

Designing an Interactive Serious Game to Investigate Acceptability of Human-Robot Collaboration in Manufacturing

beWare of the Robot v. 2.0

A novel 3D interactive and immersive serious game that simulates in real-time collaborative manufacturing tasks between industrial robotic manipulators and humans in shared workspace.

Use case:

- Direct hand-to-hand Human-Robot Collaboration (HRC) during hand lay-up of composites
- The VE comprises a shop-floor environment, an industrial robot, a tracking-driven avatar, carbon patches and a metallic die.
- The user performs tasks in close proximity with the moving robot, while the robot handles the carbon patches.
- Safety issues arise and have to be tackled with a modern, beyond stop-and-go approach.
- Emergencies (i.e. warning audiovisual stimuli and dynamic triggering events) are employed to enhance situation awareness and anticipation of the robot motion.

Project Goals:

- Platform for experimentation (HRI techniques / HRC fluency) - Investigate users' experience and behavior inside the collaborative VE
- Investigate HRC acceptability in regard to safety issues (physical and mental safety)
- Consider safety-based robot motion programming

H-R Collaboration scenario:

- The robotic manipulator picks and transfers carbon patches towards the user
- The user has to take the patch from the robot and to properly lay it in the appropriate position inside the metallic die located in front of him. Afterwards, the robot proceeds to feed the next patch, and the process is repeated until all different patches are correctly placed.
- When the user's body is in very close proximity with the robot's forearm, a sound alarm is turned on, to warn the user of the robot's proximity and a possible collision. The robot speed is reduced accordingly.

Research hypothesis:

- Warning stimuli inside a VE that offers immersion and real-time interaction can provide to the user augmented situational awareness and enhanced perception of the robot's motion.

Wide blending of Interaction Techniques:

- Collision detection, Ray-casting, Child/parenting functions, head and skeletal tracking, real walking, tracking-driven virtual hand

Implementation:

Software: Unity 3d™, Rhinoceros™, 3dsMax™, C#, Kinect SDK - **3D UIs:** Oculus Rift DK2 HMD (immersion, stereoscopic vision and head tracking of yaw and pitch angles), and Kinect sensor (11 body joints skeletal tracking navigation, avatar control)

