The Lip Shaped Parameter Analysis for Cardinal Vowels of Mandarin Chinese

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Abstract

In this paper, we mainly focus our study on the cardinal vowels [a],[i],[u] and[e] of mandarin Chinese. Based on the dimensioning system which is built by MATLAB, we mark the inner lip lines and out lip lines of each frame of videos, and get relevant parameters, such as inner lip width, outer lip width, inner lip height, outer lip height, the lip opening degree, labial convexity, etc., based on the above parameters, we make a description and an analysis about the vowels' lip physical features of mandarin Chinese.

Keywords

Mandarin Chinese; vowels; lip contour; parameters.

1. Introduction

The interaction between speech acoustics and visual information is very important for human people's understanding of language speech. In recent years, the study of language shifts from acoustics study to physiological study, one of them is to study the motion of lip by video, which can be extended in lip-reading and other relevant fields [1-2]. The video image processing technology is often used to automatically retrieve the lip contours, to get the parameters of lip's motion, and to build a model of the lip's motion [3-4]. The language study of lips earlier started in 1950s, at that time, Language scientists use mirror to research the lip's motion which is in speech. With the development of technology, nowadays the study of lips is usually by the means of extracting lip contours, and has achieved great progress that a lip parameters data has been built. [5]. In this paper we mainly focus on the cardinal vowels [a], [i], [u] and [e] of mandarin Chinese to descript and analyze their lip physical features.

2. Lip contour detection

As the colorimeter of lip's feature is obvious, in recent years, both the domestic and foreign scientists use the colors characteristic of lip to detect lip contours. Edge detection method is often used to extract lip contours, but the problem is the accuracy of extracting inner lip parameters is still the bottleneck of edge detection method. In order to improve the accuracy of extracting inner and outer lip parameters, we have developed a new system by MATLAB, which can mark the lip contours and extract parameters. The new system has realized lip contours' extraction by marking the key points manually and fitting the lip contours. The major function of the new system including: showing the video frame by avi.; basic CRUD (create retrieve, update, and delete) operations of the lip's key points; the setting of key frame; the different display of lip modes; video playback; the lip parameters' extraction and the store of data.

The key points of lip are determined on MPEG-4 basis, in which there are 16FDP points of the mouth. First, taking the convenience of marking and fitting the curve of lip into account, there are 20key points being set, which contain 8 inner lip points and 12 outer lip points as the Figure 1. Then, two order polynomial fit method is used to connect and smooth the key points with each other to forming the lip contours as the Figure 2. Third, mark the key points on each frame, and a whole syllable lip contour image is eventually made, as the Figure 3.
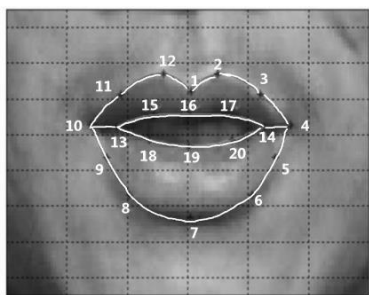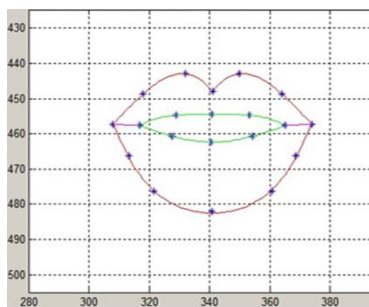
Figure 1. The key points   Figure 2. The lip outlines   Figure 3. The marked lip contours

3.   The lip's parameter definition

The algorithm of Liew et al. (Liew, et al. 2000) supposes that the lip is bilateral symmetry, they set the a series of parameters such as lip width (w), up lip height (h1), down lip height (h2), the sunken of philtrum (xoff) and the radian of arc for down lips to descript the lip's contours and get the lip's outline by both left and right mirror images effects, as the Figure 4. In order to keep the accuracy of the different phonemes' lip contours, based on the way of predecessors' parameter definition, in our study there are 9 parameters designed, as the Figure 5. The 'w' stands for the lip width, the 'h' stands for the lip height. 'w1'is the outer lip width, and 'w2' is the inner lip width; meanwhile, 'h1'is the outer up lip height, and 'h2' is the outer down lip height, 'h3'is the inner up lip height, 'h4' is the inner down lip height, 'h5' is the lip's openness, and xoff is the lip's protrusion. The lip's openness is the vertical distance between the inner up lip and down lip, and its value can show the openness of mouth.
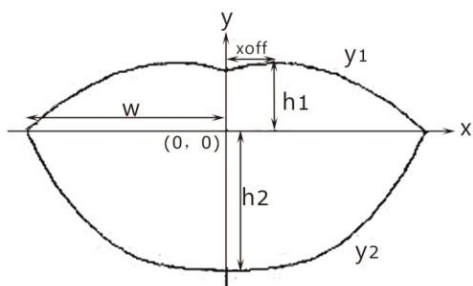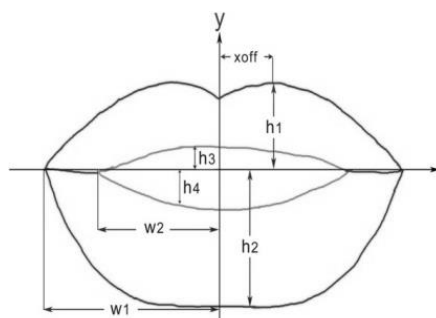

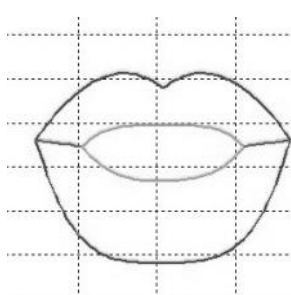Figure 4. The Liew lip contour   Figure 5. The figure of lip parameters
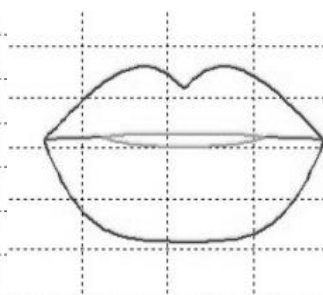

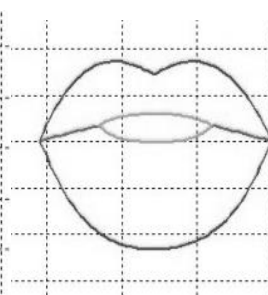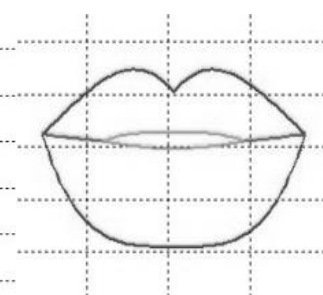Figure 6. [a]   Figure 7. [i]   Figure 8. [u]   Figure 9. [e]

4.   The lip's parameter analysis of mandarin Chinese

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4.1 S the lip forms' features of vowels

In our study, there are four university students' video signals have collected, we mainly focus on the cardinal vowels [a], [i], [u] and [e] to descript and analyze their lip physical features. [a] is the central back and non-round vowel, the openness of mouth is big and looks like a yawn in pronunciation. [i] is

the front and non-round vowel, the mouth is almost closed and the lip is flat in pronunciation. [u] is the back and non-round vowel, the openness of mouth is small and both up and down lips are very close in pronunciation. [e] Is the back semi-high and non-round vowel, the mouth smiles in pronunciation. Figure 6-9 are the lip contours of vowels [a], [i],[u] and[e].

4.2 The lip's parameter of vowels.

Based on the relevant parameters which are extracted from the target frames, we have analyzed the four cardinal vowels [a],[i],[u] and[e].

Table 1 Three Scheme comparing

vowels	W1	W2	H1	H2	H3	H4	H5	xoff
a	32.50	20.52	15.01	26.15	3.53	4.19	7.72	8.88
i	32.29	17.66	14.62	20.41	1.38	1.66	3.03	9.38
u	31.24	15.52	17.11	22.86	2.45	3.55	6.00	10.21
e	33.38	19.31	13.52	19.03	1.38	1.11	2.48	9.10

As Table 1, we can come to the following conclusions: 1) the lip width of [a] and [e] are significantly larger than [i] and [u]; 2) the value of [u] 's'h1' is the largest, and there is little difference among vowels [a],[i] and[e]; 3) the parameters of 'h3', 'h4', 'h5' are in consistency, which is shown as [a]>[u]>[i]>[e], and it is can be known the openness of [a] is the largest; 4) the value of [u] 's'xoff' is the largest, and there is little difference among vowels [a],[i] and[e].
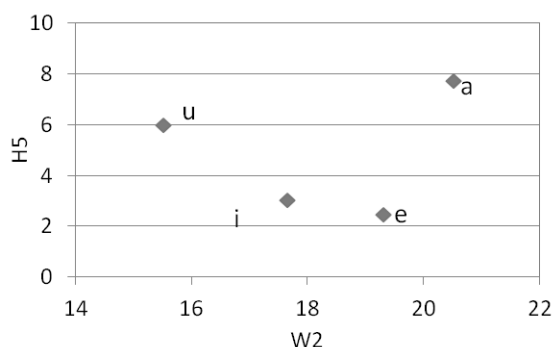

Figure 10. The pattern chart of lip form

A pattern chart of lip form can be drawn by the abscissa of 'w2' and the ordinate of 'h5', as Figure 10. The parameters of 'h5'and 'w2' are about the inner lip contour, which can represent the distinctive features of vowels, and they are the most important parameters in linguistic study.

5. Conclusion

In this paper, there is a marking platform of lip contours have built, based on it we have marked the inner and out lip lines, and extracted the main parameters to analyze the lip physical features of vowels' of mandarin Chinese on the linguistically level. All of the work in this paper have laid the foundation for the study of automatic synthesis of lip and lip recognition , the change of lip is a highly dynamic process, for the future studies we not only focus on the static processes of lip, but the dynamic processes of lip and the coarticulation process as well.

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