Third point of view Augmented Reality for robot intentions visualization

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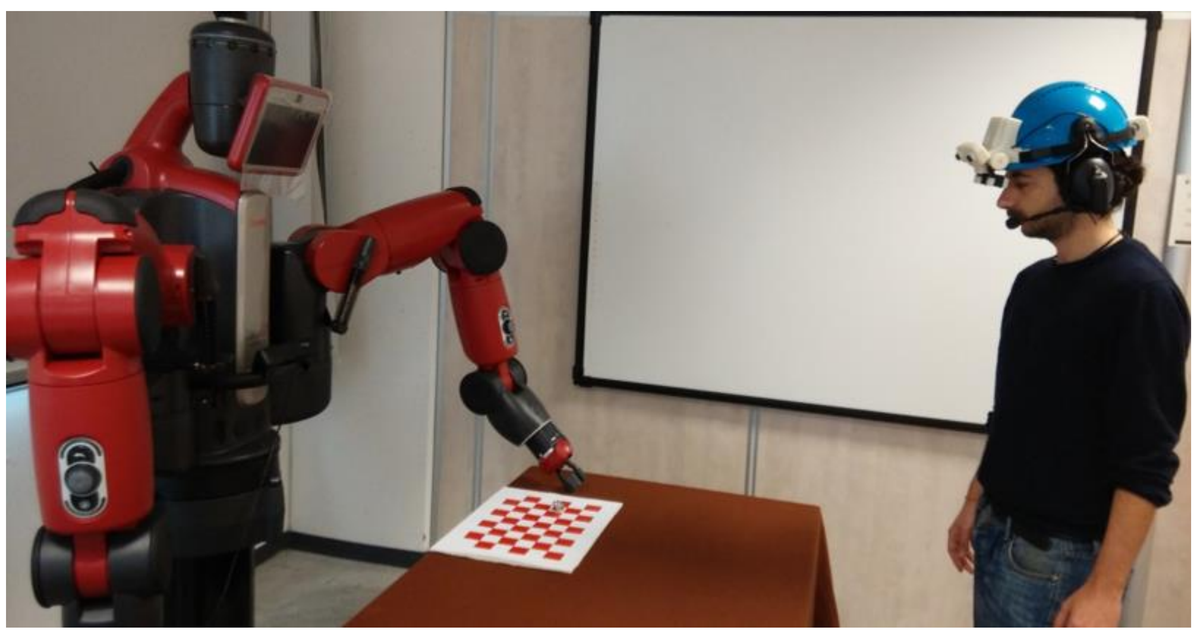
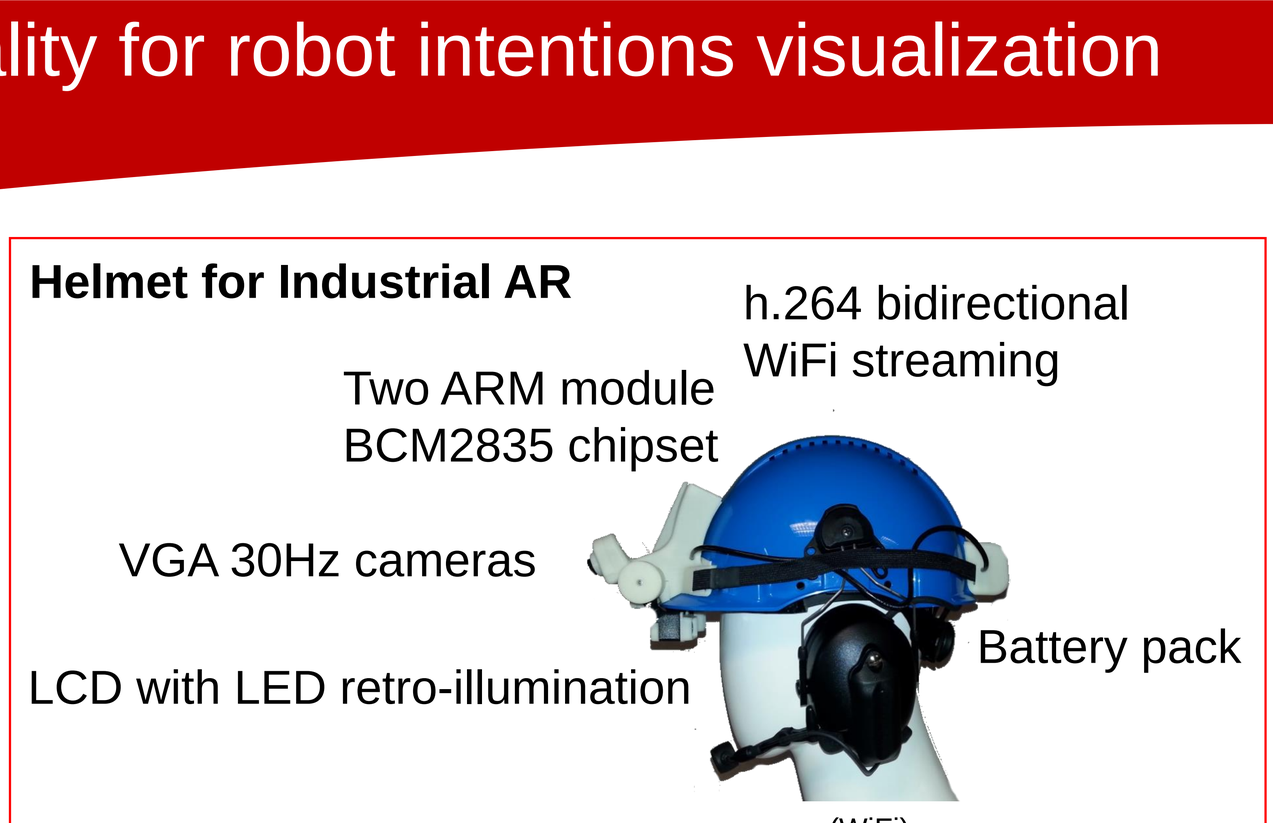
Lightweight, **head-up displays** integrated in industrial helmets allow to provide contextual information for **industrial scenarios** such as in maintenance. This paper addresses the case of **information sharing** by a Baxter robot displayed to the user overlooking the real scene. System design and interaction ideas are being presented.

Context and Goal:

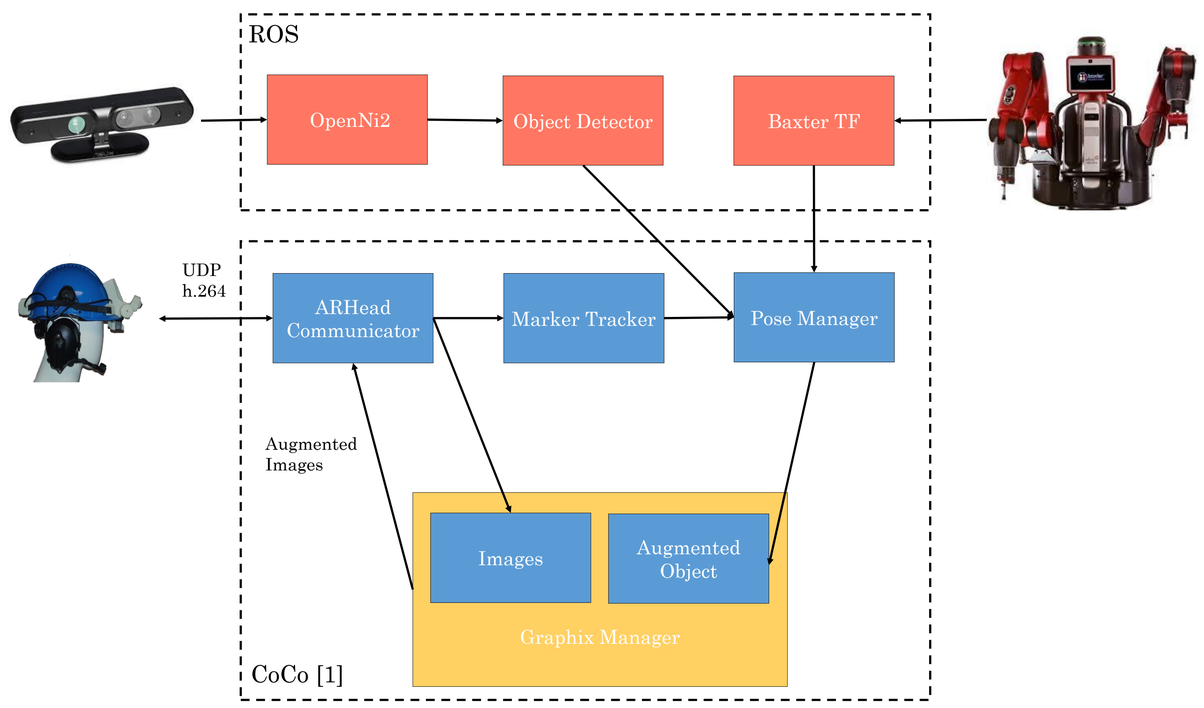
- A new generation of robotic systems is being introduced in working environments (Industry 4.0)
- **Cooperation** with human workers in the execution of tasks, Human Robot Communication (**HRC**).
- Understanding the **intention** of the robot contextualized over the working environment.
- **Augmented Reality** to highlight robots intentions.
- Eye-wear display integrated in a **working helmet**.



Helmet for Industrial AR

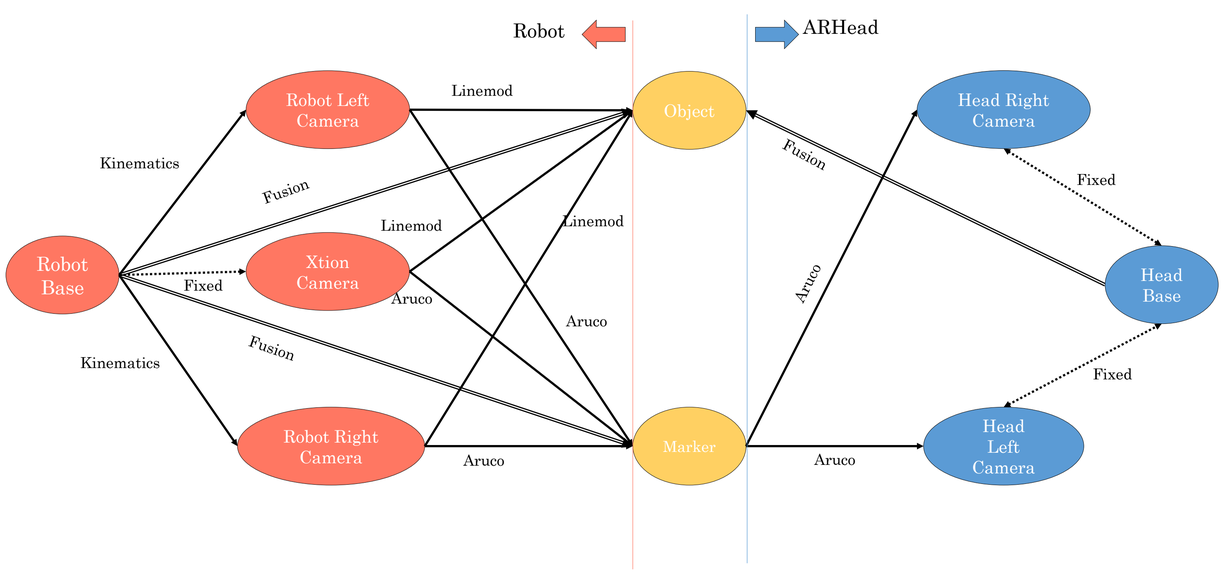


Architecture



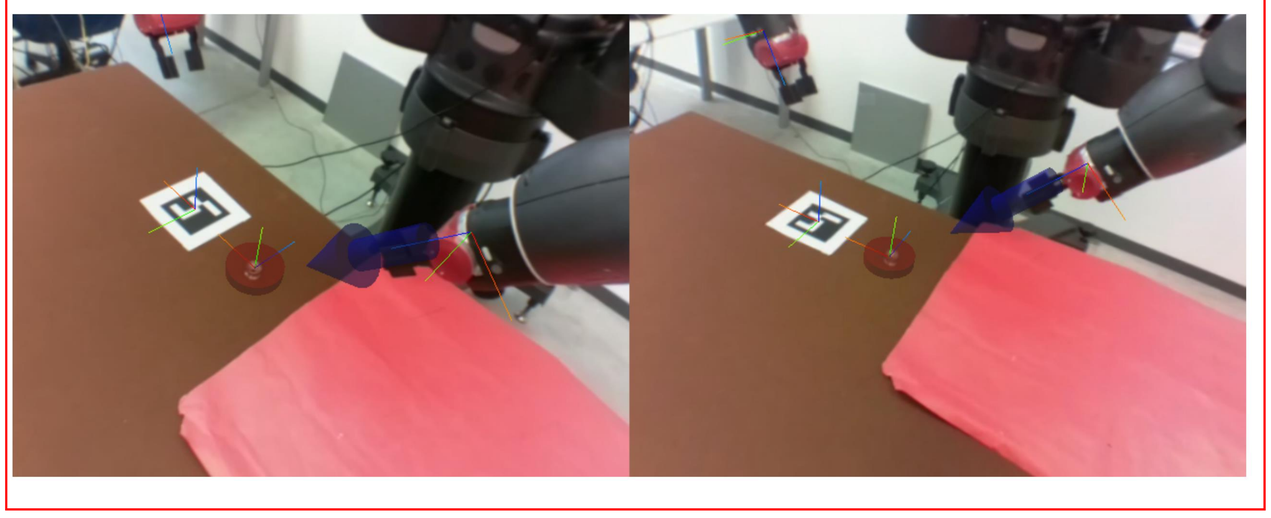
Interaction

- The robot **localizes** an object (LINEMOD) fusing the Robot's hand cameras and the User's helmet displays a co-located **highlight** of the object in the field of view of the operator
- **Transferring of the pose** of the object from the robot systems to the operator ones without the need of performing object recognition in the helmet.
- An Aruco **marker** is used to find the calibration between the User and Robot reference frames
  - Robot mounted Asus xTion for marker tracking
  - Embedded cameras in the Helmet



- Possibility to display any poses for which the transformation from the robot base frame is known
  - End-effector planned **trajectory**
  - Robot **workspace**
  - **Highlighting** of the target object

Result



Conclusion

The paper has presented the architecture and the reference frame issues that emerge from creating a **third point of view augmented reality feedback** based on robot state. The main challenge in present setup is the **quality of the tracking** to obtain the common integrated reference system with the robot. The next stage is the investigation of **effectiveness of the feedbacks**, and the understanding on feedbacks that can be **adapted** depending on the level of **uncertainty of the tracking**.

Acknowledgements

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[1] Ruffaldi E. & Brizzi F. (2016). CoCo - A framework for multicore visuo-haptic in mixed reality. In *SALENTO AVR, 3rd International Conference on Augmented Reality, Virtual Reality and Computer Graphics* . Springer
[2] W.Huang,L.Alem,andF.Tecchia,"Handsin3d" Lecture Notes in Computer Science, 2013