# Avoidance of the singularities of a redundant arm through visual servoing

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Teleoperated systems based on a redundant robotic arm, a camera and an ungrounded handheld device are today a powerful solution for object handling tasks. On the one hand, the robotic arm and the camera make it possible to defer the direct contact of toxic or dangerous objects to handling systems in secure environments. This distance ensures the safety of the users without sacrificing their awareness of the information necessary for the manipulation. On the other hand, the use of an ungrounded handheld device allows the user to intuitively control the movements of the robotic arm, thus ensuring a quick grasp of the system and a faithful expression of its expertise.

However, the use of this type of teleoperated system is risky as it leads to ignore the kinematic differences between a user's arm and a robotic arm. A movement that can be performed by a user may well be impossible for a robotic arm, leading to an unrealistic or even dangerous command; and it may be difficult to intuitively warn the user of this risk so that he performs the necessary corrections.

This problem of singularity of a robotic arm can be reduced by adding additional degrees of freedom to realize the desired commands. Based on this solution, the track explored here is to exploit the visual feedback of the camera to offer an additional degree of manipulability to avoid a singularity. The objective is then to subtly modify the user's command to avoid singularity, and to deceive his perception to keep an impression of fidelity of the robot's movements with respect to its commands and thus an impression of telepresence.