Robot Action Anticipation for Collaborative Assembly Tasks

Anticipative interaction primitives for human-robot collaboration

Authors: Guilherme Maeda, Aayush Maloo, Marco Ewerton, Rudolf Lioutikov, Jan Peters

Publisher: AAAI Fall Symposium - Technical Report

Year: 2016

> The robot should decide whether to hand over a screw or a plate and which plate;

> As the experience with a given user grows, it learns the pattern in which the parts are being assembled;

> Use a lookup table containing variations of assembly sequences, previously demonstrated by different users;

> Use nearest neighbour sequence in the table that matches the actual sequence of human actions.
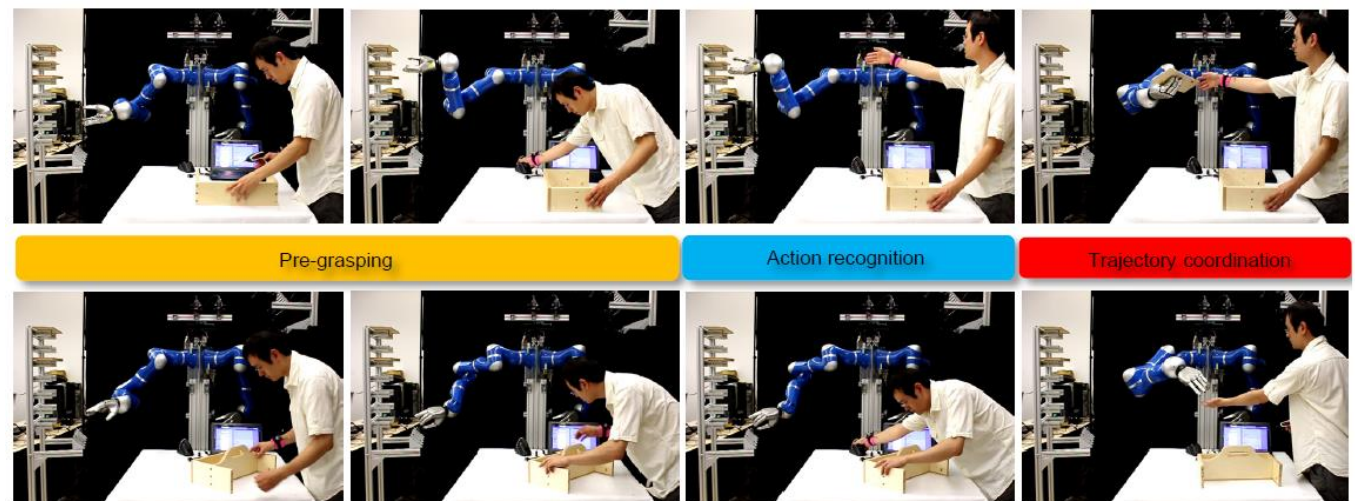
Anticipation in Human-Robot Cooperation: A recurrent neural network approach for multiple action sequences prediction

Authors: Paul Schydlo, Mirko Rakovic, Lorenzo Jamone, José Santos-Victor

- The robot must predict human actions and intent, and understand human non-verbal cues: gaze and body posture;

- Encoder-decoder recurrent neural network topology;

- Predicting multiple action sequences;

- Aside from the camera, there were wearable sensors to detect gaze.

Prediction-Based Human-Robot Collaboration in Assembly Tasks Using a Learning from Demonstration Model

Authors: Zhujun Zhang, Gaoliang Peng, Weitian Wang, Yi Chen, Yunyi Jia, Shaohui Liu

➢ Human intention prediction providing the required pieces to the human worker;

➢ ConvLSTM to predict intention and CNN to recognize the part needed;

➢ There are speed limits on the robot, it normally stays out of the human safety zone and when moving close to the human, the robot moves at a speed that is slow enough to raise no risk;

➢ The users shows first the assembly order.
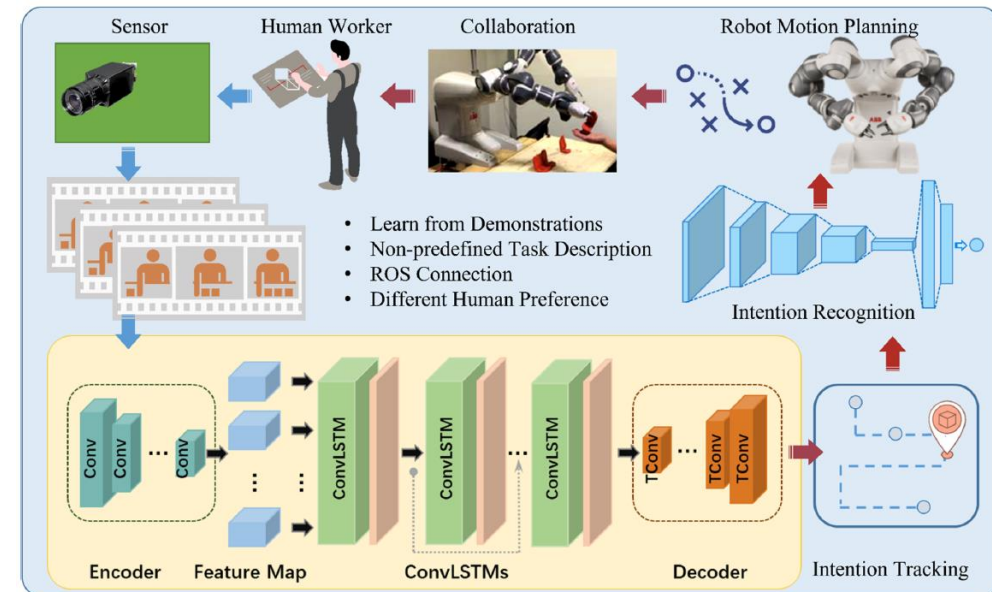
Fostering short-term human anticipatory behavior in human-robot collaboration

Authors: Loizos Psarakis, Dimitris Nathanael, Nicolas Marmaras

➢ Tried to foster human anticipatory behaviour towards the robot, through visual cues of the robot's next move;

➢ The user has more trust in the robot and therefore the task completion time is decreased;

➢ The testing remained limited to VR;

➢ The user movement was detected using wearables.
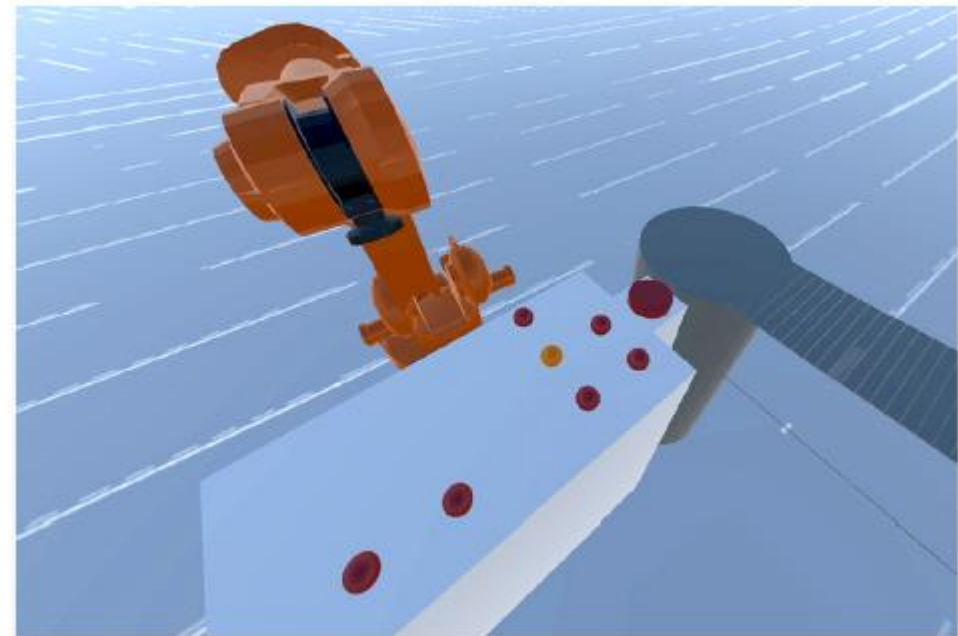
Social Cobots: Anticipatory Decision-Making for Collaborative Robots Incorporating Unexpected Human Behaviors

Authors: Görür O., Rosman B., Sivrikaya F., Albayrak S.

Publisher: ACM/IEEE International Conference on Human-Robot Interaction

Year: 2018

➤ The objective is to handle unexpected conditions:

  ➤ when the human's intention is estimated to be irrelevant to the assigned task and may be unknown to the robot, e.g., motivation is lost, another assignment is received, onset of tiredness;

  ➤ when the human's intention is relevant but the human doesn't want the robot's assistance in the given context, e.g., because of the human's changing emotional states or the human's task-relevant distrust for the robot;

➤ Partially observable Markov decision process (POMDP);

➤ Tested in Simulation.

Summary

DATA SOURCES	SUPERVISED LEARNING	UNSUPERVISED LEARNING	REINFORCEMENT LEARNING	OTHERS
• RGB/RGBD images: pose, gaze, hand gestures, emotions, object information • Voice commands • Accelerometry • Muscular Activity • Sensor Fusion	• Recurrent Neural Networks such as LSTM • Convolution Neural Networks (CNN) • Nearest Neighbor • SVM • Decision Trees • Naive Bayes	• Gaussian Mixture model (GMM) • Hidden Markov model (HMM) • Variational Autoencoder (VAE)	• Q-learning • SARSA • Markov decision processes (MDP)	• Look-up table of assembly sequences • Open Pose

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