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# Towards constructing a historically-grounded gesture-timbre space of Guqin playing techniques

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## Introduction:

Guqin is an ancient (~3000 yo) Chinese zither instrument known for its **timbral variability**. Most of its playing techniques were developed no later than Ming Dynasty (14-16 century). Numerous ancient text dating back to the 900s have provided guidelines for gestures of defined Guqin playing techniques and recommendations on timbre aesthetics.

Nevertheless, a large part of Guqin pedagogies is **metaphoric**, mind instead of body-centered, and include **limited justifications** on recommended gestures.

## Objective:

This work attempts to **digitize and concretize** the sonic implications in Guqin gesture-timbre writings, and variegate within the vocabulary of playing techniques by designing and recording a **dataset of isolated, short representative Guqin timbres labeled by gestural data**.

## The Text: <Tangchenzhuo zhifa> 唐陈拙指法 (est 860~900)

- Chen Zhuo 陈拙 (Late Tang dynasty: mid 9th century)
- Include technical (hand control and tone production) and expressivity (aesthetics of tone) instructions 【诀, 法, 用】, on three fundamental elements of qin playing 【指, 声, 韵】: finger, sound, resonance

## Case Studies:

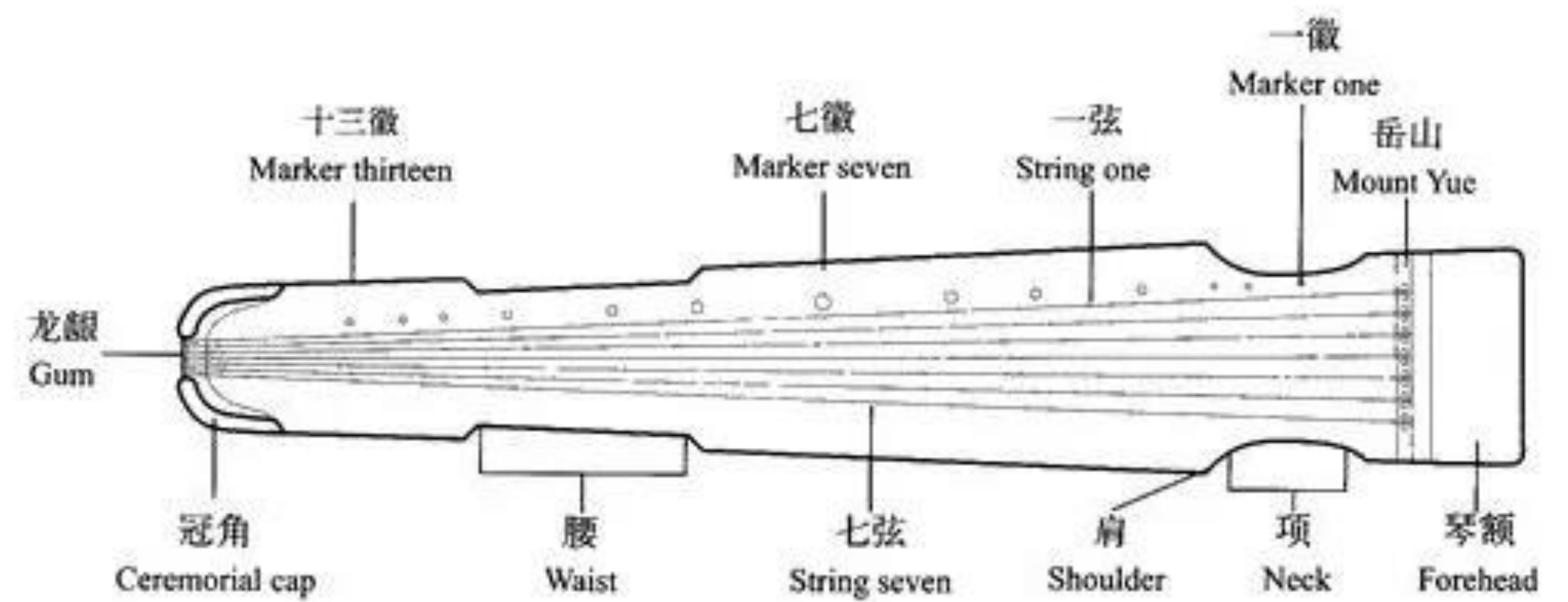
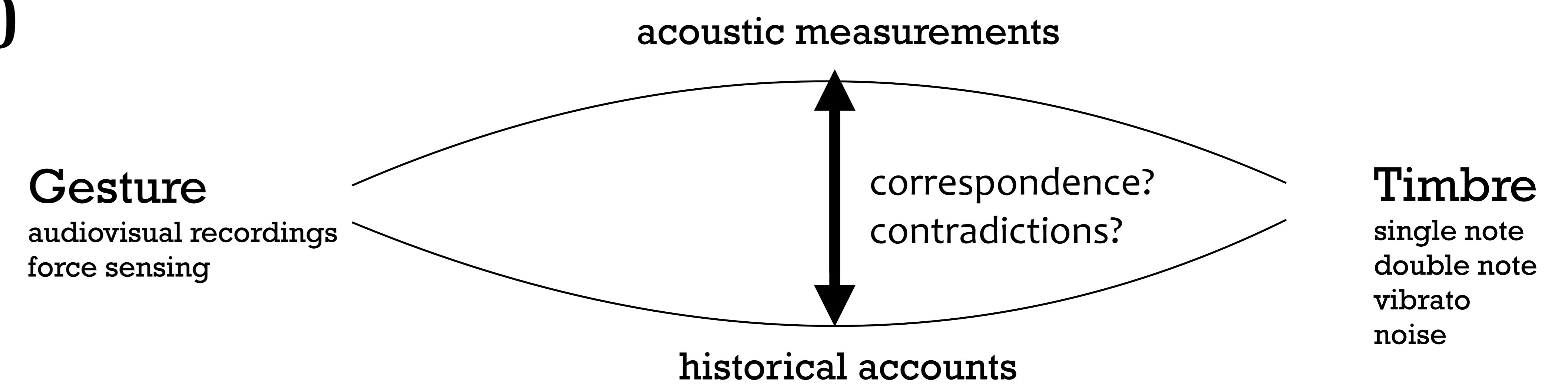
How do the gestural degrees of freedom identified for each case affect the resulting timbres?

### Acoustics-oriented techniques:

- **Single note open string**
  - 指分远近轻重徐急: "For short sounds the finger is positioned on the surface, passing lightly over the string, the attack light and sudden; For long sounds, the finger slowly approaches from far away, goes deep into the string and attacks violently"
  - 声分刚柔: "The outward plucking corresponds to firm sounds - clear and far-reaching; the inward plucking corresponds to soft sounds - harmonious and unctuous"
- **Single note harmonics**
  - 徽正则鸣, 徽差则塞: "Sound rings only if finger strikes at precisely the markings, otherwise it will be dampen and stuffy."
- **Double note**
  - How do the two notes fuse under different modes of attacks?

### Context-dependent techniques:

- **Vibrato and portamento**
  - **Resonance:** how do force and timing of lefthand movement affect the modification of resonance
  - **Noise:**
    - noise from nails (right hand attack)
    - noise from flesh (left hand portamento/vibrato)



## Feature extraction:

- **Gestural:** fingers, attack positions, direction, inferred force, left/right hand timing coordination
- **Timbral:**
  - **Partials distribution moments:** centroid, skewness, kurtosis
  - **Spectrotemporal modulations:** Joint time-frequency scattering Transform (JTFS)
  - **Noise:** Noise-to-harmonics ratio
  - **Deep embeddings:** openl3

## Gesture-Timbre Space:

- **Multidimensionality scaling:** Isomap, TSNE, PCA
- Future: gesture-conditioned timbre synthesis

\ Gestural DoF	Right hand				Left hand							
	position	finger	direction	excitation mode	position	point of contact	amplitude	frequency	force	timing		
<b>single note</b>	1. ~9cm from Mountain Yue 2. marker 1 3. marker 2-3 4. marker 4 5. marker 5-6	1. thumb 2. index 3. middle 4. ring	1. inward 2. outward	1. basic pluck 2. flick 掣 3. slap 提 4. knock 敲	/							
<b>single note harmonics</b>				selected and adapted pluck techniques							selected markers and their deviates	1. 抑泛 (index) 2. 覆泛 (thumb and index) 3. 牙泛 (thumb)
<b>double note</b>				selected chords (octave, fifth, tritone, second)							1. open 2. pressed 3. harmonics 4. open+harmonics 5. open + pressed 6. pressed + harmonics	
<b>vibrato / portamento</b>				selected start and end positions							1. between flesh and nail 2. finger belly 3. knuckle	1. long 2. short 3. circular

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