Using photogrammetry for the objective study of ancient bowed instruments: a machine learning approach

Philémon Beghin, Anne-Emmanuelle Ceulemans, François Glineur
UCLouvain
philemon.beghin@uclouvain.be, anne-emmanuelle.ceulemans@uclouvain.be,
francois.glineur@uclouvain.be

The morphology of today's violin differs greatly from that of the first instruments of the late 16th century. Between 1750 and 1850, in order to meet the standards suggested by famous orchestras and conservatories, many ancient violins have been reduced. For example, the following figure shows a reduced pre-1750 violin as it looks today (left) and an estimate of its original dimensions (right) [1].

Figure 1: Reduced violin and estimation of its original dimensions.
Height of the sound box: now 35.4 cm - original c. 38 cm.

Given the paucity of written sources, the only way to improve our understanding of the violin family in this period is to study the instruments themselves. Hence, we aim at developing a set of tools able to analyse three-dimensional geometrical shapes acquired by photogrammetry. Our purpose is to differentiate ancient reduced violins from ancient unreduced violins. Using their geometrical representation, we want to quantify their specific characteristics, detect possible anomalies and, if applicable, reconstruct their original morphology. Ultimately, we will classify a corpus of ancient violins according to these aspects, thanks to unsupervised and supervised machine learning techniques.

Photogrammetry outputs point clouds and polygonal meshes, which are relatively large-scale and unstructured, hence are not the most suitable to apply standard classification techniques or models. Our first objective is thus to identify mathematical models that are precise enough to describe the three-dimensional shape of our digitised violins, but which are at the same time convenient for a classification purpose.

More precisely, we will focus mainly on the surface of the violin soundboard which we wish to represent as a piecewise function. This function will correspond to the height of the soundboard with respect to a symmetry plane of the violin (identified using Principal Component Analysis). The domain of this function will be carefully computed from the photogrammetric point cloud and mesh, so that the graph corresponds only to the upper part of the soundboard, eliminating the ribs (lateral parts). We will then apply different regression techniques on the point cloud to compute the piecewise representations of the surface (such as linear regression, B-splines, etc.), on a predefined partition of the domain, and use the coefficients of those fitted representations to classify instruments with standard machine learning techniques. We will present preliminary results obtained after performing photogrammetry on a collection of 40 ancient instruments taken from the Museum of Musical Instruments, Brussels.

References

[1] K. Moens *Les voix médianes dans l'orchestre français sous le règne de Louis XIV, L'orchestre à cordes sous Louis XIV.*, dir. J. Duron – F. Gétreau, Paris, 2015, 119–138.