Abstract: We have modeled more than twenty Chinese traditional and folk instruments using Csound, and used traditional scores for each instrument as examples. We will play musical excerpts using the Csound designs for our demo, as well as playing several of the smaller acoustic instruments "live" for comparison.

CHINESE INSTRUMENTS

Previous work on modeling instruments has primarily focused on simulating western instruments. Researchers have also explored the acoustics of the Japanese shakuhachi and large Chinese bells. They have not devoted as much attention to the other Chinese instruments.

Chinese wind instruments include a range of colorful instruments with distinctive characters. The dizi is the most common of the Chinese flutes, and it has a bright buzzing quality produced by a rice paper membrane glued over a special hole. The dizi often takes a leading role in ensembles, where its bright timbre allows it to cut through even large groups. Other types of Chinese flutes include the xiao (vertical flute), paixiao (panpipes) and xun (ocarina).

The bawu is a folk instrument, easier to play than the dizi. Players hold the bawu transversely like the flute, but with the player's mouth completely covering the blowhole, which has a narrow triangular tongue cut into a copper strip covering the hole. The copper tongue vibrates when the player blows producing a sound similar to a recorder or clarinet, but more mellow. Solos for the instrument are usually very lyrical and romantic in character. Though almost never performing as a solo instrument in Chinese orchestras, the bawu commonly accompanies dance and singing of the Miao, Yi and Hani minorities in southwest China. The hulusi, another folk instrument, sounds similar to the clarinet. The hulusi has a playing tube and one or more drone tubes.

The sheng is perhaps the most distinctively Chinese of the wind instruments. It characteristically plays two or more tones at a time in an organum style of open fifths and octaves. The sheng is a mouth organ with a ring of bamboo pipes attached to a wind chamber. Each pipe contains a free reed similar to the tongue of the bawu. The performer blows through a blowpipe into the wind chamber while covering the holes of the sounding pipes. Instrument builders often add two or more dummy pipes for balance. Figure 1 shows the pitches of the pipes on our Cantonese sheng, though other designs are also common. The normal sheng has a very expressive quality due to the human wind source, and the instrument also sounds when the player inhales through it, a common performance technique. The instrument has a bright timbre which blends well with other instruments, and it serves to "fuse" together diverse instruments in the Chinese orchestra (1). When performers sound two or more tones on the sheng, the lower tones are usually much stronger than the higher ones, blending the upper tones with the upper partials of the lower ones. The fusheng is a folk version of the sheng.

The pitched percussion instruments include the pengling, boling, xing, dagu, xiao, chu, muyu and qing. Ling is the Chinese name for small bells, and these instruments feature frequently in Chinese orchestras, small ensembles, Buddhist ceremonies and ethnic music such as the Naxi orchestra. The most common version is the pengling ("colliding bells"), a pair of clapperless brass bells which the performer strikes together. The instrument dates back over 1000 years in central China, and has a bright punctuating quality similar to the Western triangle. Tibetan versions of the ling, called boling ("bowl bells"), are larger and flatter, and date even earlier. The Tibetan instrument has a more haunting, mysterious quality. Both Chinese and Tibetan bells have a connecting chord which allows the performer to hold one bell in each hand while striking them together with their mouths facing upward. The xing is a closely-related single Buddhist bell loosely nailed to the end of a wooden stick. The mouth faces upward as the performer strikes the bell with a thin metal rod. Non-pitched percussion instruments include the bo, flat drum, side drum, muyu tube, daluo and Chinese woodblock.

The plucked string instruments often have of a "twanging" sound than their Western counterparts. Members of the plucked strings include the ruan, liuqin, zheng, pipa, yangqin and sanxian. The bowed strings include the erhu and its larger and smaller cousins.
CSOUND DESIGNS

We modeled several Chinese wind instruments and pitched percussion instruments using group additive synthesis, optimizing the parameters with a genetic algorithm (2). We also designed a sampling-wavetable model for the ruan, liuqin and zheng. We plan to model other plucked strings in the coming months, including the pipa, yangqin and sanxian. The bowed strings are the most difficult to model, but we have a rough wavetable model of the erhu. We will try to improve on it, and extend it to the higher bowed strings.

Our Csound designs allow composers to conveniently resynthesize these instruments and modify the designs (such as changing the wavetable formants). We have conducted listening tests, and the results show that the resynthesized instrument tones are indistinguishable from the originals. Real-time synthesists will find the instrument designs particularly useful since they only use three or four wavetables for each tone, and only about 12 wavetables for the entire pitch range. The models also lend themselves to applications such as timbral interpolation.

CONCLUSION

Current instrument design is an art of trial and error as composers and researchers create new sounds and compositions. Our Chinese instrument designs can serve as a departure point. The synthetic designs can be used without regard for the physical limitations of the acoustic instruments, such as range breaks and fingerings. You can also combine features of separate instrument designs to create hybrid instruments. We plan to publish our designs in the upcoming book Chinese Cooking with Csound.

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REFERENCES


FIGURE 1. Pitches of the pipes on a Cantonese sheng.