COMPUTATIONAL ONSET DETECTION FOR THE HAEGEUM: ADDRESSING CULTURAL AND ACOUSTIC COMPLEXITY

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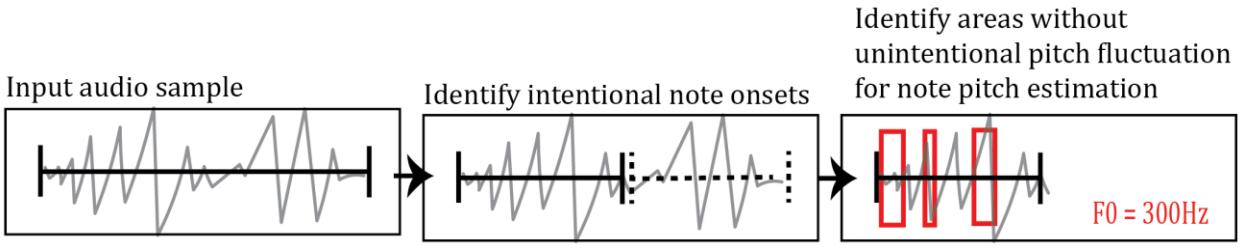
Abstract

The haegeum, a two-stringed bowed instrument integral to Korean traditional music (*Gugak*), presents significant challenges for automatic onset detection due to its flexible intonation, extensive ornamentation, and protracted transient phases that embody the *Gugak* aesthetic in which each tone is conceived as a "living entity" possessing its own expressive identity [1].

This study proposes a multi-layered onset detection framework that combines an Onset Detection Function (ODF) [2] with a Stable Phase Deviation Function (SPDF) [3], specifically designed to model the haegeum's complex acoustic characteristics.



To establish a culturally informed ground truth, we conducted an annotation experiment comparing onset labelling behaviours between Western-trained and Gugak-trained musicians. In line with previous findings on annotator variability [4], our analysis revealed systematic group-level differences: Gugak-trained annotators consistently marked onsets later and with greater variability than their Western-trained counterparts. Statistical evaluations using t-tests and F-tests confirmed the significance of these trends, indicating that auditory segmentation and onset perception are influenced by cultural background and musical training.

Insights from this study informed the design of a tolerance window adapted to the haegeum's gradual sound stabilisation. Within this framework, the ODF accurately detected initial bow–string contact points, while the SPDF refined these detections by isolating stable tonal regions, yielding onset predictions that more closely aligned with perceptual ground truth. This dual-layer approach demonstrated particular efficacy in rhythmically complex passages characterised by rapid bowing, extended transients, and delayed tonal convergence.

By incorporating culturally and instrument-specific parameters, this work advances onset detection methodologies for non-Western instruments and contributes to the broader field of computational ethnomusicology. Furthermore, it provides a technical foundation for the development of culturally sensitive performance analysis systems and pedagogical feedback tools for haegeum instruction.

References

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