Automatic Angle Recognition in Hallux Valgus

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Background

- Hallux valgus - technical term for the foot deformity commonly referred to as a bunion.
- The foot is a complex mechanical structure comprised of 26 bones and many articulations that are maintained by a sophisticated arrangement of ligaments and muscles.
- More than 140 surgical correction procedures have been described, each focusing on different components of the deformity.
- Limited understanding of the bony relationships that are central to the deformity and should form the focus of surgical correction to most accurately predict both symptom and deformity reduction.

Objective

The objective of this project is to utilise machine learning techniques to assess the relationship between multiple bony segments on pre- and post- operative x-rays and patient satisfaction, to identify the optimal approach to surgical correction.

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Methodoloy: A neural network is used to identify sub images containing the phalanges of interest. The following section describe the neural network, its architecture, training and the dataset used. This is followed a detailed description of the proposed method for recovering the the angle phalanges in the recovered subimages.

Dataset labelling

The data samples are labelled matching the requirements of the Neural Network (NN). To do so, two classes are established, F1 and F2. F1 is assigned to the proximal phalanx of the hallux and F2 to the metacarpal. Next, each data sample is hand-labelled by enclosing said bones under a bounding box and assigned its corresponding class. The accuracy of the bounding box is not as relevant, yet the general vector formed by the bone inside it must be identifiable.

Trainning

The NN was trained through Darknet. A set of pre-trained weights was used as the basis.

Measures:

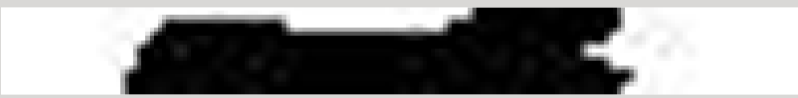
- Mean Average Precision (mAP)
- Sum-squared error loss

Angle Estimation

Image Transformation

Image Segmentation and Point Extraction

Followed by vectorization and angle computation



Conclusion

The results demonstrate that YOLOv3 network can identify both the hallux and 1st metatarsal from radiographic images. The method presented above can then be used to extract the HVA from these images.