**Automated measurement of skin, fat and muscle thickness from ultrasound images**



CHAPTER 1

**Introduction**

This chapter introduces the project by first describing the problem at hand, and the motivation behind this project. This is followed by the goal of this project, and the proposed method for achieving this goal. The section concludes with a look at related work.

* 1. **Description and motivation**

Machine learning is, according to Géron, the science of programming to computers so they could learn from data. Therefore, it is a powerful tool that has been revolutionizing the world since the development of its first application in the 1990s, an spam filter [1]. However, it has been challenging apply ML in medicine due to one main reason: the lack of available labeled data [2]. For this reason, in the last decade, many scientists have developed approaches to handle this problem, and to use available unlabeled data set which are larger than labeled such as semi-supervised learning, multiple instance learning and transfer learning for tasks that include segmentation, computer-aided diagnosis and others [2].

This project is based on ultrasound images from the Reference Models for Multi-Layer Tissue Structures project developed by Erdemir Lab, a Cleveland Clinic biomedical laboratory [3]. The data in this project consist of the complete set of the Erdemir Lab’s project with approximately 5000 ultrasound stacks (stack refers to the full 3D ultrasound image that consist of multiple 2D slices) that have been obtained, labeled and analyzed by Dr. Erdemir and his team who have significant experience in cadaver testing of musculoskeletal joints, in particular, the foot and the knee.

**There are two main motivators for automating the skin, fat and muscle measurement of the ultrasound images. The first is to reduce the time it takes a medical expert or engineer to do the analysis and labelling. Using a software like xxxx to do manual annotation of the boundaries between each layer for one slice takes xxx – xxx, depending on the experience of the specialist. For large data set, such as data from** Reference Models for Multi-Layer Tissue Structures [3], it is not reasonable. Annotating the entire data set would take xxx (assuming xxx per slice, and 300 slices per image) using a manual method. [4]

The second motivator is to remove the inter-variability between different ultrasound radiologist or engineer’s annotation. Due to one limitation of ultrasound images is that the tissue interface boundary of the muscle fascia that may appear as a false bone boundary and the boundaries are not well defined, the positions of these points are subjective. Remove this variability would help to ensure a more objective annotation.

Automating the annotation of the boundaries between the layers and the measurement of the skin, fat and muscle means that the entire data could be processed without the need for personnel to inspect. Also, if this method proves successful and has a high accuracy, the processing time reduces, and it could be used by clinics for diagnosis and by laboratories for research.

* 1. **Goal of the project**

The goal of this project is to develop a model for fully automated measurement of the skin fat and muscle thickness in ultrasound slices.

* + 1. **Proposed method**

The proposed method consists of two stages. For the first stage, an artificial neural network is used to identify four landmarks on a single 2D slice from an ultrasound stack. These landmarks are used in combination with algorithms developed by Erica Neumann [4] to get the thickness of every layer. The second stage uses a linear regression model to get a function that show how the thickness of every layer varies over time.

To test the results of the first stage, the predicted measurements will be compared to measurement done by Erica Neuman using a semi-automatic code and manually annotated landmarks [4].

CHAPTER 2

**Data**

This section describes the proposed method that combines a neural network and a linear regression from phase 1 and 2.

CHAPTER 3

**Experiments**

This section describes the proposed method that combines a neural network and a linear regression from phase 1 and 2.

**Project Breakdown**

**First phase**

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| **1st step** | * Read the previous work done by Erica Morrill. |
| **2nd step** | * Segmenting the ROI using Python 3 from ultrasound images provided by Cleveland Clinic. |

**Second phase**

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| **3rd step** | * Create the ground truth |
| **4th step** | * Define the proportion of the date for the train, dev and test set. * Establish an evaluation metric |
| **5th step** | * Choose and evaluate some CNN architectures |
| **6th step** | * Tune hyperparameters |

**Third phase**

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| **7th step** | * Establish evaluation metric |
| **8th step** | * Choose and evaluate some CNN architectures |
| **9th step** | * Tune hyperparameters |

# **Bibliografía**

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