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Recordings of Italian opera orchestra and soloists in a silent room

Dario D'Orazio, Simona De Cesaris and Massimo Garai

*DIN, University of Bologna, viale Risorgimento 2, 40136 Bologna, Italy; dario.dorazio@unibo.it;
simona.decesaris2@unibo.it; massimo.garai@unibo.it*

Anechoic recordings of symphony orchestras have been proposed in the literature and have been used in a multitude of studies concerning both innovative measurements and psychoacoustic experiments. Using the same approach, the present work shows the results of a recording campaign focused on the Italian Opera. Different motifs from Italian Operas have been played by professional musicians and soloists in the silent room of the Bologna University. The excerpts have been chosen because of their musical style characteristics and their acoustic properties (dynamics, timbre, vibrato). The chosen motifs come from scores of Donizetti, Verdi and Puccini, in order to consider various orchestrations and Opera styles.



1 Introduction

Anechoic recordings have been in use since the '70s for listening tests. The earlier anechoic excerpts were recorded in the BBC anechoic chamber [1] and widely used, e.g. in the development of Ando's theory [2]. They consist of compositions for a small orchestra, recorded by one point microphone, with a low dynamics.

In 1988 Hidaka et al. [3] recorded an orchestra in a normally reverberant concert hall (the Minoo Civic Hall in Osaka, Japan), but surrounding the stage with an acoustically absorptive enclosure. The study was mainly oriented to compare different miking techniques. A large orchestra was used: the string section was composed by 16 first violins, 13 second violins, 11 violas, 8 cellos and 6 double basses, 4 musicians for each woodwind instrument, a large brass section, 4 percussions, etc. . . 22 microphones have been used at the same time during the performance: 8 used as "main" and the remaining as "spot" microphones for each section.

In the same years, in the frame of the ARCHIMEDE project [4], supported by Bang & Olufsen and DTU, excerpts for soloist (speakers and musicians) in various acoustic conditions (anechoic chamber, listening room, studio, church) were recorded.

While in the ARCHIMEDE project solo performances were recorded, Vigeant et al. [5] recorded symphonic music using multichannel techniques. Musicians were recorded individually in the DTU anechoic room, using a video recording of the conductor and a 3D array of five omnidirectional microphones. Two or three musicians have been recorded for each string part, one musician for the remaining parts. The recordings have been used by musicians as a promotional tool and by researchers as a sound source for MIMO auralizations [6].

Pätynen et al. [7] recorded symphonic and opera music by using an approach similar to the Vigeant's one, but extending the miking spatial resolution. Several musicians and a soloist were recorded individually in the anechoic room of Espoo University, using an array of 22 microphones.

Other projects provided anechoic recordings of soloists and choir [8, 9, 10].

2 Selecting the music material

The present work aims at extending the availability of recorded (quasi)-anechoic material, introducing three Italian opera recordings, played by orchestra and soloists. Music material for the present recordings was chosen to represent the most performed Italian composers and their styles.

Under the definition of "Italian opera" there are compositions from the XVII century (the birth of melodrama, G. B. Peri, etc. . .) to the contemporary years. Each period has been characterized by a writing style, from early polyphony to serialism. At the same manner in each period a listening ambient has been used, from the first court rooms (e.g. the *Cornero Odeum* in Padua) to the multipurpose opera houses of the XXI century. Finally the compositions of various ages need different orchestral compositions: few instruments and basso continuo for the recitative in the XVIII century, a large orchestra in Puccini's operas.

The statistics of opera performances in the 2015–2016 season (see Annex A for details), shows that Italian authors and Mozart are dominant (Figs. 1 and 2). These results agree with Hidaka's ones [11], in which the 1997–98 season at 32 major opera houses around the world was analyzed. Basing on a statistical results, the music material for the present study has been chosen from the classical age of the melodrama, which spans from the early XIX century to 1930s.

The first excerpt is an aria ("Come Paride vezzoso") from the opera *L'elisir d'amore* by Gaetano

Table 1: Synthesis of the previous anechoic recordings and the presented ones.

Author(s)	Type	Mics	Location	Music materials	Year
Burd [1]	ensemble	1	BBC	Gibbon: <i>Royal pavane</i> Mozart: <i>Symphony KV 551</i> , 4th mov Arnold: <i>Sinfonietta, opus 48</i> , 4th mov Haydn: <i>Symphony no.102</i> , 2nd mov Wagner: <i>Siegfried Idyll</i>	1969
Hidaka et al. [3]	ensemble	29	Theatre ¹	Haendel: <i>Water music</i> Mozart, <i>Le Nozze De Figaro</i> (Ouv.) Beethoven: <i>Symphony no.3</i> , 4th mov Glinka: <i>Ruslan And Lyudmila</i> (Ouv.) Verdi: <i>La Traviata</i> (Preludio) Brahms: <i>Symphony no.4</i> , 1st mov J. Strauss: <i>Pizzicate-Polka</i> Bizet: <i>L'Arlesienne</i> , Minuet Bruckner: <i>Symphony no.4</i> , 1st mov Debussy: <i>Après-midi d'un faune</i> Mahler: <i>Symphony no.5</i> , 4th mov Mussorgsky: <i>Pictures at an exhibition</i> Šostakovič: <i>Symphony no.5</i> , 1st mov	1988
Hansen and Munch [4]	solo	1	DTU	excerpts for solo ²	1991
Vigeant [5]	solo ³	5	DTU	Brahms: <i>Symphony no.4</i> , 3rd mov Mozart: <i>Symphony no.40</i> , 1st mov Stravinsky: <i>Circus Polka</i>	2005
Pätynen et al. [7]	solo	22	Espoo	Mozart: <i>Don Giovanni</i> , aria Beethoven: <i>Symphony no.7</i> , 1st mov Bruckner: <i>Symphony no.8</i> , 2nd mov Mahler: <i>Symphony no.1</i> , 4th mov	2009

(1) Mino Civic Hall with “anechoic room installed around stage”; (2) Excerpts for guitar, cello, percussions, trumpet and cornet solo; (3) music materials wasn't available

Donizetti (1797-1848), whose first representation was in 1832 at the Teatro della Cannobiana of Milan (now Teatro Gaber). The excerpt represents the *belcanto* in the Italian opera: a *cavatina* for coloratura baritone in which the figure of *Belcore* appears in the first act. The soloist part includes a *cadenza* and some agility passages (see Fig. 3). In this motif there are various soloists parts (the tenor *Nemorino*, the sopranos *Adina* and *Giannetta*) and a choir. The score shows several *tempo* variations: the “largetto” in 3/4 then the “andantino” in 4/4, the free “colla voce”, which resolves to the initial time (“a tempo”) in the final.

The second recording is extracted from the opera *Il trovatore* by Giuseppe Verdi (1813-1901), first represented in 1852 at Teatro Apollo of Rome (now demolished). In the *cabaletta* of *Leonora* “Di tale amor, che dirsi” the soloist figure is a lyric soprano in which voice weight and agility coexist. In this excerpt the Verdian orchestra is complete (strings, full woodwinds with ottavino, full brasses with bass trombone). The final part presents a *crescendo* with a wide dynamic range and an accelerated *tempo*. It is worth noting that the successful result of an opera singer is due also to facial expression and body movements, which add something to the singing voice but make very difficult to fix it in a single audio record.

In order to complete the temporal evolution of the Italian Opera, the third motif is the *romanza* “Oh Mio

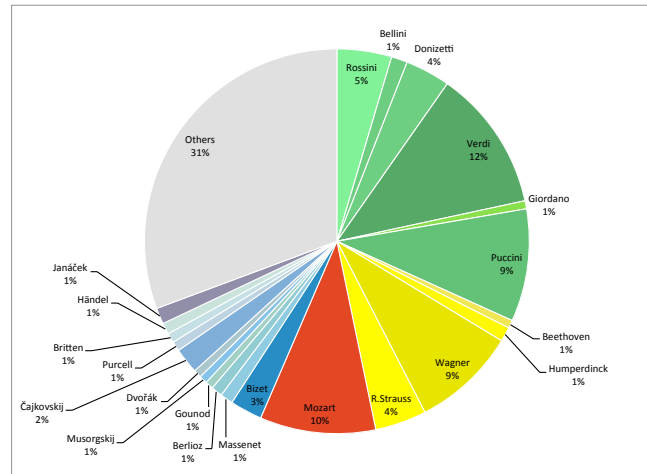


Figure 1: Analysis of the authors and operas represented in the 2015–2016 season at 51 of the most important opera houses (see Annex A for details): the most represented composers (green: Italian authors, yellow: German authors, red: Mozart, blue: French authors, etc...).

Table 2: Presented anechoic recordings.

Composer	opera	Act	Aria
Donizetti	<i>L'elisir d'amore</i>	1st	Come Paride vezzoso
Verdi	<i>Trovatore</i>	2nd	Di tale amor, che dirsi
Puccini	<i>Gianni Schicchi</i>	1st	O mio babbino caro

Babbino Caro” from the opera *Gianni Schicchi* by Giacomo Puccini (1858–1924), whose first representation was at Metropolitan Theater of New York City in 1918. Here the soprano sings with slight voice and the music is a *siciliana* played by a large string section, few woodwinds and a harp. The recording includes initial clusters for strings and brasses.

A fourth excerpt (the aria “Tacea la notte placida” from Verdi’s *Trovatore*) was discarded after the recordings, due to problem of mismatched timing between sections. On one hand the music accompaniment is written as regular sequence of triplets. On the other hand the execution needs a continuous variation in tempo and dynamics, in order to emphasize the soloist. When the metronome is quite low (“andante” in the present case) there are several problems of mismatching timing when each instrument is recorded as solo.

3 The orchestra

Professional musicians from the Corelli Orchestra of Ravenna and soloists were asked to join this research. Some musician already had experiences in recording contemporary and pop music too. The arrangement of the recording has been similar to the one in previous literature [5, 7]: only one musician per instrument played all parts one after another, following a reference video of the conductor with a pianist. During the recording takes, the musicians heard the sync piano and the previous tracks through closed headphones. Following musician requirements, the right channel only was powered to the headphones for self-hearing.

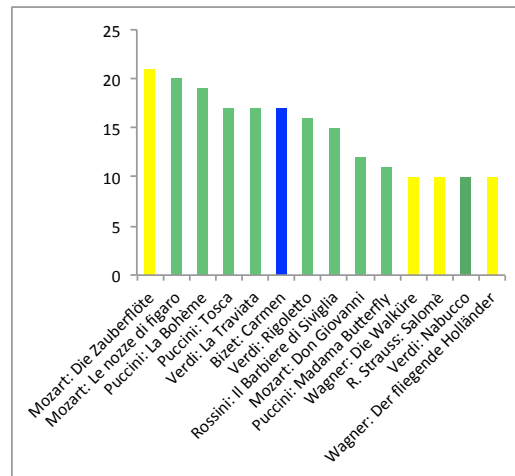


Figure 2: Analysis of the authors and operas represented in the 2015–2016 season at 51 of the most important opera houses (see Annex A for details): the most represented operas. The colors point out the language of the operas: German (yellow), Italian (green), French (blue).

Table 3: Orchestral parts during recordings (vli: violin, vla: viola, c: cello, db: double-bass, fl: flute, ob: oboe, cla: clarinet, bas: basson, ho: horns, tba: trumpet, tbn: trombone, ha: harp).

Excerpt	1 st vli	2 nd vli	vla	c	db	fl	ob	cla	bas	ho	tp	tbn	ha
Donizetti	8	6	5	4	3	2	2	2	2	2	2	3	–
Verdi	10	8	6	6	4	2 ^a	2	2	2	4	2	4 ^b	–
Puccini	12	10	8	7	5	2 ^a	3 ^c	3 ^d	2	4	3	–	1

(a) a flute and a piccolo; (b) three trombones and a bass trombone; (c) a oboe and a English horn; (d) two clarinets and a bass clarinet.

Three soloists and thirteen musicians were recorded. With respect to Pätynen's work, where each string part has been recorded once, in the present work the strings have been recorded several times (see Tab. 3). The conductor attended all the recording sessions, in order to evaluate the effectiveness of the single takes on the general impression of the orchestra. Double basses and cellos have been recorded in the first session, followed from the second violins and the violas. Only a single track of the first violin has been recorded as reference for the intonation. In the second session brasses have been recorded: horns, trombones and trumpets. From the third session (woodwinds) onward the piano track has been removed from the audio monitoring heard by musicians during recordings. In the fourth session all the parts of the first violins have been recorded, looking for the proper 'color' of the orchestra. In the last session a harp was recorded and some takes were overdubbed.

The recording room was the silent room of the University of Bologna. The room was measured using a prototype of omnidirectional sound source [15] and the extracting the reverberation time using the envelope of the IRs [13, 14], due the high slope of the decay. The faint reverberation at low frequencies (see Fig. 4) was not considered as a problem, since the decay time of the instruments which produce fundamental frequencies below 150 Hz.

The image shows a musical score for a soloist and piano accompaniment. The score is written in G major and 3/4 time. The soloist part is in bass clef, and the piano accompaniment is in treble and bass clefs. The lyrics are: "mor, ce - de a Mar - te, Di - o - guer - rie - e - ro, fin - la - ma - dre dell' A - mor." The score includes various musical notations such as slurs, accents, and dynamic markings like *ff* and *f*. There are also performance instructions like "6" and "12" indicating fingerings or measures.

Figure 3: Score for soloist and piano accompaniment of the final of the first Donizetti's excerpt: agilities of the soloist on the *larghetto* reprise and final *cadenza* ("A-mor").

4 Recording techniques

A great deal of attention has been devoted in the previous studies to the miking techniques. Hidaka et al. used several small diaphragm mics: B&K 4003 (omni), B&K 4006 (omni) and Schoeps for the main, as a spot Schoeps for woodwinds and strings, Neumann SM-81 for brasses and AKG C451E for percussions. Hansen and Munch used both cardioid (Sennheiser MKH40, B&K 4011, Schoeps MK4) and omnidirectional (B&K 4003) mics, depending on the environment. Vigeant et al. used small diaphragm DPA 4006 omnidirectional microphones. Pätynen et al. used large diaphragm Rode NT1 [7] microphones.

Audio-Technica AT 4050 large diaphragm microphones have been used in the dodecahedral array used in the present work, thanks to the good recording capability and low noise characteristics (see Fig. 5). The microphones have been used in their omnidirectional configuration and have been preamplified and AD converted by a RME Micstasy, set with about 35 dB of gain. A pad attenuation of -15 dB was used for the trombone takes only.

Moreover, several reference microphones have been placed in the room in order to compare and equalize the recorded tracks (see Tab. 4 for details of the configuration).

5 External resources

Some of previous anechoic works have been distributed in a commercial CD [20, 21] or free download [7, 8, 9]. The recorded material of Vigeant's work [5, 6] wasn't distributed.

Audio tracks of this work (recorded at 48 kHz/24 bit) are freely available for academic uses. See more at <http://acustica.ing.unibo.it/opera>.

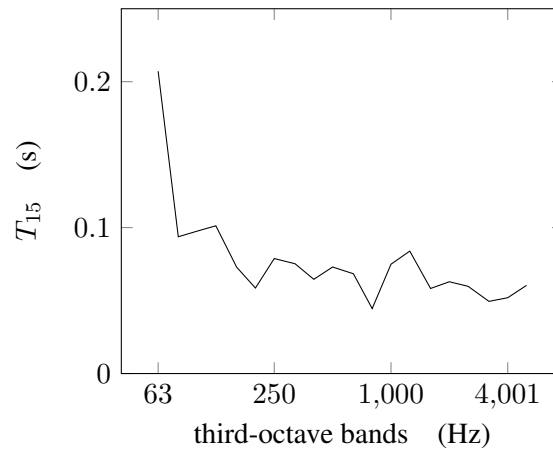


Figure 4: Reverberation time measured in the silent room during the recordings.

Table 4: Details of the microphone configuration used during the recordings.

No.	Type	Elevation (degree)	Azimuth (degree)	r (m)
1	AT 4050	52.6	120	1.1
2	AT 4050	52.6	0	1.1
3	AT 4050	52.6	240	1.1
4	AT 4050	-10.8	240	1.1
5	AT 4050	10.8	300	1.1
6	AT 4050	-10.8	0	1.1
7	AT 4050	10.8	60	1.1
8	AT 4050	-10.8	120	1.1
9	AT 4050	10.8	180	1.1
10	AT 4050	-52.6	60	1.1
11	AT 4050	-52.6	180	1.1
12	AT 4050	-52.6	300	1.1
13	B&K 4190	-6.5	107	2.7
14	B&K 4190	-15.3	0	1.1
15	B&K 4190	-15.3	120	1.1
16	AT 4050	-6.5	103	2.7
17	AT 4050	-8	105	2.2

6 Conclusions

Quasi-anechoic recordings of opera excerpt were presented. Soloists and musicians were recorded following procedures similar to those found the previous literature. All string parts were recorded using a complete string section, playing one instrument at a time.

The recorded material is free of use for academic uses. In the authors' hope, the excerpts may be useful for further researches in the field of opera house acoustics, extending the available corpus of anechoic recordings [22].



Figure 5: Recording setup during the recordings.

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Appendix A

The opera performed in the 2015–2016 season were analyzed in the following theatres: Aalto Musiktheater Essen, Bayreuther Festspielhaus, Bayerische Staatsoper (München), Bolshoi Theater (Moscow), Bremen Theatre, De Nationale Opera (Oslo), Deutsche Oper (Berlin), Erkel Theatre (Budapest), Glyndebourne Opera House, Gross Festspielhaus Salzburg, La Monnaie (Bruxelles), Leipzigoper, Lyceum Theater (Barcelona), Luzerner Theater, Magyar Állami Operaház (Budapest), Metropolitan Theater (New York City), Nationaltheater Mannheim, New National Theatre (Tokyo), Opéra Bastille (Paris), Odeon Theatre Nancy, Ooperabaletti (Helsinki), Opéra Grand Avignon, Opéra National de Bordeaux, Opéra National du Rhin (Strasbourg), Opera Royal de Liège, Opernhaus Zürich, Oper Frankfurt, Oper Stuttgart, Palais Garnier (Paris), Royal Danish Theater (Copenhagen), Royal Opera House (London), Seattle Opera, Semperoper Dresden, Staatsoper Hamburg, Státní Opera (Prague), Sydney Opera House, Teatro alla Scala (Milan),

Teatro Colon (Buenos Aires), Teatro Campoamor (Oviedo), Teatro Carlo Felice (Genova), Teatro Comunale (Bologna), Teatro dell'Opera (Rome), Teatro La Fenice (Venice), Teatro Real (Madrid), Teatro Regio (Parma), Teatro Regio (Torino), Teatro San Carlo (Naples), Teatr Wielki (Warsaw), Tokyo Opera City Concert Hall, War Imperial Opera (San Francisco), Washington National Opera, Wiener Staatsoper. Operettas and musicals weren't taken into account in the statistics.