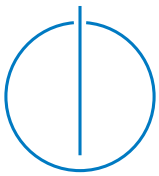
DEPARTMENT OF INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Master's Thesis in Biomedical Computing

# Segmenting 3D intracranial aneurysms in Time-of-Flight Magnetic Resonance Images.

Dhaval Shah



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# Segmenting 3D intracranial aneurysms in Time-of-Flight Magnetic Resonance Images.

# Segmentierung von intrakraniellen 3D-Aneurysmen in Flugzeit-Magnetresonanzbildern.

| | |
|---|---|
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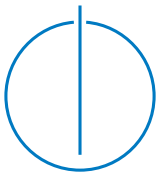
| Submission Date: | January 23, 2021 |



I confirm that this master's thesis in biomedical computing is my own work and I have documented all sources and material used.

München, January 23, 2021 Dhaval Shah

# Abstract

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# Contents

# 1 Introduction

## 1.1 Background

An intracranial aneurysm is a bulge located in a blood vessel in the brain, and the rupture of an intracranial aneurysm is a very serious incident that has high fatality and morbidity rates TODO: add ref + details . Unruptured intracranial aneurysms (UIAs) affect approximately 3-5% of the adult population, irrespective of geographical location and/or ethnicity [5]. The clinical manifestations of UIAs however, are subtle, with only approximately 10-15% of intracranial aneurysms being symptomatic [1]. TODO: risk of rupture of aneurysm Therefore, the diagnosis of an intracranial aneurysm is primarily done through the use of imaging modalities such as intra-arterial digital subtraction angiography (IADSA), computed tomography angiography (CTA) and magnetic resonance angiography (MRA). The diagnosis of aneurysm before symptoms arise allows possible intervention, if deemed necessary based on size and location TODO: ref . TODO: risk factors? TODO: differences in imaging modalities?

## 1.2 Motivation

Due to rapidly growing workload of radiologists and radiology department, it could be beneficial to introduce a reliable method for automated detection of UIAs from diagnostic images of patients. TODO: refs TODO: more

## 1.3 Goal

Design a neural network. Also, focus on trying to reduce need for large computations by attempting to use 2d networks, but still reproduce aneurysm segmentations in 3d. TODO: elaborate and extend

# 2 Related Work

## 2.1 Computer Assisted Detection

TODO: CAD in use in general clinical scenarios

TODO: CAD use/research with respect to UIAs

## 2.2 Deep learning based aneurysm detection

Detection of UIAs using deep learning is an active area of study, whose biggest challenge - as it is for a large number of medical tasks - is obtaining labeled data. A recent challenge TODO: Find journal entry for MICCAI2020 challenge you took part in allowed multiple teams access to a dataset of UIAs, and produced a variety of approaches tackling the problem. Prior to this, the gold standard seems to have been achieved by Sichermann et. al. [3] with the DeepMedic framework [2]. TODO: Gold standard for aneurysm detection - [3] TODO: Talk about other methods of TOF-MRA aneurysm detection with DL, e.g. [4]

Deep learning methods have also been used for detection of aneurysms in other parts of the human anatomy, including the aorta... TODO: Talk about various methods related to deep learning in aneurysm detection

A large number of methods also aim to detect or segment UIAs in computed tomography (CT) angiography images... TODO: About various image modalities used

TODO: Differences in domain

TODO: 3d NN's, subsection?

TODO: 2d NN's, subsection?

TODO: hybrid (3d+2d) NN's, subsection?

# 3 Time-of-Flight Magnetic Resonance Angiography

As discussed previously, Time-of-Flight (TOF) Magnetic Resonance Angiography (MRA) is an imaging modality used for diagnosis of UIAs. The following chapters will discuss deep learning methods to segment UIAs on these images, however it is also valuable to go deeper into the acquisition of these images.

## 3.1 Dataset

The dataset used was obtained from the Aneurysm Detection And segMentation (ADAM) Challenge 2020, a medical image analysis challenge organised as part of MICCAI 2020. The train dataset of TOF-MRAs consists of **113** cases which are split into 93 containing at least one untreated, unruptured aneurysm (35 baseline and 35 follow-up of the same subject, and 23 unique subjects), and 20 scans without intracranial aneurysms. TODO: Add images of each type TODO: Table? TODO: Train/Validation split?

## 3.2 Analysis

TODO: Analyse dataset e.g. aneurysm sizes

## 3.3 Acquisition

## 3.4 Comparison to other modalities

TODO: Look for some open source cranial CT-MRA with labels TODO: Look for some cranial DSA-MRA, maybe ask Supro if you can use the old ones

# Acknowledgments

I thank everyone who participated and pledge for world peace.

# Glossary

**glossary** is a list of definitions for special terms in your thesis

# Acronyms

**ADAM** Aneurysm Detection And segMentation

**CT** Computed Tomography

**MRA** Magnetic Resonance Angiography

**TOF** Time-of-Flight

**TUM** Technische Universität München

**UIA** Unruptured Intracranial Aneurysm

# List of Figures

# Bibliography


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