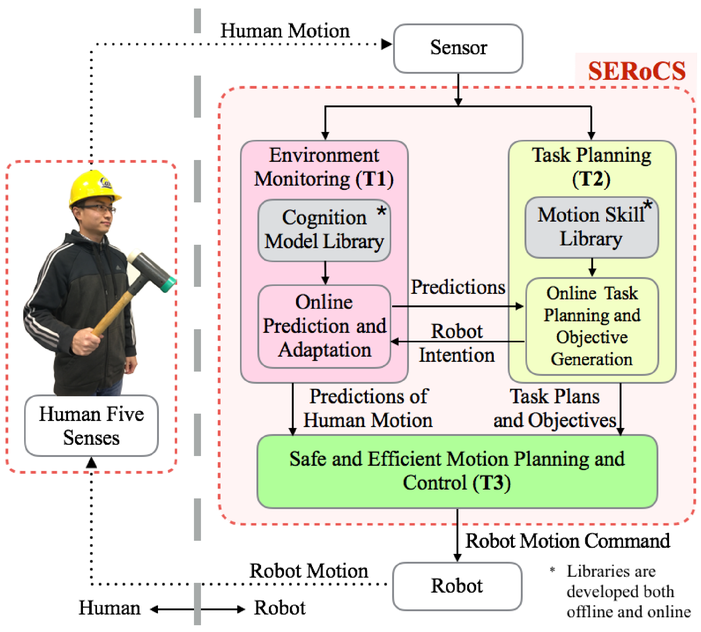
Introduction to Human Robot Interaction:

- HRI leverages the strengths of humans and robots to work collaboratively together on various tasks.
- Robots are equipped with various cognitive and learning abilities to pick the right plan to help the human.
- By using intelligent safety software along with physical barriers, humans and robots can be brought closer together to work efficiently.

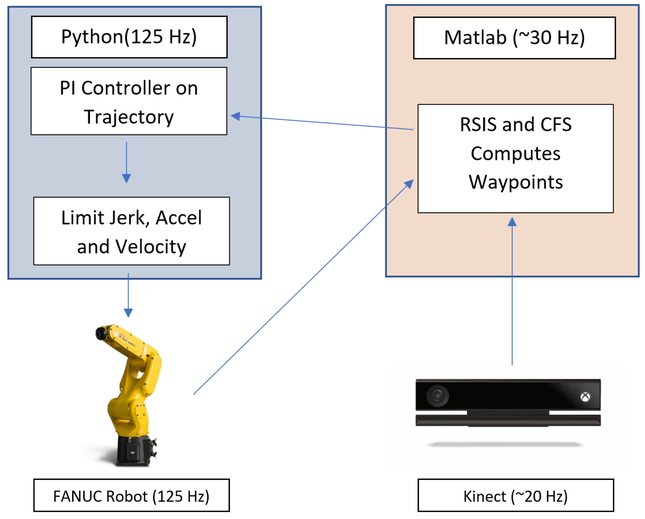


1. Recognize Human's Trajectory (using tracking points and RNN) and infer the performed plan.
2. Robot performs matching action to task using Long Term Planner. (~ < 50 Hz)
3. Faster Planner is used for safety and navigation while optimizing trajectory.

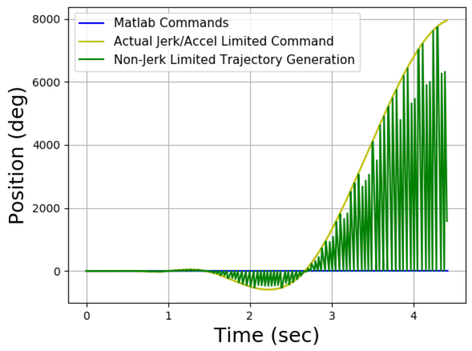


Our Human-Robot Interaction System

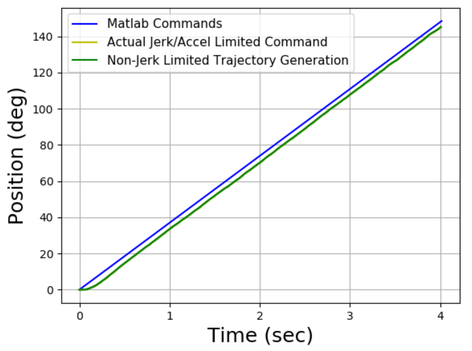
Experiment — Implementing New Tracking Controller:



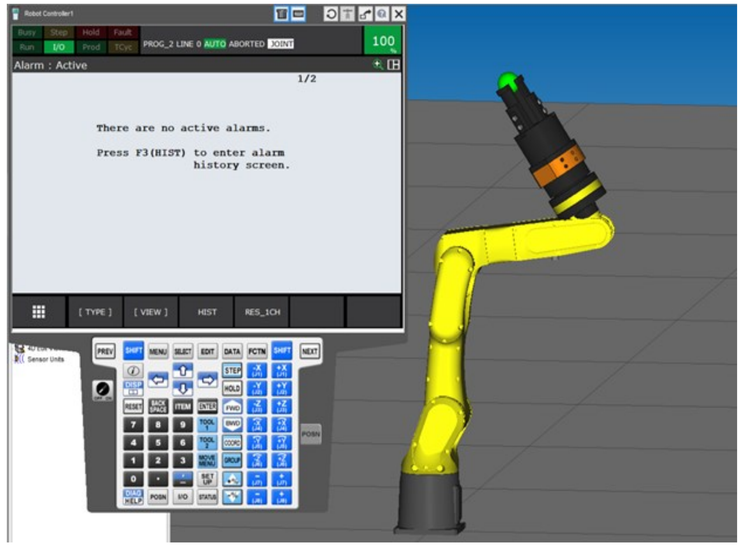
- When the robot recognizes the action of the human, the robot matches that with its own action and longer term plan.
- RSIS and CFS work to break down longer term plans into waypoints that also maintain safety using the safety planner and the Kinect.
- To interface with the robot, StreamMotion, a new control method must be used with the robot to define trajectories.
- StreamMotion requires joint positions defined at 125 Hz and sent to the robot or robot simulator using UDP.
- To meet these constraints:
  1. When RSIS computes a new target position at 30Hz, save that in a python thread safe variable.
  2. When StreamMotion requires a new joint position, initially a fast online linear interpolater was attempted to define trajectory, proven unstable.
  3. Instead of linear interpolation, a feedback and feedforward controller where PI is feedback component between the desired and current commanded position proved to be more effective.
  4. Once that's complete, compute the constraints on jerk/accel/velocity and ensure those are met by editing the trajectory online.
  5. Send desired joint positions and repeat.



Linear Interpolation of One Joint's Trajectory (Ramp Input, Unstable)



PI Tracking Controller on One Joint's Trajectory (Ramp Input, Stable)



FANUC Robot-Provided Simulator using StreamMotion

Task Completion Time Study:

- Motivation: In Human-Human teams, each person monitors the progress of the other to adapt their actions (ex: when playing soccer or lifting heavy objects)
- Human-Robot Interaction can maximize the utility of each agent by adapting their actions based on the status of the task.
- Our goal is to dynamically switch actions of the robot based on the progress of the task i.e. how long the task is taking. If it is taking a long time we are "stuck" on the task and it is not progressing well, therefore, we should try another method to achieve the goal.

Future Work:

- The work developed here for controlling the FANUC robot will have much importance in future experiments in the lab.

In Task Completion:

- Task Structure: Examine the varying structures of different tasks and their completion characteristics as well as the utilization of each agent.
- Increase online data about the status of the completion progress of the task to make better decisions on the next task for the robot, including other factors such as human emotion through facial recognition.
- Increase communication from agent to agent through verbal and visual methods.

The authors acknowledge the technical support from FANUC. This work is related to National Science Foundation Award #1734109.