Interdisciplinary Classification of Audio Effects in the Audio Effect Ontology

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Abstract. This paper discusses an extension to the Audio Effect Ontology (AUFX-O) for the interdisciplinary classification of audio effect types. The ontology extension implements a unified classification system that draws on knowledge from different music-related disciplines and is designed to facilitate the retrieval of audio effect information based on low-level and semantic aspects. It extends AUFX-O enabling communication between agents from different disciplines within the field of music creation and production. After briefly discussing the ontology, we show how it can be used to efficiently classify and retrieve effect types.

1 Introduction

In modern music production, composers and producers can choose from a large number of audio effect implementations of a variety of effect types. Identifying suitable effects for specific tasks typically remains a time-consuming manual process. Moreover, the aspects by which audio effects are described and classified can differ depending on the discipline in the field of music production and composition. This paper introduces an extension to the Audio Effect Ontology (AUFX-O) we presented in [4], for the interdisciplinary classification of audio effect types. AUFX-O is designed to describe audio effect implementations, i.e. sound transformation devices, and their use in music production process. While the core ontology already allows for the annotation of effect types with commonly used tags, this ontology extension introduces defined concepts for effect description. It implements a unified classification system that draws on knowledge from different music-related disciplines and is designed to facilitate the retrieval of audio effect information based on low-level and semantic aspects. Its design is aimed at enabling communication between agents adhering to data models with conceptualisations informed by and supporting different disciplines, both technical and artistic. After briefly discussing the ontology model, we show how an effect type can be described based on low-level and high-level descriptors.[1]

[1] Since AUFX-O and its extension are domain-specific we refer the reader to [7] for a detailed discussion of audio effect types and their implementation.

2 Audio Effect Classification

Digital audio effects are used by composers, performers and sound engineers. They can be classified based on different aspects that are relevant for these individual disciplines. For instance, a software developer would put emphasis on the signal processing techniques applied in the effect implementation, whereas a musician may prefer to describe effects by their perceptual qualities or by high-level semantic descriptors. An example for such a discipline-specific classification is given in [3, 2], where effects are categorised based on the perceptual attributes most affected by a given sound transformation. The perceptual axes are *loudness, pitch, time, space, and timbre.*[2] Audio effects may also be classified by the way its parameters are controlled, for instance by way of manual input, low frequency oscillators (LFOs), or noise generators. Lower level descriptions include the signal processing strategies applied in a given effect type's implementation and their characteristics, such as the processing domain (i.e. time or frequency domain)[3], and the algorithm or model implemented for their realisation. Figure 1 illustrates layers of discipline-specific classifications ranging from low-level to high-level descriptors. In an effort to unify these classification approaches an interdisciplinary classification model has been proposed in [3, 2], which forms the basis for the AUFX-O classification extension.

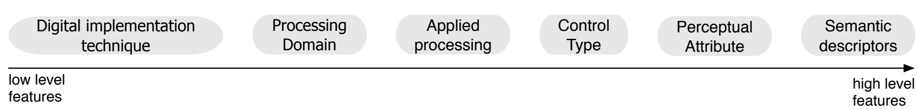

Fig. 1. Layers of discipline-specific classifications ranging from low-level to high-level features.

3 The AUFX-O Classification Extension

The main classes and properties of the AUFX-O extension are shown in Figure 2. The extension incorporates the classification systems discussed in Section 2, including the classification based on perceptual attributes which we evaluated by conducting listening tests [6]. The extension links to AUFX-O via the `:effect_type` property that links instances of the `aufx:Fx` class conceptualising audio effects on an abstract level (as physical phenomena) to instances of the `EffectType` class. Semantic descriptors and the common name of an effect type are linked via annotation properties, while object properties relate `EffectType` to `PerceptualAttribute`, `ControlType` and `AppliedProcessing`. The latter can be further described with object properties linking the `Implementation Technique` which in turn is linked to its `ProcessingDomain`. While the ontology contains individuals of the `PerceptualAttribute` and `ProcessingDomain` classes, other concepts contain subclass structures for further specialisation.

[2] for a detailed discussion of music perception see [1]

[3] *Time domain* refers to the variation of a signal's amplitude over time; in the *frequency domain* signals are represented by a magnitude and phase as a function of frequency.

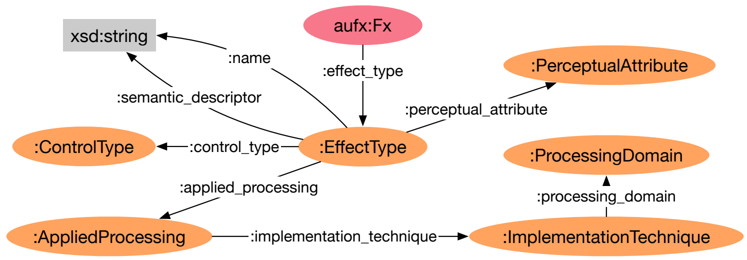

Fig. 2. Main classes and properties in the AUFX-O classification extension.

We illustrate how effect types are modelled with the example of the *chorus* effect. A chorus effect artificially simulates the doubling of voices occurring when several musicians play the same melody in unison and slight pitch, dynamic, rhythm and timbre differences arise because the instruments are not physically identical, nor are perfectly tuned and synchronised. This widely used effect provides some "warmth" to a sound, and can be considered an effect on *timbre*. While its usual implementation involves one or many delay lines, with modulated length and controlled by a *white noise*, more realistic sounding implementations use several slightly pitch-shifted and time-scaled versions of the same sound with refined models and mixing them together. Listing 1 shows how this knowledge is encoded in the ontology. The `Chorus` class is defined as a subclass of the `EffectType` class, as well as of several anonymous classes reflecting the descriptors discussed in Section 2. Anonymous classes further describe the processing applied and the techniques needed for the effect's implementation. For instance, the ontology reflects that for the implementation of the chorus effect there are three possible processing strategies, `AddingDelayedSignal`, `TimeScaling` and `Transposition`. Applying transposition, i.e. the changing of pitch of a sound, can be achieved by three different implementation techniques. These include the `PhaseVocoder` technique in the `FrequencyDomain` and the `SOLA` technique in the `TimeDomain` [7].

4 Conclusions and Future Work

We discussed the ontological representation of an interdisciplinary classification system for audio effects implemented as an extension to AUFX-O. We showed how the extension can add value to the ontology by allowing users and agents to retrieve audio effect implementations based on different characteristics that are important for different disciplines in the field of music composition and production. Future work includes extending the ontology with a more thorough coverage of effects used in music production, and further development of the linked data service we presented in [5], exposing metadata about audio effect implementations.

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```
Class: Chorus
        Annotations:
                semantic_descriptor "warm sound",
                semantic_descriptor "several performers" ,
                name "Chorus"
        SubClassOf: EffectType, applied_processing some
                (AddingDelayedSignal or TimeScaling or Transposition),
                control_type some WhiteNoiseControl,
                perceptual_attribute value Timbre

Class: DelayLine SubClassOf:
        ImplementationTechnique and (processing_domain value TimeDomain)

Class: PhaseVocoder SubClassOf:
        ImplementationTechnique and (processing_domain value FrequencyDomain)

Class: SOLA SubClassOf:
        ImplementationTechnique and (processing_domain value TimeDomain)

Class: TimeScaling SubClassOf:
        AppliedProcessing and (implementation_technique some
            (AdditiveModel or PhaseVocoder or SOLA))

Class: Transposition SubClassOf:
        AppliedProcessing and (implementation_technique some
            (AdditiveModel or PhaseVocoder or SOLA))

Class: DelayLine SubClassOf:
        ImplementationTechnique and (processing_domain value TimeDomain)

Class: AddingDelayedSignal SubClassOf:
        AppliedProcessing and (implementation_technique some DelayLine)

Class: AdditiveModel SubClassOf:
        ImplementationTechnique and (processing_domain value FrequencyDomain)
```

Listing 1. Excerpt from the AUFX-O classification extension relating to the effect type *Chorus*.

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