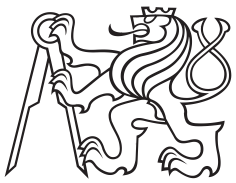
Bachelor's thesis



Czech Technical University in Prague

F3

Faculty of Electrical Engineering
Department of Cybernetics

Extraction of features from moving garment

Michal Neoral
CYBERNETICS AND ROBOTICS, Robotics

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Supervisor: Ing. Pavel Krsek, Ph.D.

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Acknowledgement / Declaration

Foremost, I would like to thank to Ing. Pavel Krsek, Ph.D. ...

Prohlašuji, že jsem předloženou práci vypracoval samostatně a že jsem uvedl veškeré použité informační zdroje v souladu s Metodickým pokynem o dodržování etických principů při přípravě vysokoškolských závěrečných prací.

V Praze dne 5. 5. 2013

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Abstrakt / Abstract

Tento...

Klíčová slova: dynamický model; model oděvu, textilie; extrakce příznaků; 3D obraz; silueta.

Překlad titulu: Získání příznaků z obrazu pohybující se látky

This...

Keywords: dynamic model; garment model; feature extraction; 3D image; silhouette.

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Chapter 1
Introduction

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1.1 Motivations

This bachelor thesis is part of Clothes Perception and Manipulation project (CloPeMa, 2012-2015) funded by the European Commision [1]. CloPeMa is research project which aims to advance the state of the art in the autonomous perception and manipulation of fabrics, textiles and garments. The CLoPeMa robot will learn to manipulate, perceive and fold a variety of textiles. This bachelor thesis describes the design of method of measurement and extraction of image features.

1.2 Goals

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1.3 Description of workplace

1.3.1 Manipulator

The base is composed of two robotic manipulator arm Motoman MA1400. First arm is called as `r1` (or also appears like `R1`). Second arm is similarly marked `r2` (`R2`). The arms `r1` and `r2` are placed on the turntable. The turntable is rotated about an axis known as `external axis` (or `Ext.` or possibly as axis `13`). Location of arms and rotating around the `Ext.` axis can be better seen from (figure 1.2). Each arm of manipulator has 6 axes, which is able to rotate. The axes are labeled according to the manufacturer with the letters `S`, `L`, `U`, `R`, `T` and `B` (figure 1.3). This designation is not enough to for recognize them and name of letters was assigned the number

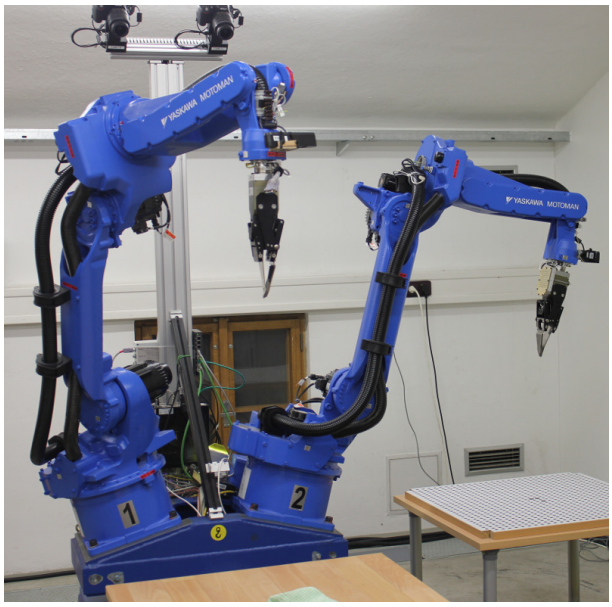
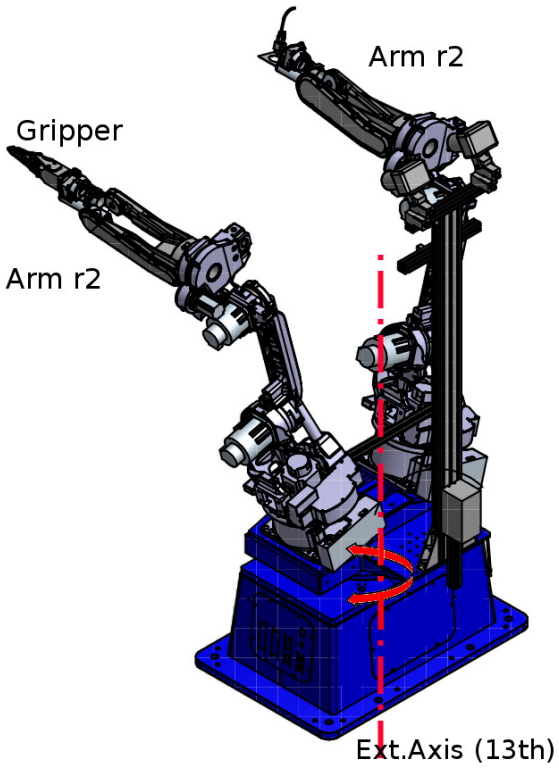


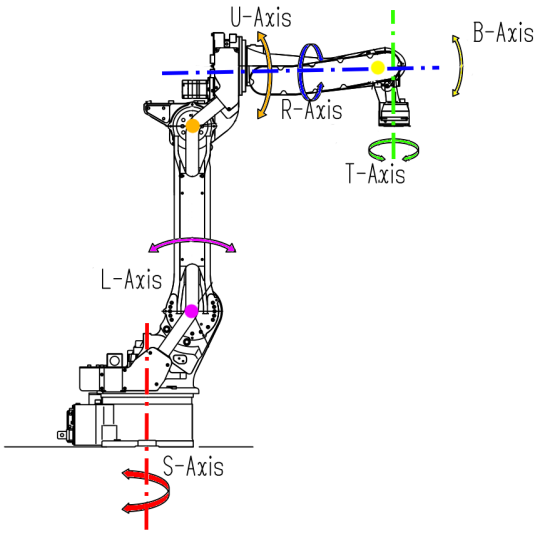
Figure 1.1. Manipulator of CloPeMa project location at CTU

of the on which this axis are located. Eg.: `S` axis located on the arm `r1` will be called `S1`, etc. Similarly to the designation of arms we can meet even using small letters (eg.: `s1`).



[fig:motomanAndTable]

Figure 1.2. Identification of arms and location of external axis.

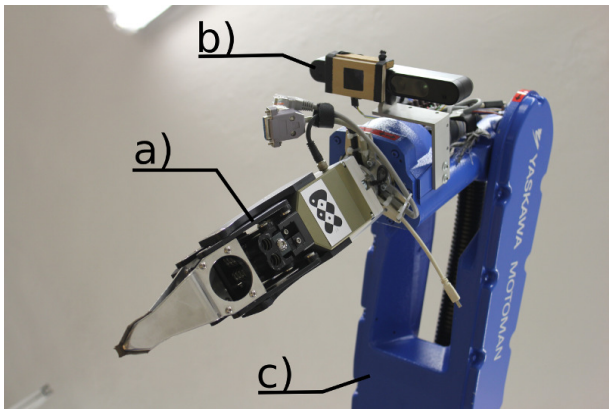


[fig:motomanAxis]

Figure 1.3. Description of robotic arm Motoman MA1400 - axis.

1.3.2 End effector

Each of arms `r1` and `r2` are ended with eletricly controlled grippers. (figure 1.4). Grippers are used to grasp of garment.



[fig:gripper]

Figure 1.4. End effector (gripper). a) gripper, b) sensor Asus Xtion, c) end of arm on which the gripper is mounted.

[secc:camera]

1.3.3 Sensors

The next important part of manipulator is camcorder Asus Xtion. This camcorder is able to record RGB images and depth maps. Camcorder mounted on the arm `r1` is called `xtion1` and camcorder mounted on the arm `r2` is called `xtion2`. Position of cameras is shown in figure 1.4.

[sec:requirements]

1.4 Requirements of experiment

The requirement on the experiment is to obtain mathematical features by which could be used to estimate the parameters of the dynamic physical model of garment. These symptoms we determine by tracking hanging garment. Movement of hanging garment will cause the movement of the manipulator gripper that holds garment. Based on the sensors that we have available, we have chosen:

- simplest movement, which we think could give us the necessary data to obtain the parameters of the dynamic model of garment **lepší překlad**. This movement is the movement of garment in the plane, ideally excited by moving gripper of a garment in a straight line (line segment).
- two types of motion tracking

a) with standart RGB video camera tracking a silhouette of garment against the constant background when garment is moving **perpendicular to the optical axis**.
b) with rangefinder tracking when garment is moving **along the optical axis**.

Chapter 2
Way of getting data

2.1 Realisation

Already during the first experiments, we found that the dynamics of the manipulator is not fast enough to perform the desired movement of the gripper with garment necessary speed. (section ??). However, it is possible to achieve the required speed when the motion will be based on a single joint. That is why we had to limit the movement of the gripper with the garment implemented that the movement of gripper along line segment is approximated by moving the gripper on the part of the circle. Another limitation is the spatial limitation, such that it is not possible to place the camera `xtion` in the appropriate position to capture RGB images (ie, the position where the gripper with garment moves perpendicular to the optical axis) and then the camera `xtion` move to position suitable for capturing depth maps (ie, the position where the gripper with garment moves along the optical axis). These restrictions are solved via camera `xtion` position (ie the position of the arm with the camera) which is fixed in the same position for record RGB videos as well as for sensing depth maps. Instead, the arm with garment makes a move of gripper with two different ways so that the movements fulfilled the conditions for sensing with each sensors (chap. ?? — perpendicular position vs. along the optical axis).

2.2 Positions of Manipulator

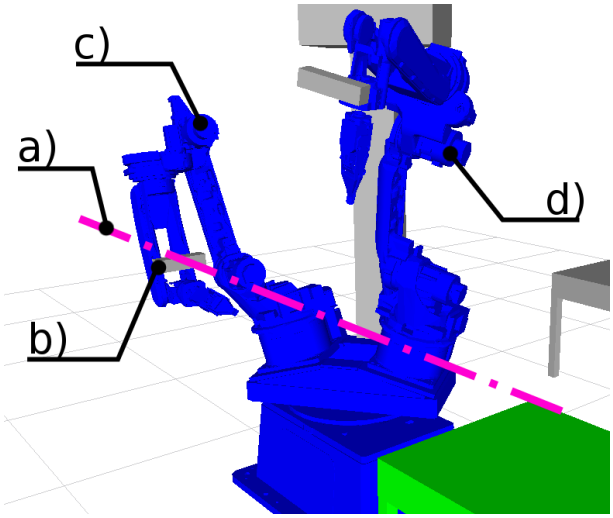
2.2.1 Arm with Sensors

The record is captured with camera `xtion1` mounted on the arm `r1`. The arm `r1` moves into position where the optical axis of the camera heads horizontally. Simultaneously is the optical axis of the camera oriented towards arm `r2` (figure 2.1).

2.2.2 Arm with Garment

Garment is held by gripper mounted on arm `r2`. Arm `r2` have two basic positions:

- **Position for Measurement** — The arm `r2` is in a position and ready for execution experiment. The arm `r2` holds garment in the gripper. The arm `r2` is in a height at which camera `xtion1` can capture movement of garment. The arm `r2` is in a position which it can perform movement required for the experiment (chap. ?? a chap ??).
- **Position for Reference Image** — This position is used for record a reference image of background, for improve results of the experiment. The record is used for filtering background from RGB image. The reference image of background is captured that the arm `r2` (in which gripper is held garment) change position so that the arm `r2` was completely out of recorded area of `xtion1`. In this position is performed the record of background and the arm `r2` with the garment was returned to the position of measurement. More to filtering out background will deal in chapter ??.



[fig:OptOsa]

Figure 2.1. Position of arm with camera. a) optical axis of camera xtion1, b) camera xtion1, c) arm r1, d) arm r2.

[subsec:refRGB]

2.2.3 External axis

`Ext.` axis (axis `13`) is rotated so that in the background of captured garment is as least as possible disturbing objects. The best is single color flat surface.

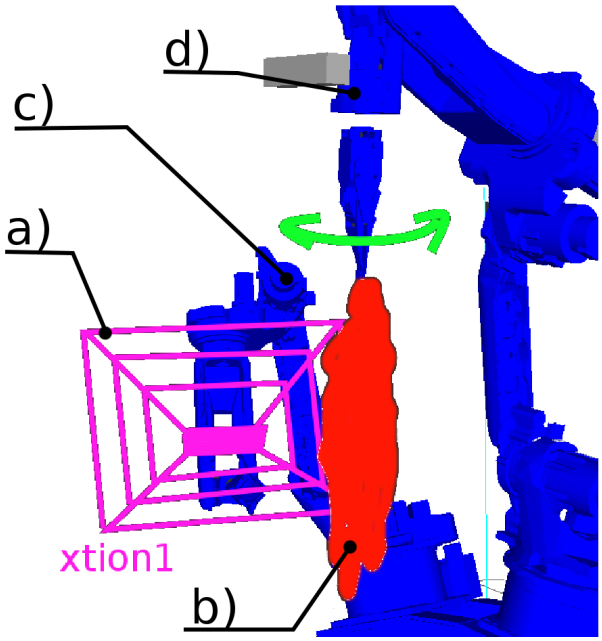
2.3 Arms movement

2.3.1 Movement of the arm so as garment moved perpendicularly to the optical axis

The arm `r1` does not perform any movement and is in the position described in the chapter ??. In gripper of arm `r2` is held garment. The arm `r2` makes a desired movement with this garment so that it rotates about an axis `B` certain angle and will return back to initial position. For better describe of the movement is movement mooted in the figure 2.2. This movement is suitable for capturing with RGB camera.

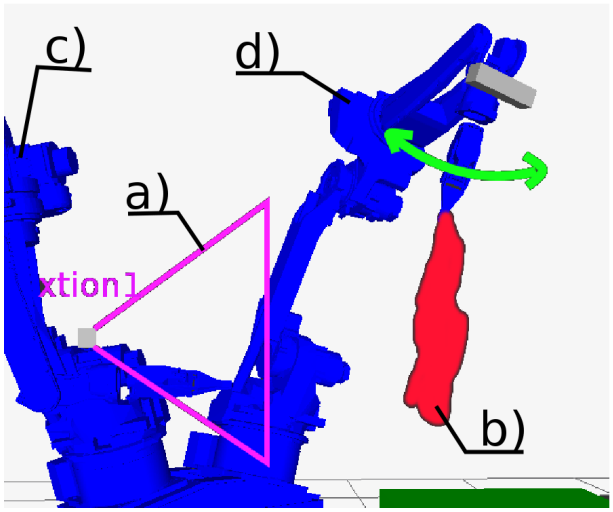
2.3.2 Movement of the arm so as garment moved along to the optical axis

The arm `r1` does not perform any movement and is in the position described in the chapter ??. In gripper of arm `r2` is held garment. The arm `r2` makes a desired movement with this garment so that it rotates about an axis `R` certain angle and will return back to initial position. For better describe of the movement is movement mooted in the figure 2.3. This movement is suitable for capturing with rangefinder.



[fig:kolmoOptOsy]

Figure 2.2. Suggestion of movements of gripper with garment perpendicular to optical axis. a) mooted of field of vision of camera xtion1, b) garment, c) arm r1, d) arm r2.



[fig:rovnoOptOsy]

Figure 2.3. Suggestion of movements of gripper with garment along to optical axis. a) mooted of field of vision of camera xtion1, b) garment, c) arm r1, d) arm r2.

Chapter 3
Data Saving

3.1 Format of Recorded Data

Data is stored by using rosbag (tool of ROS) in the format `.bag` to the folder saved in the `local_options.py` file (`path_to_workspace/clopema_cvut/clopema_collect_model_data/src/local_options.py`).

3.2 Topics

Of reason saving disk space and capacity of the transmission channel are recorded only selected topics which are saved in `topics.txt` (`path_to_workspace/clopema_cvut/clopema_collect_model_data/matlab/topics/topics.txt`). For this experiment I choose these topics:

Současný stav - předělat - již nevyhovuje

```
/joint_states
/tf
/xtion1/depth/camera_info
/xtion1/depth_registered/camera_info
/xtion1/projector/camera_info
/xtion1/rgb/camera_info
/xtion1/depth/image_raw
/xtion1/rgb/image_raw
/xtion1/depth/disparity
```

3.3 Format of Names of Recorded Files

Recorded files have names in the form `name_speed_AX.bag` (table 3.1)

name	your choosen file name
speed	choosen speed of manipulator
A	axis, which was executed movement **R** or **B** (figure 1.3)
X	number of topics file

[explanation]

Table 3.1. Explanation of format file name.

Chapter 4
Data Processing

Chapter 5
Results

Chapter 6
Discussion

Chapter 7
Conclusion

References

[clopema] [1] CloPeMa. *Clothes Perception and Manipulation.* Visited on 2014-03-20, `http://www.clopema.eu/`.

[yaskawa] [2] Yaskawa Motoman Robotics. *Datasheet of MA1400 robot.* Visited on 2014-04-03, `http://www.motoman.com/datasheets/MA1400.pdf`.

[hlavac] [3] Milan ŠONKA, Václav HLAVÁČ, and Roger BOYLE. *Image processing, analysis, and machine vision.* Thomson, edition 3 edition, 2008. ISBN: 0-495-08252-X.

Appendix A
Specification

Appendix B
Content of included DVD

Appendix C
List of shortcuts

CTU	Czech Technical University in Prague.
RGB	The aditive color model of using Red, Green and Blue colors of lights to create or capture the required color.
ROS	The Robot Operating System.

Appendix D
Brief Manual to Get Data Manually

Appendix E
Brief Manual for Using in Own Code