Parameter optimization of the Hoang method for the muscle medial gastrocnemius

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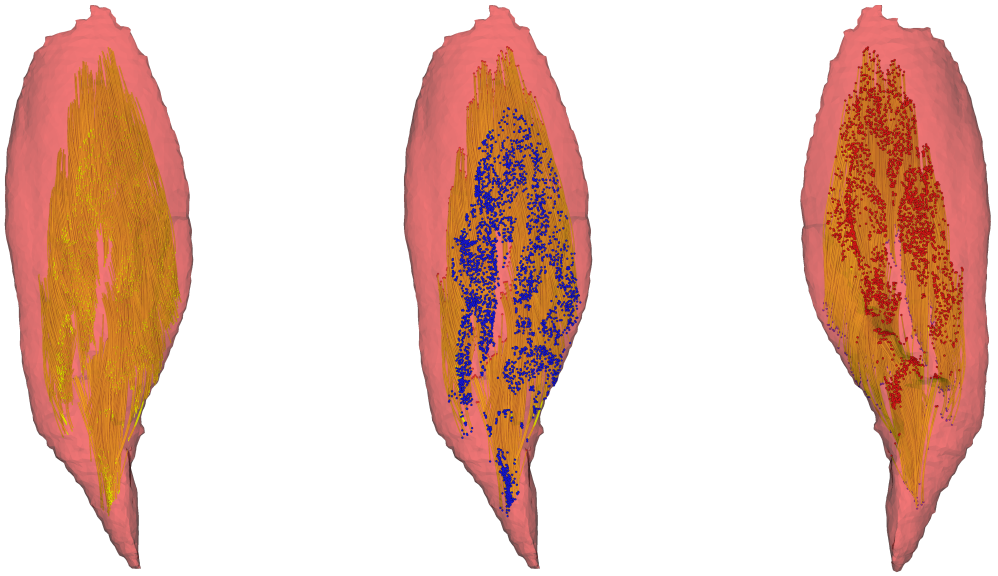
1 Introduction

The main focus of the previous work, for details please see Hoang, D. L. (2023), was the decomposition of skeletal muscles into mechanical fibers, that approximate real muscle fibers and tendons. The developed method, called the Hoang method, accepts many fine-tuning parameters for its execution. The issue is determining such parameter configuration that would yield the most accurate results (i.e., most realistic fibers). In this work, therefore, the goal is to automatically find these optimal values for the muscle *medial gastrocnemius*, for which we have clinical data that serve as the ground truth.

2 New measured data for medial gastrocnemius



(a) Fibers obtained via DTI **(b)** Front attachment points **(c)** Back attachment points

Figure 1: Medial gastrocnemius

From the authors of the research paper Handsfield et al. (2017) we were provided data about the muscle *medial gastrocnemius*, which is the inner head of the calf muscle. The authors of this publication obtained muscle fibers by diffusion tensor imaging (DTI) of a real muscle, please see Figure 1. To use the Hoang method, the fibers needed to be preprocessed to obtain

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the attachment areas of the muscle - see Figure 2 for results. The method used to obtain the attachment areas is described in Kohout, J., Červenka, M. (2017) .

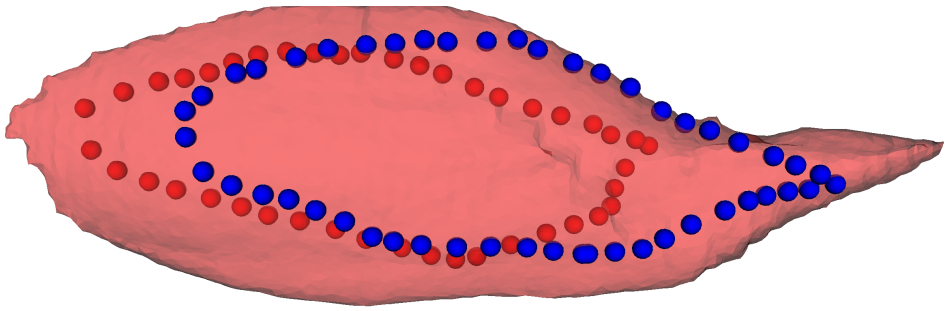

Figure 2: Medial gastrocnemius with attachment areas

3 Honeybee mating optimization algorithm

To determine the optimal parameters, a genetic algorithm was employed, specifically the *Honey Bee Mating Optimization* algorithm was adopted. The cost function, which is used to measure the effectiveness of the algorithm, was defined as the Mean Squared Error (MSE) between the original set of fibers and the set generated by the Hoang decomposition. The choice for this algorithm was influenced by its detailed description and utilization in the work of Alireza, B. D., Zeinab, F. (2013).

4 Conclusion

The best fine-tuning parameters for the Hoang decomposition of the *medial gastrocnemius* have been found, but further rigorous testing has to be made, especially for other muscles of the human body, where the biggest challenge is the scarcity of such high-quality data.

Acknowledgement

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