
AugmEnted ROBotIc Control

- AEROBIC, MINDEF -

Project Report

Neuromorphic Engineering & Robotics/SiNAPSE

National University of Singapore
Center for Life Science

Copyright © National University Singapore 2016

This document is created with LaTeX. Confidential and Proprietary.

SINAPSE

THINK BIG
think different

Electronics and IT

Aalborg University
<http://www.aau.dk>

Title:

Project Title

Abstract:

Here is the abstract

Theme:

Scientific Theme

Project Period:

Fall Semester 2010

Project Group:

XXX

Participant(s):

Abhishek Mishra

Dimple Bhuta

Nida Abbasi

Pan An

Supervisor(s):

Sunil Kukreja

Copies: 1

Page Numbers: 9

Date of Completion:

November 25, 2016

The content of this report is freely available, but publication (with reference) may only be pursued due to agreement with the author.

Contents

Preface	ix
1 Objectives	1
2 Materials and Methods	3
2.1 Motion Segmentation	3
2.2 Vibro-Tactile Haptic Glove	4
2.3 VR Simulation	4
3 Conclusion	7
A Appendix A name	9

Todo list

Preface

Here is the preface. You should put your signatures at the end of the preface.

National University of Singapore, November 25, 2016

Author 1

<username1@XX.aau.dk>

Author 2

<username2@XX.aau.dk>

Author 3

<username3@XX.aau.dk>

Chapter 1

Objectives

Fast Motion Segmentation with Neuromorphic Sensors Utilizing Biological Principles A biologically inspired algorithm utilizing saccade like micro-motions to capture data from a neuromorphic imager was developed. The algorithm concerns the development of novel asynchronous signal processing algorithms to process information resulting from the micro-motions.

Vibro-Tactile Haptic Glove We aim at designing a lightweight, wireless vibro-tactile glove to facilitate human perception of remote robotic environments. The vibratory actuators are placed at sensitive locations of the palm to deliver precise and localized haptic feedback. The objective is to make these gloves robust to user's hand poses.

Virtual Reality Visualization The project enables a VR environment (CAVE or virtual headset) to communicate, transfer and render data wirelessly at a low latency between robots and haptic gloves. In case of haptic gloves, the objective is to allow rendition of virtual objects in form of vibratory stimuli. In case of robots, the objective is to transfer visual scene information in near real-time from remotely located robots to a VR environment. In addition, a tele-operator can control the robots to perform appropriate actions as tracking and following other objects and object recognition.

Chapter 2

Materials and Methods

2.1 Motion Segmentation

A motion segmentation strategy using biologically inspired principle of embodied cognition was developed. Embodied cognition states that body is an active part of perception as opposed to pure feedforward perception models. This form of action based active perception is used by animals to process information from their surroundings. Some common examples include whisker motion for sensing immediate surroundings, ear tympana motion for accurate source localization, and saccades in eyes for scene perception. We developed an algorithm for motion segmentation by taking motivation from biological principles of saccades. The algorithm performance was characterized through experiments in controlled environments. Motion segmentation is a critical pre-processing step for autonomous robotic systems to facilitate tracking-following of moving objects in cluttered environments. Using a frame-rate camera, localization and tracking of moving objects is straightforward applying object recognition algorithms but requires significant computational resources. Event based sensors are low power analog devices that represent a scene by means of asynchronous information updates of only the dynamic details at high temporal resolution and, hence, require significantly less calculations. High temporal resolution allows for the extraction of relevant spatiotemporal scene statistics and is useful for real-time robotic applications. Our saccade or micro-motion based framework uses a biologically inspired motor perturbation induced perception strategy, that facilitates the separation of static and dynamic elements of a scene. We introduce the concept of spike-groups as an optimal method to calculate scene statistics. Using this novel approach, spatiotemporal data are partitioned into elementary, independent event groups (spike-groups), which are subsequently used to characterize objects in a scene. In addition, we show that inherent vibrations present in a sensor's mounting platform can be used to enhance motion segmentation. Experimental results show that our algorithm is

able to classify moving objects in real-time with dense labelling.

2.2 Vibro-Tactile Haptic Glove

The second generation of vibro-tactile haptic gloves was developed. These gloves have the capability of rendering spatial touch information with amplitude modulation. The high-density gloves have 18 vibratory eccentric rotating mass actuators. The actuator locations were selected to deliver haptic feedback at the most used and sensitive areas on the palm-side of the hand during exploratory procedures. The actuators are held in place by a flexible PCB, made from polyimide, to closely represent the topography of the hand, minimize wiring complexities, prevent displacements after prolonged usage and give a more natural skin-like feel. The control box is placed at the wrist location. The vibration intensity and their activation is controlled wirelessly through a graphical user interface (GUI) that is designed to send custom stimulation patterns. The GUI enables single and multiple actuator activation with amplitude modulation for intensity control. In near-field operation the latency is low permitting real-time feedback. The control box consists of two pulse width modulation (PWM) drivers and one Arduino microcontroller. The computer transmitting an encoded stimulation signal received by the control box initiates the communication pathway. This signal is sent to a microcontroller for actuation. In addition, the control box contains a power source for the system. A prototype of the second generation haptic glove is shown in Figure 1.

As reported in D9 report, we developed the second generation vibro-tactile gloves with flexible PCB to reduce wiring. However due to the stiffness of the PCB and the dissipation of vibro-tactile stimuli on the palm region experienced by the user, we developed third generation of vibrotactile glove. In this version, we use wires to fasten the actuators and give the user a more natural feel.

In the third-generation, eighteen actuators are placed at sensitive locations of human's hand. This generation of haptic glove is flexible and light weight.

2.3 VR Simulation

We aim at rendering complex virtual objects as shown in Figure 2, to the user by mapping their shapes to the vibratory stimuli on the haptic glove.

A VR environment is built inside the CAVE with 4 projectors using Unity development platform. We have developed a pick and place VR simulation as shown in Figure 3. We are evaluating strategies for the rendition of 3-dimensional geometric shapes to the user with the vibro-tactile glove.

An ART D-track system as shown in Figure 4, is used to track the position and the movement of a user accurately in the VR environment. The ART-DTracking(Advanced Realtime Tracking) system, which is used for interaction in this case, will be used

for providing gesture data. Simple clustering algorithms are used to locate the human hand and body. The position data is then translated and recorded into position data in the VR system for further usage.

This tracking system will also be used by a tele-operator to interact with a virtual avatar of the robot deployed in a remote location. Depth sensors like RealSense or Kinect are used to render the scene around robot in the VR environment.

Chapter 3

Conclusion

In case you have questions, comments, suggestions or have found a bug, please do not hesitate to contact me. You can find my contact details below.

Jesper Kjær Nielsen
jkn@es.aau.dk
<http://kom.aau.dk/~jkn>
Fredrik Bajers Vej 7
9220 Aalborg Ø

Appendix A

Appendix A name

Here is the first appendix