

**Research Topic for the ParisTech/CSC PhD Program**  
*(one page maximum)*

**\*Field (cf. List of fields below):** Information and Communication Sciences and Technologies

**Subfield:** Robotics

**Title:** Human–Robot Collaboration in Integrated Manufacturing using Augmented Reality

**ParisTech School:** Ecole Nationale Supérieure d'Arts et Métiers Paristech - ENSAM

**Advisor(s) Name:** Fakhreddine Ababsa, Full Professor, Arts & Métiers ParisTech  
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**(Lab, website):** Institut Image , LISPEN. <http://institutimage.ensam.eu/>

**Short description of possible research topics for a PhD:** (10-15 lines in English + optional figure)

In the industry of the future, robots would work in collaboration with human by jointly performing the assigned tasks and sharing the same workspace. Hence, their actions must be controlled in real time according to the human actions. Visual tracking would allow the worker to be located in the workspace and to recognize his gestures in order to anticipate the robot's control avoiding any collision with him. The aim of this PhD proposal is to investigate new approaches for human-robot collaboration using augmented reality. The idea is to develop an augmented reality system, which allows the worker to visualize simultaneously and in real time the robot's control information and also the instructions to be performed by the user. 3D human tracking and gesture recognition based on machine learning approaches will also be investigated. A depth sensor placed in top will be used, the acquired data will be analysed to detect the operator's presence area and to recognize his gesture. Natural user interface will be developed in order to control the application: changing the context/scenario of AR, stopping the robot, etc.

**Required background of the student:** (Which should be the main field of study of the applicant before applying)

The candidate should have a Master degree or equivalent in Robotics, computer science, or related disciplines. Required skills are experience in C++ software development, Machine learning and pattern recognition, applied mathematics, and a good command of English (reading/writing/speaking). In addition, the successful candidate will be highly self-motivated, passionate about his/her work, and has good ability to work both independently as well as in a team in a multidisciplinary environment.

**A list of 5(max.) representative publications of the group:** (Related to the research topic)

1. Cyrille Migniot, Fakhreddine Ababsa: Hybrid 3D-2D human tracking in a top view. J. Real-Time Image Processing 11(4): 769-784 (2016)

2. Madjid Maldi, Fakhreddine Ababsa, Malik Mallem, Marius Preda: Hybrid tracking system for robust fiducials registration in augmented reality. *Signal, Image and Video Processing* 9(4): 831-849 (2015)
3. Hajar Hiyadi, Fakhreddine Ababsa, Christophe Montagne, El-Houssine Bouyakhf, Fakhita Regragui: A Depth-based Approach for 3D Dynamic Gesture Recognition. *ICINCO* (2) 2015: 103-110
4. Cyrille Migniot, Fakhreddine Ababsa: Part-based 3D Multi-person Tracking using Depth Cue in a Top View. *VISAPP* (3) 2014: 419-426
5. J. Chardonnet Interactive Dynamic Simulator for Multibody Systems. Chardonnet, J. *International Journal of Humanoid Robotics*, 9(3): 1250021–1,1250021–24. 2012.