

Development of the RWC Music Database

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Abstract

In this paper I introduce the *RWC (Real World Computing) Music Database*, a copyright-cleared music database (DB) that is available to researchers as a common foundation for research. Shared DBs are common in other research fields and have made significant contributions to progress in those fields. The field of music information processing, however, has lacked a common DB of musical pieces or a large-scale DB of musical instrument sounds. The RWC Music Database was therefore built as the world's first large-scale music DB compiled specifically for research purposes. It contains six original component DBs: the *Popular Music Database*, *Royalty-Free Music Database*, *Classical Music Database*, *Jazz Music Database*, *Music Genre Database*, and *Musical Instrument Sound Database*. The DB has been distributed to researchers at a nominal cost to cover only duplication, shipping, and handling charges (i.e., it is practically free), and has already been widely used.

1. Introduction

I believe that research into music information processing will be advanced if music databases (DBs) are available that can be used by various researchers. The main purposes and advantages of such commonly available DBs can be summarized as follows:

- Researchers will be able to use the DBs as a common benchmark for comparing and evaluating various methods related to music information processing. The lack of common music DBs available worldwide for research purposes at almost no cost has made it difficult to establish benchmarks (evaluation frameworks) for much of the research done regarding music information processing.
- The DBs will stimulate research in corpus-oriented approaches that use statistical methods and learning techniques. Recent progress in the use of statistical methods in other research fields such as speech recognition has been largely due to the availability of large DBs.
- Researchers will be able to use the DBs for research publications and presentations without conventional copyright restrictions. It has been difficult to demon-

strate research using copyrighted musical pieces that will be included in, for example, conference videos and CD-ROMs.

Although there is an enormous amount of music available on commercially distributed compact discs around the world, it is difficult to use this music for the above purposes because of copyright restrictions. Commonly available DBs with copyright-cleared pieces are therefore essential to encourage the healthy development of this research field.

Various commonly available DBs have been built in other research fields such as speech and image processing since the importance and significance of such DBs have been widely recognized. The field of music information processing, however, has long lacked a copyright-cleared DB of musical pieces that can be used as a common foundation for research. For musical instrument sounds, there are the McGill University Master Samples [1] and the University of Iowa Musical Instrument Samples [2] released for public use, and private collections assembled within companies [3]. Nevertheless, there has still been a need for a large-scale common DB containing the sounds of many musical instruments played in various styles.

I therefore organized the RWC Music Database Sub-Working Group (chair: Masataka Goto) in the Real World Computing Partnership (RWCP) of Japan and constructed in fiscal 2000 and 2001 a music DB — the *RWC (Real World Computing) Music Database* [4, 5] — that researchers can obtain and use freely in common for research purposes. The *RWC Music Database* features six component DBs: the *Popular Music Database* (100 pieces), *Royalty-Free Music Database* (15 pieces), *Classical Music Database* (50 pieces), *Jazz Music Database* (50 pieces), *Music Genre Database* (100 pieces), and *Musical Instrument Sound Database* (50 instruments). For all 315 musical pieces performed and recorded for the DB, we prepared original audio signals, corresponding standard MIDI files, and text files of lyrics (for songs). For the 50 instruments, we captured individual sounds at half-tone intervals with several variations of playing styles, dynamics, instrument manufacturers, and musicians. The following sections describe the design policy of the *RWC Music Database* and then explain the specifications of each of the six DBs.

Table 1: List of music compact discs (CDs) and DVD-ROMs for distributing the RWC Music Database.

Content (Version)	Quantity	CD/DVD Catalog Number	Piece/Inst. Nos.
<u>P</u> opular Music Database (Original Version: <u>M</u> ixed)	7 CDs	RWC-MDB-P-2001-M01 ~ M07	Nos. 1–100
<i>ditto</i> (Karaoke Version and Vocal-only Version: <u>S</u> eparate)	14 CDs	RWC-MDB-P-2001-S01 ~ S14	Nos. 1–100
<u>R</u> oyalty-Free Music Database (Original Version: <u>M</u> ixed)	1 CD	RWC-MDB-R-2001-M01	Nos. 1–15
<i>ditto</i> (Karaoke Version and Vocal-only Version: <u>S</u> eparate)	1 CD	RWC-MDB-R-2001-S01	Nos. 1–15
<u>C</u> lassical Music Database (Original Version: <u>M</u> ixed)	6 CDs	RWC-MDB-C-2001-M01 ~ M06	Nos. 1–50
<u>J</u> azz Music Database (Original Version: <u>M</u> ixed)	4 CDs	RWC-MDB-J-2001-M01 ~ M04	Nos. 1–50
<u>M</u> usic <u>G</u> enre Database (Original Version: <u>M</u> ixed)	9 CDs	RWC-MDB-G-2001-M01 ~ M09	Nos. 1–100
<u>M</u> usical <u>I</u> nstrument Sound Database (<u>W</u> ave Files)	12 DVDs	RWC-MDB-I-2001-W01 ~ W12	Nos. 01–50

Catalog number: RWC-MDB-[Content]-[Year]-[Version][Volume No.], Content, Version: The underlined letter, Year: Made in 2001

2. Design policy

The RWC Music Database Sub-Working Group had to address various design, trade-off, and copyright issues in building the *RWC Music Database*. In this section, I summarize the most important issues.

2.1. Content

We decided to include musical instrument sounds as well as musical pieces.

With respect to musical pieces, an ideal DB would contain many richly varied musical pieces, in various genres, of the highest quality possible. For practical purposes, though, we had to build our DB under production resource constraints such as our budget and available time. We therefore took up three major music genres — popular, classical, and jazz — and constructed the *Popular Music Database*, *Classical Music Database*, and *Jazz Music Database*. Moreover, we constructed the *Royalty-Free Music Database* to provide well-known popular songs and the *Music Genre Database* to provide a variety of genres. We tried to include as many realistic pieces as possible in a way that reflected the complexity and diversity of real-world music. For example, as well as ensuring that various styles, moods, tempi, and lengths were represented, we also included as many professional composers, lyric writers, arrangers, singers, and players as our resources allowed.

With respect to musical instrument sounds, we constructed the *Musical Instrument Sound Database* covering 50 musical instruments and, for each instrument, recorded individual sounds at half-tone intervals. Furthermore, to provide variety in playing style, dynamics (stress), instrument manufacturers, and musicians, we made many recordings for each type of instrument.

2.2. Copyrights of musical pieces

To make our DB available to researchers around the world, we had to obtain all the necessary copyrights and associated legal interests related to this DB.¹ We there-

¹Note that our DB is not copyright-free even though it is available for free for research purposes: we reserve all necessary copyrights and neighboring rights. All users of the DB must submit the user agreement

fore included 315 pieces (for the five component DBs) that were all newly performed, sung, and recorded for the purpose of inclusion in the DB. For the *Popular Music Database*, we included 100 pieces that were originally composed and arranged in modern popular music styles (the lyrics were also originally written). For the *Royalty-Free Music Database*, we included 15 public-domain traditional popular-music pieces that were originally arranged for this DB. For the *Classical Music Database*, we selected 50 well-known public-domain pieces. For the *Jazz Music Database*, we included 50 pieces where four well-known public-domain pieces were originally arranged and the other 46 pieces were originally composed and arranged. For the *Music Genre Database*, we included 100 pieces where 27 public-domain pieces were selected for some music genres (classical, marches, vocals, and some traditional Japanese music) and the other 73 were originally composed and arranged.

2.3. Standard MIDI files (SMFs) and lyrics text files

We prepared transcribed SMFs for all 315 pieces. These were stored in SMF format 1 (multiple tracks) and conform to the GS format. Given the corresponding audio signals, most of them were transcribed by ear. These SMFs are valuable because they can be freely used for research purposes and can also be used as effective substitutes for scores. Song lyrics are provided as separate text files.

2.4. Audio signals before mixdown

In addition to the original audio signals after mixdown, we obtained audio signals of all the tracks before mixdown, which are usually not available on commercially distributed compact discs. Since each track generally corresponds to a different instrument's part, the audio signals of each part can be studied.²

To obtain this valuable information, the processes of recording, mixdown, and mastering (including mastering effects) were done on *Pro Tools* (Digidesign, Inc.), a pro-

form to the general manager of the *RWC Music Database*.

²This correspondence was not always possible for live-recording pieces in the classical and jazz music genres because several parts were sometimes mixed within a single track.

fessional digital audio production system. The Pro Tools data made it possible to browse all the tracks and to mix them down with different mixing balances.

2.5. Distribution media

We used music compact discs (CD-DA: stereo, 16 bit / 44.1 kHz) as the medium for distributing the audio signals of musical pieces. Each piece is provided as an “Original Version” that was mixed just as a producer originally intended. For the *Popular Music Database* and *Royalty-Free Music Database*, we also prepared music compact discs containing both a “Karaoke Version” that mutes the vocal part of the original version and a “Vocal-only Version” that records only the vocal part. On the other hand, we used DVD-ROM discs as the medium for distributing the *Musical Instrument Sound Database*. The recorded sounds of this DB are provided as monaural sound files at 16 bit / 44.1 kHz in the RIFF WAVE format.

Table 1 lists the music compact discs and DVD-ROMs. Each of the musical pieces and musical instruments has a unique “piece/instrument number” (sequential within each DB) that should be referred to for research use and publication (e.g., RWC-MDB-P-2001 No. 28).

3. Six component databases

The following subsections provide an overview of the six component DBs [4, 5].

3.1. Popular Music Database

This DB consists of 100 songs — 20 songs with English lyrics performed in the style of popular music typical of songs on the American hit charts in the 1980s, and 80 songs with Japanese lyrics performed in the style of modern Japanese popular music typical of songs on the Japanese hit charts in the 1990s. All 100 songs with vocals were originally produced in as rich a variety as our resources allowed. As a result of our attempts to achieve a good male-female balance in the 100 songs and to include songs by vocal groups, there are 50 songs by 15 male singers, 44 songs by 13 female singers, and 6 songs by 6 vocal groups.

3.2. Royalty-Free Music Database

This DB consists of 15 songs, 10 well-known standard popular songs with English lyrics and 5 well-known children’s songs with Japanese lyrics. All 15 public-domain songs were originally arranged and recorded for our DB. This DB was built to provide well-known popular songs, while the *Popular Music Database* contains only original popular songs.

3.3. Classical Music Database

This DB consists of 50 pieces:

- Symphony: 4
- Concerto: 2
- Orchestral: 4
- Chamber: 10
- Solo: 24
- Vocal: 6

All 50 public-domain pieces were originally recorded for our DB. These pieces were selected to represent a rich variety of instrumentation, style, period, composer, and mood. We did not intend to produce a mere anthology of well-known musical pieces: we tried to include pieces that have been previously used in research or have interesting aspects from a research viewpoint.

3.4. Jazz Music Database

This DB consists of 50 pieces:

- Instrumentation variations: 35 pieces
(5 pieces × 7 instrumentations)
- Style variations: 9 pieces
- Fusion (crossover): 6 pieces

All 50 pieces were originally produced for our DB, except for the composition and lyric writing of four style-variation pieces. First, the instrumentation-variation pieces were recorded to obtain different versions of the same piece; i.e., different arrangements performed by different player instrumentations. Five standard-style jazz pieces were originally composed and then performed in modern-jazz style using seven instrumentations: 1) piano solo, 2) guitar solo, 3) duo (vibraphone + piano, flute + piano, or piano + bass), 4) piano trio, 5) piano trio + trumpet or tenor saxophone, 6) octet (piano trio + guitar + alto saxophone + baritone saxophone + two tenor saxophones), and 7) piano trio + vibraphone or flute. Second, the style-variation pieces were recorded to represent various styles of jazz. The nine pieces, which include four well-known public-domain pieces, consist of vocal jazz (two), big band jazz (two), modal jazz (two), funky jazz (two), and free jazz (one) pieces. Finally, the fusion pieces were recorded to obtain music that combines elements of jazz with other styles such as popular, rock, and Latin. They include music with an eighth-note feel, music with a sixteenth-note feel, and Latin-flavored music.

3.5. Music Genre Database

This DB consists of 100 musical pieces, three for each of 33 genres and one for a cappella. It is divided into 10 main categories (popular, rock, dance, jazz, Latin, classical, marches, world, vocals, and traditional Japanese music) and 33 subcategories (popular, ballads, rock, heavy metal, rap/hip-hop, house, techno, funk, soul/R&B, big band, modern Jazz, fusion, bossa nova, samba, reggae, tango, baroque, classic, romantic, modern, brass band, blues, folk, country, gospel, African, Indian, flamenco, chanson, canzone, traditional-style Japanese popular music *Enka*, Japanese folk music *Min’you*, and ancient Japanese court music *Gagaku*). Note that this does not mean to imply that all music can be categorized in this way: these categories were used simply for convenience when record-

ing the pieces. All 100 pieces are original recordings, 73 being original compositions and 27 being existing public-domain pieces.

3.6. Musical Instrument Sound Database

This DB covers 50 musical instruments and provides, in principle, three variations for each instrument. It thus comprises performances of about 150 instrument bodies. To provide a wide variety of sounds, we took the following approach.

- *Variations* (3 instrument manufacturers, 3 musicians): Each variation featured, in principle, an instrument from a different manufacturer played by a different musician.
- *Playing style* (instrument dependent): Within the range possible for each instrument, we recorded many playing styles.
- *Pitch* (total range): For each playing style, the musician played individual sounds at half-tone intervals over the entire range of tones that could be produced by that instrument.
- *Dynamics* (3 dynamic levels): We also recorded each playing style at three levels of dynamics (forte, mezzo, piano) spanning the total range of the instrument.

In producing RWC-MDB-I-2001 No. 01 “Piano”, for example, we used three pianos from three different manufacturers and recorded, for each of 88 keys, four different playing styles (normal, staccato, pedal, and repeated playing of the same sound) at three dynamic levels (forte, mezzo, and piano). In other words, we recorded a total of 3168 ($3 \times 88 \times 4 \times 3$) individual sounds for this DB item. These sounds were assembled into 36 ($3 \times 4 \times 3$) files, each holding 88 keys’ worth of sounds.

The sounds of these 50 instruments were stored in 3544 monaural sound files having a total size of about 29.1 Gbytes and a total playback time (including mute intervals) of about 91.6 hours. Each file, in principle, holds a collection of individual sounds in the order of ascending pitch across the total range of an instrument. In addition, about five color photographs of each individual instrument were also taken and assembled into 948 files (about 703.1 Mbytes).

4. Conclusion

I have introduced the *RWC Music Database* containing the six original component DBs. This DB is available to researchers around the world at a nominal cost to cover only duplication, shipping, and handling charges (i.e., it is practically free). It is possible to access information on obtaining the DB by entering “RWC Music Database” in any WWW search engine. As shown in Table 2, it has already been widely used in various research themes, including, but not limited to, music un-

Table 2: Number of orders for each component database of the RWC Music Database as of December 12, 2003.

Component database	Organizations
<i>Popular & Royalty-Free Music Database</i>	94
<i>Classical Music Database</i>	85
<i>Jazz Music Database</i>	79
<i>Music Genre Database</i>	72
<i>Musical Instrument Sound Database</i>	76
Total number	406

derstanding, music structure analysis, musical instrument analysis/identification, sound source segregation, noise reduction, music information retrieval, and music-related visualization. With this DB, researchers can now use copyright-cleared musical pieces and musical instrument sounds for each stage of problem finding, problem solution, implementation, evaluation, and presentation.

In the future, it will be necessary to add various metadata (descriptions of contents) to the DB pieces through cooperation with several research institutes. We hope that our DB will be widely used worldwide, and that various other DBs for music information processing will follow, thus accelerating progress in this field of research.

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6. References

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