CHARACTERIZING MUSICAL TEXTURES

David Huron
Conrad Grebel College
University of Waterloo
Waterloo, Canada N2L 3G6

Early music, electroacoustic music, and non-western musics have challenged contemporary music theorists to provide analytic tools which are less genre-specific and more universal in their scope of applicability. The notion of musical 'texture' is a promising topic for the development of analysis tools since, as with the terms 'timbre' and 'sonority,' the notion of musical texture has an apparent universality which seems to be less true of concepts such as harmony. It is possible to imagine music without harmony, but it is difficult to imagine sounded music which would be devoid of texture. Texture may thus provide a useful probe by which, for example, the organization of electroacoustic works may be directed related to the organization of music of the common practice period, or even to non-western traditions.

This paper briefly synopsizes a project whose goal was the derivation of an analytic model for characterizing musical textures. The model was derived through a four-part analytic process. First, a semantic analysis was carried out on the term 'texture' as used in normal musical discourse. Such an analysis can alert us to subtleties and distinctions which can assist in model-building. Second, various textural 'factors' were proposed — that is, quantifiable characteristics of a musical work which may contribute to the formation of the work's texture. Third, the proposed textural factors were combined and permuted to form all possible models. Each of the derived models was evaluated according to its ability to correctly classify the texture of a number of *a priori* classified works. Fourth, the models were evaluated with regard to their conceptual elegance — that is, the degree to which a model provides a conceptual framework which helps to explain or clarify what we mean by texture.

Semantics of 'Texture'

Lexicographers and linguists have shown that concepts can be clarified through detailed examination of the semantic context in which the utterance is made. To this end a sample of English-language[1] writings on music were perused and a body of 109 quotations assembled in which the word 'texture' appears. These quotations were then analysed according to the denotations or connotations entailed. The word 'texture' was found to occur in a wide variety of circumstances and with innumerable shades of meaning. Despite this diversity there appear to be three common meanings characteristic of the term 'texture.'

1. A term referring to the *number* or *volume* of simultaneous things happening in a sound field; that is, to the density of concurrent sonic images or sources.
2. A term which refers to the *diversity* of elements or activities in a sound field; that is, a term which characterizes musical passages on a continuum from homogeneous activity to heterogeneous activity.
3. A generic term for the general sonic activity entailed in a work; a very broad term for what is going on — but a term which always connotes a *sonic* or 'surface level' grounding in the description.

Of these three definitions, the first and second provide the most concrete points-of-departure for a study of texture. We can continue by considering two properties: the *number* or density of concurrent sonic activities, and the *diversity* of these activities. If we begin by assuming that these two properties are independent of one another, it is possible to conceptualise them in terms of two orthogonal axes: the 'few-many' dimension and the 'uniform-varied' dimension.

Traditional musical terminology distinguishes four broad categories or types of textures: monophony, homophony, polyphony, and heterophony. A computer database was assembled consisting of exemplars of the four classic textures: 37 solo folk ballads, 25 four-part hymns, 78 Bach keyboard fugues, and a selection of Chinese, South Indian and Southeast Asian heterophonic works. Along with a number of hybrid textures, the entire database consists of more than 450 works.

Textural Factors

Given this database a series of measures were needed which might assist in the categorization of the four major textures. A measure of the *number* of sources in a musical texture might be trivially defined as the number of concurrent parts in a score. More problematic is how one measures the musical *diversity*. Four major areas of diversity might be identified: pitch diversity, rhythmic diversity, pitch-movement or contrapuntal diversity, and timbral diversity. Six measures were devised in order to reflect different types of diversity. The measures included pitch sharing, pitch-class sharing, unison motion, semblant pitch motion, onset synchrony, and instrumental (timbral) homogeneity. All six measures were combinatorially combined to form a number of different models.

Measuring Predictive Success

Discriminant function analysis methods were used to evaluate the predictive abilities of each of the models. Discriminant analysis produces a set of equations that can be used to predict which category best fits a given input data set.

When all six factors are employed in a discriminant function analysis, the success rate in correctly classifying the texture of 143 works was 100 percent. Given this success rate it is likely that one or more of the analysis factors may be superfluous or redundant. A 'leaner' model can be identified by iteratively removing factors from the analysis until the predictive capability of the model begins to degrade.

The results of the discriminant function analysis show that a wide variety of models can be constructed which will perform quite well in identifying the musical texture of a work. The most important factor in textural discrimination was found to be onset synchrony, while pitch sharing was found to be the second most useful factor of the six factors studied. The minimum number of discriminant factors necessary to distinguish four categories (monophony, homophony, polyphony & heterophony) is two.

Conceptual Elegance

In addition to displaying a good predictive performance, a good model should also provide a meaningful conceptual framework for the phenomenon. Evaluating the conceptual elegance of a model is less straightforward than measuring its predictive success. We look for a model which is simple to understand, and which produces results which make intuitive sense. In particular, we look for a model in which *like* is matched with *like*, and *similar* is topologically near.

Two factors were found to be especially elegant in the characterization of texture: semblant inter-part pitch motion and onset synchrony:

Semblant Motion. In traditional music theory, contrapuntal motions can be categorized into four types: parallel, similar, oblique, and contrary motions. These four categories can be grouped into two broad classes according to whether the pitch motions are positively correlated (parallel & similar) or negatively correlated/uncorrelated (contrary &

oblique). The first class of motions might be called *semblant,* and the second class might be called *non-semblant.* Given any two notated voices, it is thus possible to measure the proportion of semblant motions compared to the total number of contrapuntal motions. If more than two voices are present in a sound field, then all pair-wise comparisons can be made and an aggregate measure of the proportion of semblant contrapuntal motion determined.

Onset Synchrony. A useful measure of rhythmic diversity is to determine the proportion of synchronous onset pairs — as compared with the total number of onset moments in a work. There are variant ways of measuring onset synchrony, but these methods produce highly correlated results, and so the measurement differences are inconsequential.[2]

A bounded two-dimensional space can be constructed using semblant contrapuntal motion and onset synchrony as the abscissa and ordinate axes. (Refer to Figure 1.) By definition, a single monophonic line will be exactly synchronized with itself in terms of onsets, and will move in precise pitch motion with itself. As a result, all monophonic works are necessarily plotted in the upper right hand corner. Hymns reside in the upper mid-left area. All of the Bach polyphonic works sit in the lower left area, while a small sample of non-western works are further to the right. The resulting space neatly divides into four quadrants representative of the four principle types of musical textures: monophony, homophony, polyphony, and heterophony. Moreover, the conceptual utility of this texture space is evident in its placement of hybrid textures, such as Kentucky folk organum or barbershop quartets.

Non-Score-Based Analysis

The analyses presented in this paper have relied upon traditional western musical notation as the source of primary data. This reliance has been a matter of convenience rather than of necessity. In principle, the measures of semblant pitch motion and onset synchronization could be determined without recourse to notated scores. In particular, since these measures are closely akin to physical/acoustical attributes, it would appear feasible that this model of texture could be implemented using signal processing technology in such a manner as to permit the analysis of music as sounded — without the need for scores.

Conclusion

Texture is a term musicians have used to refer to the number and diversity of activities in a sound field. *Number* and *diversity* exist in any and all sound fields (including silence), hence texture is a property of all sounded activity.

One way by which texture can be represented is through a two-dimensional space whose axes are onset synchronization and semblant pitch motion — that is, the degree to which notes or events sound at the same time, and the degree to which relative pitch motions between the parts or streams are the same. Generalizing further, the axes can be considered to represent the inter-stream correlations in the time domain and the inter-stream correlations in the pitch or frequency domain.

The texture-space formed by this mode of representation is useful in characterizing aspects of texture on four different levels. First, the texture-space appears to capture the broad categories of monophony, homophony, polyphony, and heterophony. Secondly, the texture-space can be used to discriminate genres of music, such as monody, organum, close harmony, traditional harmony, counterpoint, tune & accompaniment, and various non-western genres. Each of these genres appears to occupy a distinctive region in the two-dimensional space. Apart from its function in distinguishing musical genres, texture may also act within individual works to delineate formal or structural aspects. To the extent that dynamic changes of texture are evident in individual musical works, these changes can be traced as *trajectories* through the texture space. Moreover, as texture is a perceptually salient feature, dynamic changes of texture within works can operate as a form-bearing element in the manner defined by McAdams (1989).

The Synthesis of Texture

Finally, as with most analytic methods, the method presented here can be reversed and used as a synthetic or production-model rather than solely as a tool of analysis. In other words, contemporary composers (particularly those working in computer-based compositional environments) can use the notion of a texture space as a sketch-pad within which new ideas or works can be composed.

[1] A cognate word 'texture' exists in French, however there is no direct equivalent of the term in German.

[2] See Huron, D. 1989. *Voice segregation in selected polyphonic keyboard works by J.S. Bach.* Nottingham, England: PhD dissertation.

Figure 1: Texture Space