Gesture Based Robot Control

Tomasz Grzejszczak, Michał Mikulski, Tadeusz Szkodny, and Karol Jędrasiak

Silesian University of Technology
Akademicka 2, 44-100 Gliwice, Poland
tomasz.grzejszczak@polsl.pl

Abstract. The paper proposes a method of controlling robotic manipulators with use of human gestures and movement. Experiments were performed with the use of 4 degree-of-freedom AX-12 Robotic Arm manipulator with force gripper and ASUS Xtion depth sensor also called motion controller. Depth and video capture has been done via OpenNI library. The infrastructure is based on Windows Communication Foundation (WCF) for remote access, authorization, multimedia streaming and servo control. Control of robotic manipulator is implemented with use of human computer interaction algorithm basing on depth sensor information.

1 Introduction

Robotic manipulators can work automatically or manually. In manual mode it is important to retain a high level of precision (e.g. for surgical operations or transporting objects in atypical environments). This can be done using joysticks [4], or force feedback devices. However in sterile environments touching the human-machine interface carries a risk of contamination, and disease transmission. In such conditions a different approach is needed. Thus there is a need to improve the communication between human and machine to ensure a touch-free operations and to be more intuitional. This article proposes a natural way of controlling the AX-12 Robotic Arm using gestures and position of hand. The human machine interaction is provided by depth controller. There are two similar low price depth controllers: Asus Xtion and Microsoft Kinect. This article shows the solution using Asus Xtion PRO and a vision system program created with use of OpenNI library.

2 Asus Xtion PRO

Most vision systems use standard RGB camera in order to track objects. The standard image can contain an object that could be described using (x,y) coordinates. This solution however does not give us the information about how far the objet is placed. On contradiction, the depth controller such as Asus Xtion
or Microsoft Kinect is able to provide us with standard gray scale image where
the value of pixels are proportional to distance of environment to depth sensor.

The solution of proposed problem is solved using Asus Xtion depth sensor. It can work within range between 0.8m and 3.5m with 58° H, 45° V, 70° D (Horizontal, Vertical, Diagonal) angle of view. The output data is represented as a VGA (640x480) or QVGA (320x240) matrix with data proportional to distance from sensor to its field of view. The communication with PC is supported by USB [1].

Asus Xtion is delivered with programming library called OpenNI. OpenNI (Open Natural Interaction) is a multi-language, cross-platform framework that defines APIs for writing applications utilizing Natural Interaction. OpenNI APIs are composed of a set of interfaces for writing NI applications [5].

3 Vision System

In order to control the manipulator, user need to stand in front of depth sensor within the operating range. Vision system has been programmed in such way that it detects the closest object on field of view, thus the user can control the manipulator by reaching and moving hand. Vision system program has been created as a namespace that could be attached to manipulator control program. Its main purpose is to get image from depth sensor, perform the calibration and calculate the displacement of hand.

Fig. 1. Depth map with control command presented as displacement from zero point