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**Recordings of Italian Opera orchestra and soloists in a
silent room**

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Abstract:

Anechoic recordings of symphony orchestra 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 soloist in the silent room of the Bologna University. The excerpts have been chosen both because of their musical style characteristics and their acoustic properties (dynamics, tymbre, vibrato). The chosen motifs come from scores of Donizetti, Verdi and Puccini, in order to consider various orchestrations and Opera styles.

Keywords: Anechoic recordings, MIMO auralization, Italian Opera

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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 [12]. They consist of a composition for small orchestra, recorded by one point microphone, with a low dynamics.

In 1988 Hidaka et al. [2] 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 the ARCHIMEDE project [4], supported by Bang & Olufsen and DTU, recorded excerpts for soloist (speakers and musicians) in various acoustic conditions (anechoic chamber, listening room, studio, church).

While in the ARCHIMEDE project solo performances were recorded, Vigeant et al. [7] 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].

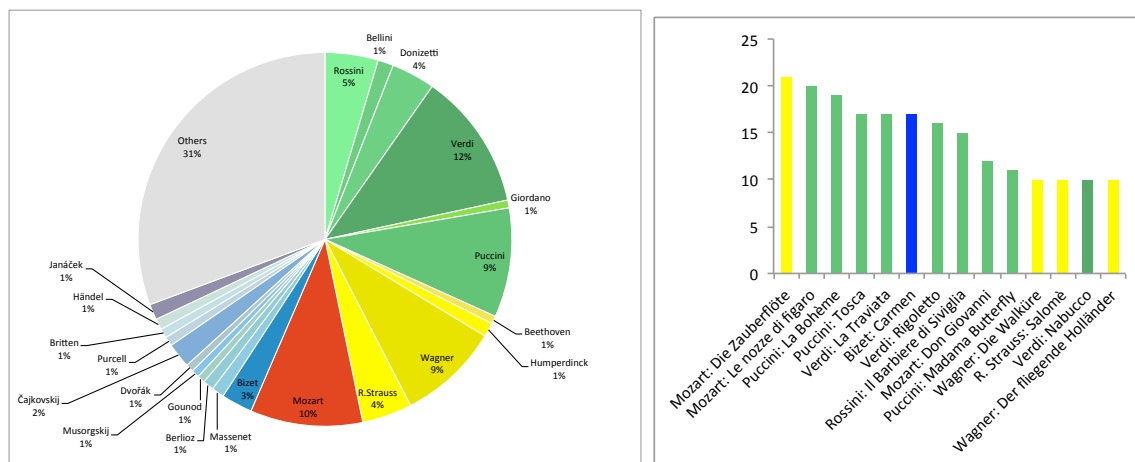
Patynen et al. [8] recorded symphonic and opera music by using an approach similar to the Vigeant's one, but extending the miking spatial resolution. Several musicians and a soloist were recorded individually in the anechoic room of Espoo University, using an array of 22 microphones. Other anechoic recordings of soloists and choir playing ancient music were provided by the CHARISMA project [9].

The present work aims at extending the availability of recorded semi-anechoic material, introducing three Italian Opera recordings, played by orchestra and soloists.

2 Selecting the music material

The statistics of opera performances in the 2015–16 season (see Annex A for details), shows that Italian authors and Mozart are dominant (Fig. 1). These results agree with Hidaka's ones [10], in which the 1997–98 season at 32 major opera houses around the world was analyzed.

Being Mozart's excerpts recorded in a previous work [8], the music material for the present



(a) Most represented composers

(b) Most represented operas. The colors point out the language of the operas: German (yellow), Italian (green), French (blue)

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).**

recordings was chosen to represent the most performed Italian composers and their styles.

The first excerpt is an aria (“Come Paride vezzoso”) from the opera *L’elisir d’amore* by Gaetano 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 coloritura baritone in which the figure of *Belcore* appears in the first act. The soloist part includes a *cadenza* and some agility passages (see Fig. 2). 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 “larghetto” 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 Babbino Caro” from the opera *Gianni Schicchi* by Giacomo Puccini (1858-1924), whose first representation was at Metropolitan Theater of New York in 1918). Here the soprano sings with slight voice and the music is a *siciliana* played by a large string section,

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. [2]	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>Apres-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 [7]	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. [8]	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
Present work	solo	15	Bologna	Donizetti: <i>L'elisir d'amore</i> , 1st act Verdi: <i>Trovatore</i> , 2nd act Puccini: <i>Gianni Schicchi</i> , 1st act	2016

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



Figure 2: 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").

few woodwinds and a harp. The recording includes the initial clusters for strings and brasses, which may be useful in some listening tests (see Fig. 3).

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 [7, 8]: 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.

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. 2). 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.



Figure 3: Score of the initial part of third excerpt (*Gianni Schicchi*, last five bars of 39), with orchestral clusters.

The recording room was the listening room of the University of Bologna. The faint reverberation at low frequencies (see fig. 4(b)) was not considered as a problem, since the decay time of the instruments which produce fundamental frequencies below 150 Hz.

Table 2: **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

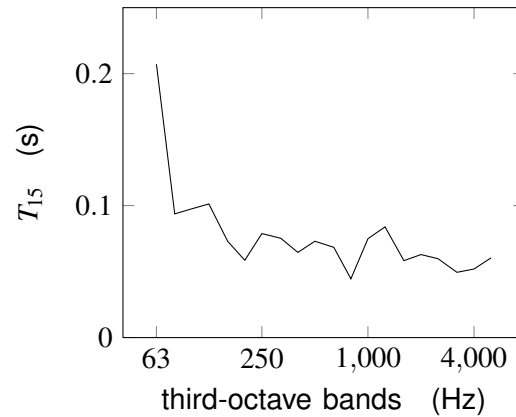
(a) one flute and one piccolo; (b) three trombones and one bass trombone; (c) one oboe and one English horn; (d) two clarinets and one bass clarinet.

4 Recording techniques

A great deal of attention has been devoted in the previous studies to the miking techniques.



(a) Positioning of the musicians during the recordings: around the performer the microphone array, on the left the monitor with the conductor video.



(b) Reverberation time measured in the listening room during the recordings [13]

Figure 4: **Mounting of the listening room at University of Bologna during the recordings.**



Figure 5: **Detail with one of the B&K 4190 microphones used as reference and one of the recording microphones AT 4050.**

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 both cardioid (Sennheiser MKH40, B&K 4011, Schoeps MK4) and omnidirectional (B&K 4003), depending on the environment. Vigeant et al. used small diaphragm DPA 4006 omnidirectional. Patynen et al. used large diaphragm Rode NT1 [8].

Large diaphragm microphones have been used in the dodecahedral array used in the present work. Audio-Technica AT4050 microphones have been used, thanks to the good recording

Table 3: 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

capability and low noise characteristics. The microphones have been used in 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. 3 for details of the configuration).

5 External resources

Some of previous anechoic works have been distributed in a commercial CD [3, 5] or free download [8]. The recorded material of Vigeant's work wasn't distributed.

All individual audio tracks of this work (12-track .wav format recorded at 48 kHz/24 bit) are freely available for academic uses. One track downmix of the soloist and orchestra is also provided for each motif. See more at <http://acustica.ing.unibo.it/opera>.

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.

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Appendix A

The opera performed in the 2015–2016 season were analyzed in the following theatres: Wiener Staatsoper, Gross Festspielhaus Salzburg, Deutsche Oper (Berlin), Leipzigoper, Aalto Musiktheater Essen, Staatsoper Hamburg, Bayerische Staatsoper (München), Bremen Theatre, Semperoper Dresden, Nationaltheater Mannheim, Oper Frankfurt, Bayreuth Festspielhaus, Oper Stuttgart, Opéra Bastille (Paris), Palais Garnier (Paris), Odeon Theatre Nancy, Opéra Grand Avignon, Opéra National du Rhin (Strasbourg), Opéra National de Bordeaux, Teatro alla Scala (Milan), Teatro San Carlo (Naples), Teatro Regio (Parma), Teatro La Fenice (Venice), Teatro dell’Opera (Rome), Teatro Comunale (Bologna), Teatro Carlo Felice (Genova), Teatro Regio (Torino), Luzerner Theater, Opernhaus Zürich, Lyceum Theater (Barcelona), Teatro Campoamor (Oviedo), Teatro Real (Madrid), Royal Opera House (London), Glyndebourne Opera House, La Monnaie (Bruxelles), Opera Royal de Liège, Státní Opera (Prague), Teatr Wielki (Warsaw), Magyar Állami Operaház (Budapest), Erkel Theatre (Budapest), Royal Danish Theater (Copenhagen), Ooperabaletti (Helsinki), De Nationale Opera (Oslo), Bolshoi Theater (Moskov), Metropolitan Theater (New York), Seattle Opera, War Imperial Opera (San Francisco), Washington National Opera, Teatro Colon (Buenos Aires), Tokyo Opera City Concert Hall, New National Theatre Tokyo, Sydney Opera House.

Operettas and musicals weren’t taken into account in the statistics.