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Instrument Library (MUMS) Revised

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An overview of the main instrument sample libraries used in psychoacoustics, sound analysis, and instrument classification research is presented. One of the central libraries, the McGill University Master Samples (MUMS, Opolko & Wapnick, 2006) is reviewed in detail. This library has over 6000 sound samples representing most classical and popular musical instruments and a wide variety of articulation styles. A closer scrutiny revealed a conspicuous amount of labeling errors, intonation inaccuracies, and the absence of an integrated database. These errors are identified and catalogued, and revisions are implemented in a form of an installer.

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Key words: timbre, audio sample, musical instruments, sound sample, music database

With the significant advances in computational auditory feature analysis and increased research activity around the perception of timbre, high quality sound sample libraries have become essential tools. Here we briefly report how we copyedited one of the central sound libraries, *McGill University Master Samples* (MUMS; Opolko & Wapnick, 1987, 2006), in order to serve the research community better. This library is one of the most often used sources of instrument samples within instrument recognition and classification research (e.g., Agostini, Longari, & Pollastri, 2003; Barrass, 1996; Eronen, 2003; Goto, Hashiguchi, Nishimura, & Oka, 2003; Röver, Klefenz, & Weihs, 2004; Wieczorkowska, Ras, Zhang, & Lewis, 2007), sound synthesis and manipulation studies (e.g., Hainsworth & Macleod, 2003; Järveläinen, Verma, & Välimäki, 2002; Lewis, Zhang, & Ras, 2006; Vijayakumar & Eswaran, 2006), and perceptual or neural experiments aimed at understanding the perception of sounds or timbres (e.g., Halpern, Zatorre, Bouffard, & Johnson, 2004; Handel, 2004; Ilmoniemi, Välimäki, & Huotilainen, 2004; Iverson & Krumhansl, 1993; Lakatos, 2000; Levy, Granot, & Bentin, 2003). The library has also been the source for an edited database (SHARC) of steady-state instrument spectra (Sandell, 1991).[1] Libraries such as MUMS are also considered to be valuable as educational tools.

There are alternatives to the MUMS library. One example is the *Musical Instrument Sample* (MIS) Database[2] (Fritts, 1997), although it has been infrequently used (Brown, Houix, & McAdams, 2001) compared to MUMS. Outside of the academic realm, *Vienna Symphonic Library* (VSL) is probably the most extensive collection of recorded instrument sounds, with a gargantuan 1.5 million samples, although other, more affordable packages are available (*GigaStudio*, *Logic's EXS24*, *Kontakt*, and *Kontakt2*, which incorporates a set of VSL sounds). These commercially released sound libraries are usually in a format that is only accessible using a proprietary interface. However, as these sounds are designed to work efficiently in music productions (they are used as *virtual instruments*), there is no certainty about which parameters of the sound have been manipulated in the first place and how the output of the samples capitalizes these parameters. Hence these commercial solutions are still inadequate for most scientific purposes.

The first release of MUMS (Opolko & Wapnick, 1987) featured 3 CDs of recorded, high quality instrument samples. More recently, the library has expanded to 3 DVDs (Opolko & Wapnick, 2006) and contains samples of most standard classical, some nonstandard classical, and many popular musical instruments. There are 6546 sound samples in the library, divided between string (2204), keyboard (1595), woodwind (1197), percussion (1087, out of which 743 are nonpitched), and brass (463) families. In principle, each note of each instrument has been recorded separately (44.1 kHz, 24-bit), and most instruments feature several articulation styles. Typically there are 29 samples per instrument, which means that the whole pitch range of the available instruments is not consistently covered. The coverage is nevertheless impressive. For example, the trumpet is

[1] http://www.timbre.ws/sharc/
[2] http://theremin.music.uiowa.edu/MIS.html

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presented by *Trumpet in C* (normal and muted), *Bach Trumpet*, *Trumpet with a bucket* (loud and soft), and *Trumpet with a cup* to name the obvious ones. Instruments capable of polyphonic output occasionally contain sound samples for chords. Some instruments also feature tremolos, arpeggios, or rolls. Percussion instruments contain a wide variety of playing techniques (*soft mallet*, *crescendo, edge hit*, *middle hit*, *tip at the bell*, etc.). Piano sounds (*Concert Hall Steinway*, *Hamburg Steinway*) contain separate recordings for dynamics (soft, medium, loud) and rare playing techniques (*plucked* and *harmonics*). The sampling of articulations is also lacking uniformity as only certain instruments contain certain features. The durations of the samples are predominantly between 2 and 10 seconds, although they also vary significantly within the instruments, which might be problematic for certain applications as the sound qualities are time-dependent. What particularly encouraged us to write the review was that we identified a considerable number of errors within the MUMS. These can be divided into sound file errors (prevalence 0.03%), erratic labeling (0.5%), pitch chroma (pitch-class; 0.2%), and octave errors (11.5%). Moreover, a large proportion of sounds (7.5%) have conspicuous tuning problems by which we refer to sounds that are out of tune ($A_4 = 445$) for more than 30 cents (excluding period instruments). When using MUMS, these problems are difficult to spot and to correct due to lack of an integrated database of the sounds; currently the catalogue of sounds is only available as a PDF image file from which no searches can be made.

The errors in MUMS are minor in nature but we think they—together with problematic file naming conventions and the lack of an index system—significantly limit the use of the otherwise excellent sound library. After doublechecking the errors we found in MUMS, we decided to publicly release the corrections, which will contain several advanced features: the filenames are represented in uniform fashion and the organization of the instruments into families has been modified to be in accordance with Adler's orchestration manual (1989) for a more systematic and intuitive classification. The errors were identified and doublechecked both aurally and using a computational F_0 estimation algorithm (Tolonen & Karjalainen, 2000), implemented in MIR Toolbox (Lartillot & Toiviainen, 2007).

For a straightforward fix of the errors in MUMS, we have prepared an installer, which copies the sounds in the MUMS library (3 DVD set) into a new location in the user's hard drive, and performs a remapping of the pitches, articulations, and instrument families. This installer is freely available from our website,[3] and also contains a database, which may be used for scanning, selecting, or ordering the sound files from within the library. Naturally, the actual MUMS library needs to be purchased from the McGill University site.[4] We hope that this improvement increases the usability and precision of this highly valuable sound library among the music cognition and music information retrieval research communities.

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[3]http://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/mums/

[4]http://www.music.mcgill.ca/resources/mums/html/mums.html

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