Chapter 50
An Intuitive Teleoperation of Industrial Robots:
Approach Manipulators by Using Visual Tracking Over a Distributed System

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ABSTRACT

Teleoperation of manipulator robots with RGB-D sensors is now mainly done using inverse kinematics techniques. In this chapter, we describe an intuitive way to teleoperate an industrial manipulator through vision sensors by directly controlling manipulator joints retargeting specific human motion. In this way the human operator has the full control of robot movements with practically no training, because of the intuitivity of this teleoperation method. The remapping into the robot joints is done by computing angles between vectors built from positions of human joints, tracked by the selected vision sensor. The obtained system is very modular which allows to change either the tracking sensor or the robot model with some small changes. Finally, the developed teleoperation system has been successfully tested on two real Comau robots, revealing to be fast and strongly reliable.

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INTRODUCTION

Teleoperation is a technique that allows human operator to move and to program a robot by simply controlling it from a certain distance. This technique is used to move robots particularly in dangerous environments and tasks, such as bombs dismantling, exploring human inaccessible sites, maintenance of nuclear facilities, underwater operations, etc. Moreover, teleoperation can be also used for robot offline programming, allowing a human operator to save a lot of time.

Teleoperation tasks can use both trivial (e.g. joysticks, keyboards, etc.), but also more complicated human machine interfaces, such as vision-based interfaces. The first ones are less intuitive to use with respect to the second ones, in fact they require some training to the human operator in order to be used properly and efficiently. The vision-based teleoperation, instead, is generally more intuitive and easier to use. In fact, it finds applications in particular for the programming of more complex robots with an high number of degrees of freedom (DoFs), such as humanoid robots (Dariush et al., 2009). Nevertheless, recently, these techniques have been applied also to industrial manipulator robots, in order to move and program them more easily and intuitively (Kofman, Wu, Luu, & Verma, 2005) (Marinho, Geraldes, Bó, & Borges, 2012). Vision-based teleoperation can be of two types, marker-based or markerless: the first is more uncomfortable because it requires to the operator to wear additional clothes, while the second is more complex to develop, because human keypoints must be estimated via software.

In this Chapter, we will present a technique that allows to teleoperate a manipulator robot with a markerless vision-based system, by using in particular a RGB-D sensor. The sensor chosen for this work is a Microsoft Kinect, that is a very cheap and powerful RGB-D device, which allows to track human movements without using any kind of uncomfortable marker. Moreover, Microsoft Kinect has a large developer community, which implies the existence of many already implemented software packages to work with.

The implementation of the whole system has been made the more modular as possible. At this purpose, Robot Operating System (ROS) middleware has been used as framework to connect the developed modules one to each other.

ROS middleware is spreading even more in both academic and industrial environments. While for the first, ROS has a great potential allowing to test new algorithms on robot on high level programming; for the second it is seen as a platform that allows to program industrial manipulator robots in order to create complex applications for their customers in less time.

THE DEVELOPED TELEOPERATION SYSTEM

In this Section we will describe how the developed teleoperation system works. First of all we will describe how the physical system used is composed and interconnected, then we will focus on how the developed algorithm works.

The System Architecture

The developed system architecture is composed by two computers: