Probabilistic Recurrent Neural Network for Human Trajectory Prediction

This NSF-sponsored research (CMMI-1830295) presents a recurrent neural network (RNN)-based method for human trajectory prediction, to enable delivery of tools and parts to the correct spatial location at the correct time for effective and safe collaboration between the robot and the human operator. A probabilistic formulation of RNN is developed to account for uncertainties in human motion, which integrates prediction outcomes across all possible prediction models weighted by their respective model probabilities. The integration is solved through Monte Carlo dropout to determine the predicted motion trajectory end-location with uncertainty quantification (**Fig. 1**).

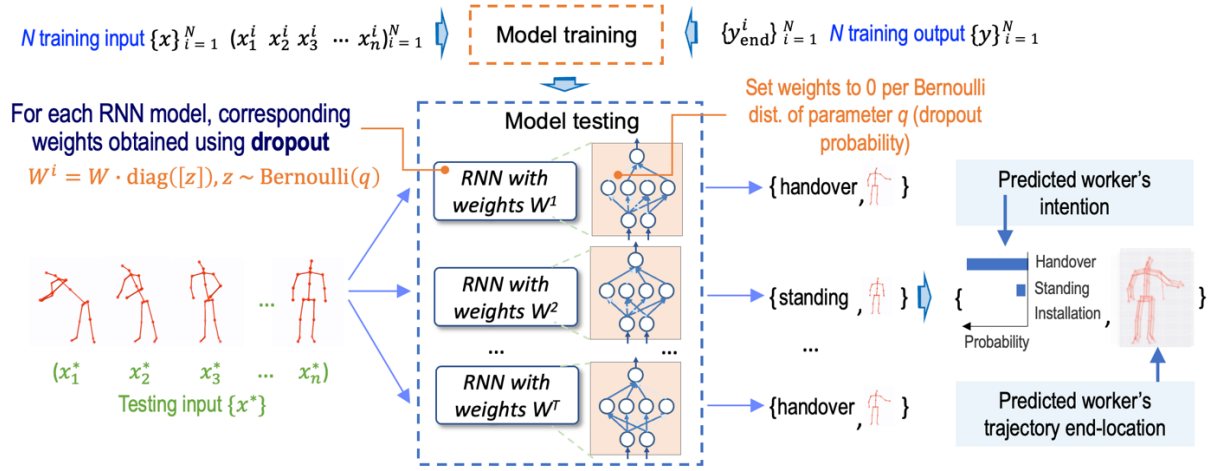

Fig. 1 Probabilistic RNN for Human Trajectory Prediction

The developed method is evaluated in a case study of car engine assembly in collaboration with the Royal Institute of Technology in Sweden. The evaluation demonstrated the effectiveness of probabilistic RNN in human-robot collaborative assembly (**Fig. 2**). Additionally, the probabilistic formulation has shown to reduce robot mis-triggering from 25% to 0% as compared to non-probabilistic RNN, ensuring effective and safe human-robot collaboration in manufacturing.

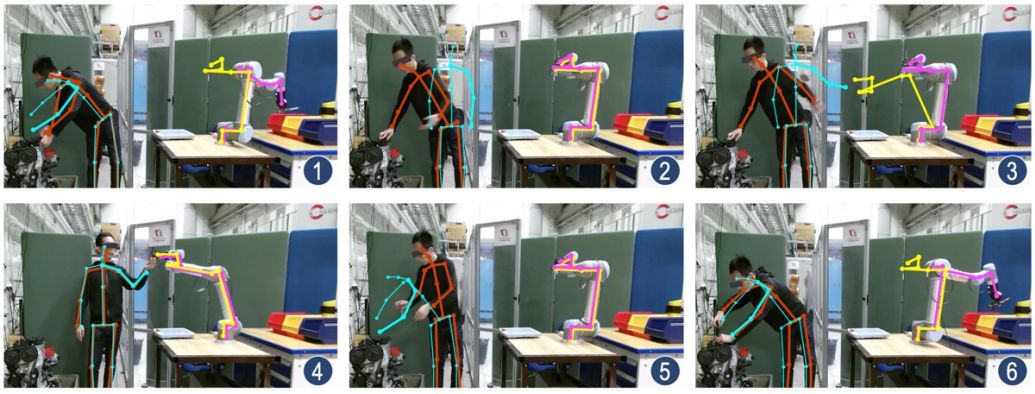

Fig. 2 Collaborative assembly enabled by probabilistic RNN

Related Publication

[1] J. Zhang, H. Liu, L. Wang, and R. Gao, "Recurrent neural network for motion trajectory prediction in human-robot collaborative assembly," *CIRP Annals – Manufacturing Technology*, vol. 69, no. 1 pp. 9-12, 2020. https://doi.org/10.1016/j.cirp.2020.04.077