Towards Transferring Human Preferences from Canonical to Actual Assembly Tasks

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Aim

Assist workers based on their individual preference.
Robot must perform secondary actions, such as supplying parts in the users' preferred order

Problem

Efficiently learn user preference in assembly tasks.
Providing demonstrations for actual assembly tasks is tedious and time consuming

Approach

Transfer user preferences from a representative **canonical assembly task** to an actual, complex assembly task

Key Insight

User preferences across different assembly tasks can be represented with a shared set of abstract, **task-agnostic features**

Features inspired from *economy of human movement (Ranganathan et al. 2013)*

- Users prefer to minimize movement – *by not changing part or tool*

Features inspired from *human task ordering (Fournier et al. 2019)*

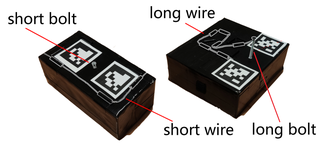
- Physical and mental effort – *users front- or back-load high effort actions*

Reward function for user i in both assembly tasks, $R_i(s) = w_i^T \phi(s)$

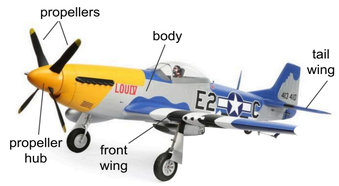
User Study

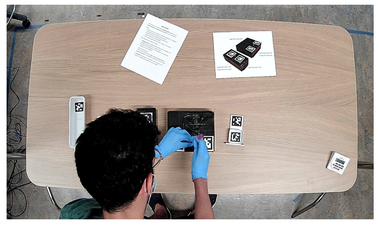
No. of participants = 19

Canonical task C
No. of steps = 6
~4 mins to complete



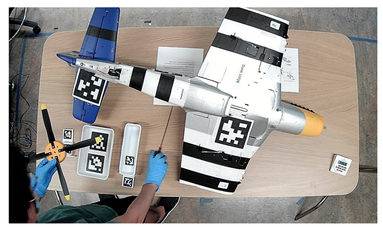
Actual task X
No. of steps = 17
~9 mins to complete



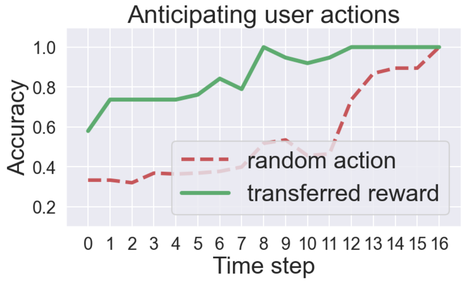


Learn weights $w_{C,i}$ for user i from demonstration in C

Compute $R_{X,i}(s) = w_{C,i}^T \phi(s)$ for all $s \in S_X$



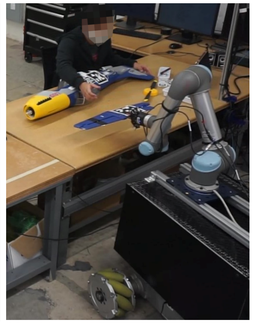
Results



Industry Impact

Will lead to improvements in efficiency and user experience in human-robot workcells

- Have robots perform ergonomically challenging tasks, currently performed by humans
- Adapt robot assistance to individual users to improve user experience and productivity



Broader Impact

Education: Include graduate and undergraduate students in this research
Outreach: Introduce ~1000 K-12 students to robotics technologies through Robotics Open House.

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