Individualization of the Physiological Articulatory Model Based on Morphological Measurements

Nana Nishimura (1010046)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 6, 2012

Keywords: morphological articulatory model, MR images.

1 Introduction

To investigate the individual differences in speech production, it is necessary to investigate the morphology and the movement of the articulatory organs during speech production. In particular, a physiological articulatory model becomes a powerful tool for investigating these problems since the limitation of the observation approaches and ethics. A number of such as models were constructed for this purpose. Most of these studies were focus on investigating the generic mechanism of speech production, which is quite different from investigation of the individual differences for each specific speakers in speech production. To discuss the individual difference in speech production using the physiological articulatory model, it is important not only reproducing speech sounds from the model but also easily adapting the shapes of the speech organs for any subjects. Among such models, the model proposed by Dang et al enables to reproduce speech sounds for articulatory targets via muscle activation. This model also enables to investigate the muscle activation in speech production or one-to-many relationship between speech sound and articulation. However, it is difficult to investigate about the individual differences using multiple models. Since, such a model has complicated structure it would take a lot of

time for construction of given arbitrary subjects from their morphological data. To efficiently construct a computational model for any subject, in this study, we propose a method that can construct personalized articulatory model for a given subject by adapting his/her morphological data to a prototype physiological articulatory model.

2 Individualization

As a individualization, we adapt the morphological data of a given subject to the prototype model, where the muscle structure was used the one of in the prototype model by adjusting proportionally to the morphology of the new model. In this procedure, first, we use two types of information: one is the contour of the articulatory organs from MR images, and the other is the size of the vocal tract in 3D. The former information is used to adaption of the prototype model and data based on the landmarks by means of the Radial Basis Function Transformation. The size information is used to fit the general shape of the prototype model to the observed data by a proportional reforming, while the muscle structure is reformed in the same way simultaneously.

This method enable to get a new model by transform the contours of articulatory organs with keeping the original structure. As a result, this process to construct the model is much more efficient than that build up such a model without the reference of the prototype model.

3 Results and Discussion

The personalized model is realized by adapting the prototype model to the personal data. In addition, normal movement of model after personalization was confirmed. The comparison shows that the proposed method can construct a personalized model with available accuracy. As a results, it suggested that the landmarks enable to reduce greatly.

4 Conclusion

In this study, we proposed a novel method for constructing a personalized physiological articulatory model by transforming the contours of articulatory organs. As a result, a personalized model constructed by our method could describe the morphological individual differences of articulatory organs comparing with the observation data. It is also important for clinical application to personalize the muscle position and inner structure of articulatory organs. Extending our framework to personalize such organs remains for a future work.