



Diploma Work

Robust feature extraction for object recognition in “library scenario” of the robotic system FRIEND

Background

One of the key requirements of service robotics is the robust perception of the environment, aiming at exact 3D localization of objects to be manipulated. For the 3D object localization based on the robot's vision, the objects of interest firstly have to be reliably recognized in the robot's camera image. Service robotic systems such as the rehabilitation robotic system FRIEND (*Functional Robot arm with frIENDly interface for Disabled people*), which has been developing at the Institute of Automation of the University of Bremen [1], are intended to support the user in daily life activities. Because of this, the object recognition must be robust enough to work effectively in both different lighting conditions that arise during the day and different background structures appearing in different robotic working scenarios.

One of the working scenarios of the system FRIEND, which consists of a 7 DoF (Degrees of Freedom) manipulator mounted at on electrical wheelchair and a computer based manipulator control (Figure 1), is so-called “library scenario” where the tasks of the manipulator is to fetch books from a shelf and bring them to the user for the purpose of lending them. The user will operate at a special developed library desk. To allow the manipulator to perform those tasks autonomously, the robot vision system must be able to recognize the object of interest, a book, and to localize it in 3D with a high enough accuracy for grasping. The robot vision system must be robust enough to cope with a clustered object environment (there may be several objects on the book shelf) and with the great variation in both the appearance of objects within a single class (books covers come in many textures), and in the appearance of the same object in different lighting conditions that arise during the robot functioning (e.g. different artificial and natural lighting). Also, books should be recognized on the.

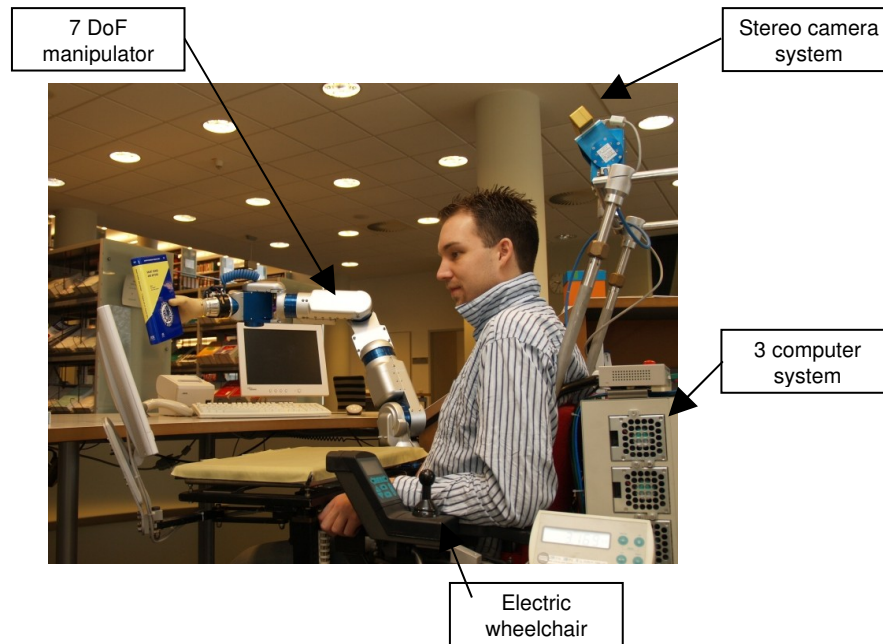


Fig. 1. Rehabilitation robotic system FRIEND; “library scenario”.

Task Description

The main objective of this Diploma Work is the development of an image processing system for extracting the features for reliable recognizing the objects of interests (books) and obstacles (background objects) in “library scenario” of the robotic system FRIEND. Robustness of feature extraction should be supported by closed-loop definition of image region of interest (ROI) and closed-loop image ROI segmentation. The idea behind this is to change processing parameters in a closed-loop manner so that current processing results, measure of quality of ROI and measure of quality of segmented ROI, are driven to desired values. The motivation comes from a fundamental concept in control theory that closed-loop systems have natural ability to provide disturbance rejection and robustness against system uncertainty, and from results obtained during the research project “Feedback structures in digital image processing” running at the IAT [3][4].

Detailed Work

1. Get familiar with the feedback structures in image processing-literature search
2. Get familiar with a selected image processing platform - OpenCV
3. Algorithm development for closed-loop definition of image ROI – testing of different measures of ROI quality; performing the tests on “input-output” controllability; feedback control design
4. Algorithm development for closed-loop image ROI segmentation– testing of different measures of segmented ROI quality; performing the tests on “input-output” controllability; feedback control design
5. Extracting of different object features and their testing for object recognition
6. Feature extraction algorithm realization using selected image processing software
7. Get familiar with robotic system FRIEND and with a MASSiVE control architecture [2]
8. Practical implementation of the developed feature extraction algorithm in system FRIEND and its online testing in different working conditions
9. Documentation and presentation of the results

Tab. 1 Time Schedule



	1 st month	2 nd month	3 rd month	4 th month	5 th month	6 th month
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

Literature

1. I. Volosyak, O. Ivlev, A. Gräser: Rehabilitation robot FRIEND II - the general concept and current implementation, *Proc. of the 9th ICORR*, Chicago, 540-544, 2005.
2. O. Prenzel, C. Martens, M. Cyriacks, C. Wang, A. Gräser: System Controlled User Interaction within the Service Robotic Control Architecture MASSiVE, *Robotica*, Special Issue; 2007.
3. D. Ristić, Feedback Structures in Image Processing, PhD thesis, Shaker verlag, 2007.
4. D. Ristić, S. K. Vuppala and A. Gräser, Feedback Control for Improvement of Image Processing: An Application of Recognition of Characters on Metallic Surfaces, the *4th IEEE International Conference on Computer Vision Systems*, New York, NY, USA, January 5-7, 2006.

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