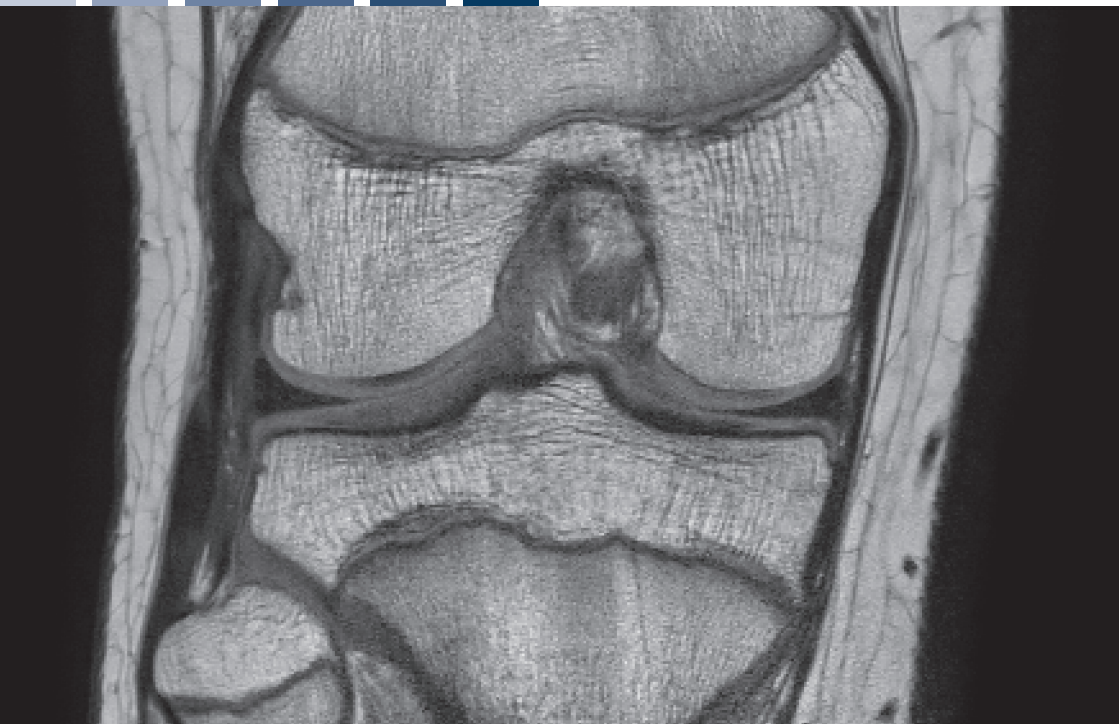
Towards Automated Age Estimation of Young Individuals

A New Computer-Based Approach Using 3D Knee MRI

Markus Auf der Mauer



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Abstract

Background: Age estimation from medical images plays an important role in forensic medicine to determine the chronological age of individuals lacking legal documentation or to discriminate minors from adults. Current methods for imaging-based age estimation are labour-intensive, subjective, and involve radiation exposure. Recent studies indicate that magnetic resonance imaging (MRI) offers a viable alternative to established methods. The *goal of this work* is to develop a fully automated, computer-based, and non-invasive method to estimate the chronological age of male adolescents and young adults based on knee MRIs.

Materials and Methods: A total of 489 three-dimensional knee MRIs were acquired from 299 male Caucasian subjects aged 13 to 21 years. The dataset was expanded with numeric data of the subjects (anthropometric measurements and assessments of knee bone maturation). The proposed solution for automated age estimation is composed of three parts: (a) *pre-processing* to standardize the data, (b) *bone segmentation* via convolutional neural networks (CNNs) to extract age-relevant structures from the images, and (c) *age estimation*. Three different methods were investigated in part (c). *Method 1* (M1) is based on machine learning (ML) and uses the numeric data to solve the task. *Method 2* (M2) is composed of a CNN which takes in knee MRIs and outputs age predictions per image slice. Subsequently, an ML algorithm is trained on these predictions and on the numeric data to estimate a single and final age per subject. Finally, *Method 3* (M3) is a variant of M2 which incorporates the numeric data into the CNN trained on knee MRIs. Similar to M2, M3 predicts a final age per subject based on ML but using only the age predictions of the CNN.

Results: The best performing method is M2 and achieves a mean absolute error in age regression of 0.69 ± 0.47 years and an accuracy in majority classification of 90.93% using the 18-year-threshold.

Conclusions: The results demonstrate the potential of this approach for age estimation based on knee MRI and ML-techniques and is expected to improve further with the incorporation of additional datasets.

Keywords: Automated age estimation · MRI · Knee · Machine learning · Convolutional neural networks · Segmentation