Ensuring Safety in Human Robot Collaboration in Assembly Applications

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Human Robot Collaboration

• Robots
  – welding, bolting, packaging
  – speed, repeatability, high payload

• Humans
  – Manipulating a wide range of parts without special fixtures
  – Natural ability to handle unexpected situations

• Collaborative frameworks have the potential for increase in productivity levels

(Source: ATACO Steel Products)
Challenges

• Unsafe to introduce robots into anthropic environments
  – High inertia
  – High power actuation
  – Electrical threats
  – Human errors

• Traditional methods to ensure safety
  – Robot is surrounded by physical or light barriers
  – Leave no scope to realize the proposed benefits of human robot collaboration

Source: http://automation-robotics.com/palletising/

Approach

- Exteroceptive sensing system to track the human

- Virtual bounding spheres to approximate the robot and human

- Pre-collision strategy based on the interference between the two spheres

- Cognitive guidance system that alerts, and corrects, the human when he/she picks a wrong part before performing an assembly operation

- Anticipatory behaviors that allow the robot to adapt its next moves when the human deviates from performing an original assembly operation, however, performs a feasible one
Exteroceptive Sensing System

- Four Kinect sensors mounted on four corners of the work cell
- Each sensor observes the human and outputs a 20 DOF human model
Exteroceptive Sensing System (Contd.)

- Positional data of individual models are fused together to generate a refined human model.
Illustration of Pre-collision Strategy
Experimental Setup
Human and Robot Safely Collaborate in a Shared Assembly Task
Summary

• We are developing a collaborative framework that allows a robot and human to safely interact and achieve shared tasks in assembly cells.

• Whereas most previous exteroceptive methods relied on depth data from camera images, our approach is one of the first successful attempts to build an explicit human model online and use it to evaluate human-robot interference.

• Real-time behavior observed during experiments with a 5 DOF robot and a human safely performing shared assembly tasks validates our approach.

• We are developing a vision-based part recognition system in order to implement the cognitive guidance system.

• Adaptation can be achieved by real-time replanning of robot’s actions based on the available sensory feedback of the state of the work cell.