Force Prediction using OCT Sensor Data by Linear Regression, CNN and RNN

Felix Wege, Yuria Konda, and Lakshamanan Chockalingam

Intelligent Systems in Medicine, Institute of Medical Technology,
Am Schwarzenberg-Campus 3, 21073 Hamburg
{felix.wege,yuria.konda,lakshamanan.chockalingam}@tuhh.de

Abstract. Content of this student project is to develop a model that gives information about the force acting at a needle tip while plunging it against a tissue. The purpose is to give the operator some kind of force feedback without measuring it explicitly. Input of this model is an optical coherence tomography (OCT) signal that is measured at the needle tip. Three models which are linear regression, convolutional neural network and recursive neural network are considered.

Keywords: Machine learning, linear regression, CNN, RNN, optical coherence tomography

1 Introduction

In medical approaches OCT scans are used to image the uppermost layer of biological tissues non-invasive. For the purpose of being able to investigate internal areas of the body with this technique, researchers have developed OCT needles. By that, inner organs can be scanned directly and for example, tumors can be classified as malignant or not. One main reason for this attempt was that large surgical interventions can be avoided in many cases what results in smaller physical damages and faster healing processes of the patients. However a large disadvantage of this procedure is that no feedback for the acting force of the needle is given. This can lead to complications and injuries in surgical treatments and makes the handling unintuitive for the operator. To address this problem, force needs to be measured in some way without expanding the clinical set up spatially and financially. Both aspects oppose the attachment of a force sensor directly on the tip of the needle and a force sensor somewhere outside the treated area tends to measure additional lateral forces of the environment. (Stick slip effect) By estimating the force with OCT scans, no further equipment is required and data is already accessible.

Therefore, in this paper three different models are developed to output a force estimation based on the oct data. These consists of a linear regression model, a convolutional neural network and a recursive neural network.

2 Data Acquisition

As stated in the introduction 1, models are build to estimate the force at the needle tip using the OCT data as input. For optimization and supervised learning, ground truth data are necessary. For this, a force sensor is integrated into the OCT system by placing it at the end of the needle.

PICTURE

Data is collected by moving the needle forward to poke against a metal plate continuously monitored. The transparent tip part of the needle deforms what leads to a faster reflection of the light in the OCT sensor and thus changes the depth of the maximal reflection.

and the oct data returns a smaller depth

3 Models

3.1 Linear Resgression

3.2 CNN

3.3 RNN

4 Results

References