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POLYPHONIC SINGING PRESENTED AS A MULTIPLAYER CLASSROOM ONLINE GAME

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ABSTRACT

This paper proposes to use web technologies in a classroom environment, in order to help singers and/or instrumentalists of all levels read and perform polyphonic music. Recent tests in conservatoires and universities have proved that networked music performances of this sort can foster interest in music reading among various groups of music students. The application presented here, *SmartVox*, is hosted on a server, either run locally or via the internet. The *server* provides a web page accessible by the *client* through an IP address (*e.g.* **smartkids.smartvox.eu**) [1], which the students type into the browser of their smartphone. Students typically access the application together, in the same classroom - but each with his/her own device - and request the individual parts of the polyphony corresponding to their tessitura. The conductor's interface, a 2nd type of *client* (**smartkids.smartvox.eu/conductor**), controls the global state of the distributed application (*e.g.* play, pause...). The coupling of auditory and visual signals, as well as the ability to render and synchronize different parts on each performer's device makes *solfège* and various forms of elaborate contrapuntal musical situations accessible to untrained musicians.

1. INTRODUCTION

This article presents the continuation of the research published in *SmartVox, a web-based distributed media player as notation tool for choral practices* [3]. Based upon a doctoral thesis investigating *audio-scores* [2], *SmartVox* was developed at IRCAM in Paris in 2015, by Benjamin Matuszewski and the author.

[1] Click on this link or type-in **smartkids.smartvox.eu** directly in the address bar of a browser connected to the internet. On the homepage, click on the screen, choose one part, and press the *send* button. Once the part loaded, the video needs to be unlocked, pressing the *play* button of the device's media player.

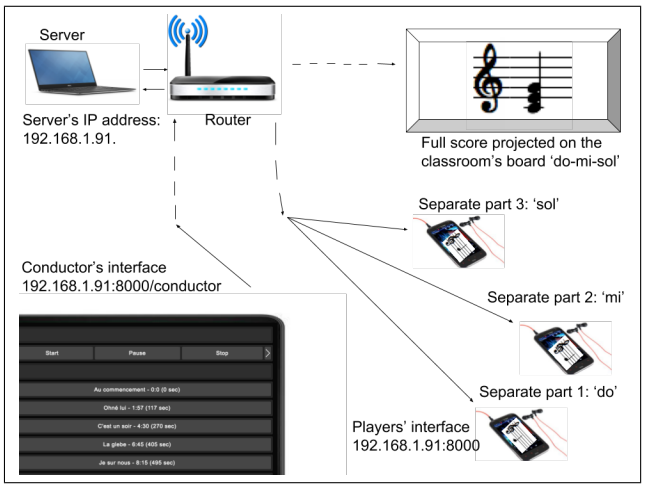

Figure 1. *SmartVox* running on a *local area network*

1.1. Technical presentation

Smartvox is open source [2], it was developed within the Javascript *Soundworks* [9] framework, running on node.js (server-side javascript). The single-page web application consists of two web clients: the *player* (see Figure 1, right-hand side) and the *conductor* (Figure 1, bottom left), that can be executed in any recent web browser on mobile devices (smartphones, tablets and laptops). The real-time communication between clients is achieved through the *WebSocket* protocol [3]. The scores are composed and/or transcribed in the *Bach* [1] environment for Max/MSP.

1.2. Nature and function of the application

Smartvox serves multimedia (audio + visual) scores in the mp4 format. Once the players have chosen their part, the application synchronizes all the videos over a shared timeline. Figure 1 shows a typical *Local Area Network* classroom setup, where no access to the internet is required, and where communication is realized through a router that generates a wifi network. A computer runs the node.js

[2] The code can be dowloaded at the following address: https://github.com/belljonathan50/SmartVox0.1
[3] https://www.w3.org/TR/websockets/

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Pieces	Player's address	Conductor's address
1. And the sea	smartvox.eu	smartvox.eu/conductor
2. Nuages	nuages.smartvox.eu	nuages.smartvox.eu/conductor
3. Smartkids	smartkids.smartvox.eu	smartkids.smartvox.eu/conductor
4. Josquin	josquin.smartvox.eu	josquin.smartvox.eu/conductor
5. Vitry	avignon.smartvox.eu	avignon.smartvox.eu/conductor
6. Tallis	tallis.smartvox.eu	tallis.smartvox.eu/conductor
7. Dunstaple	dunstaple.smartvox.eu	dunstaple.smartvox.eu/conductor
8. Dufay	dufay.smartvox.eu	dufay.smartvox.eu/conductor
9. Canons	canons.smartvox.eu	canons.smartvox.eu/conductor

Table 1. Pieces currently available on the web. The links can be copied into a browser or directly clicked on this page.

server (see the top left of the figure), which can then be accessed by all the players by typing the server's IP address into their phone's browser. Figure 1 also highlights the polyphonic nature of the application: three players each receive different pitches (*do*, *mi*, *sol*), and the resulting chord is displayed on the classroom board.

2. CASE STUDIES

Since most smartphones can today run reliable browsers (such as Chrome, Safari or Firefox), this form of web-based distributed application is an extremely simple and cost-effective way to connect and synchronize all the devices present in the same room (or on the world-wide web, but it is less relevant in this particular case). *SmartVox* was originally designed for the rehearsal and performance of my own compositions. The cues provided by this application allow singers of all levels to perform long and sometimes challenging pieces in public concerts, wearing headphones and watching their score scrolling on the screen, thus highly improving their confidence and the quality of their performance. This participative aspect also allows collaboration between professional and amateur ensembles (see Section 2.3). In the meantime, since its conception in 2015, *SmartVox* quickly found a wide range of applications in pedagogical environments, from *solfège* or *formation musicale* in conservatoires (see Section 2.1 and Table 1, piece n°3: smartkids), to more advanced courses about Renaissance polyphony for 2nd year university students in musicology (see Section 2.2 and Table 1, pieces n°4-9).

2.1. *Solfège* in conservatoires: smartkids.smartvox.eu

The *SmartKids* piece was tested in several French conservatoires [4], with children of different ages/grades, in instrumental, mixed, and *a capella* versions. For children, a distributed mobile application can be evocative of a multi-player game. This playful aspect helps to focus their attention on the demanding notions of music theory or *solfège* (see Figure 2). In a pedagogical piece composed for this system, the notation purposefully conveyed the same pitch information in four different ways:

[4] Fontenay-aux-Roses, CRI. Sussy-en-Brie, CRI. Conservatoire du 5ème arrondissement, Paris. Vitry-sur-Seine, CRD.

Figure 2. A *SmartKids* reading session during a French conservatoire *formation musicale* lesson.

- Sound frequency: a synthetic voice sings on a given pitch, *e.g.*, A = 440 Hz (audio).
- Spoken words: the synthetic voice pronounces the corresponding phoneme '*La*' (audio).
- Symbolic notation: the corresponding pitch is displayed on the musical stave (visual).
- Written text: the phoneme '*La*' is written below the stave (visual).

The pitch content of the score was sight-readable and self-explanatory. The notation of time did not require any specific knowledge either, since it displayed a scrolling playhead in proportional notation [5], thus bypassing the conventional 'bars and beat' rhythmic notation. At first sight, groups of ten to twenty children were able to sing in tune complex three-parts polyphonies. [6] After a few run-throughs, the children had memorized elements of the polyphony, and the piece could be used as source material for written melodic dictations. These classroom experiments also seemed to prompt students to propose their own musical ideas, a process later leading to forms of collaborative composition. This potential creative output associated with the use of information and communication technology (ICT) resonates with studies by Reynolds [8] and Pitts-Kwami [7], which highlights a correlation between compositional skills and the use of ITC in primary and secondary schools.

[5] The scores were realized in *bach.roll* [1]. This object allows a refined control of synthesizers (i.e. vocal synthesizers), controlled via the metadata contained in each note of the object, and subsequently sent to Max in realtime when played, *e.g.* : https://youtu.be/EcsdBrQf6Jw

[6] Live recording of a *SmartKids* reading session: https://youtu.be/syBZ3D8Pnjo

2.2. *Renaissance Polyphony* at AMU: tallis.smartvox.eu

The pieces n°4-9 of Table 1 were used extensively at Aix-Marseille University with 2nd year students in '*musique et musicologie*' (Arts Department). In this course on Renaissance polyphony, *SmartVox* was used on a weekly basis in order to let the students sight-sing the pieces that were subsequently analyzed. This practice-based approach to musical analysis allowed the students to engage personally with pieces of extremely complex construction (such as Ockeghem's *Missa Prolationum* or Mouton's *Nescient Mater*, both available at www.canons.smartvox.eu). From a pedagogical point of view, having the full score projected on the classroom's board proved to be very instructive [7] : at any time in the piece, each student could see his own part on his phone, hear through headphones a piano sound prompting him the pitches he is asked to sing, with the resulting polyphony sung by his colleagues, and displayed on the board. With this exhaustive representation, the identification of imitations between voices, canons and cadences became very clear on the score, and was at the same time directly related to a practical musical experience. At the end of the semester, the web application was used again with the students in a church, in order to record in a relevant acoustic the pieces studied during this course. [8] This form of computer-aided performance allowed us to superimpose the different takes of the recording, all perfectly in tune and in time with each other, thus making possible various cuts and edits. [9]

2.3. Productions

As well as a learning-aid used in a teaching environment, *SmartVox* is also used in diverse participative compositional experiments, which will now be discussed. These participative projects emerged from the observation that choral singing requires competencies such as vocal skills, intonation, music reading, and confidence in performance situation. This often restricts ancient and contemporary repertoire to a small group of specialists. The audio and visual guides provided by therefore seek to offer accessibility and exposure to works otherwise judged too difficult, for choirs of all levels.

2.3.1. SmartVox, the piece

The SmartVox piece/production [10] , for 5 soloists, choir, and tape, was premiered in Nantes in March 2017 [11] . Involving a local choir each time, this project has a participative aspect that makes it financially viable. SmartVox was therefore performed again in Rouen in April 2018. The use of audiovisual notation for this piece was justified by its microtonal language, because of the confusion that the notation of such intervals may cause for some singers.

2.3.2. Le temps des nuages [12]

This piece (see Table 1, piece n°2), based on poems by French philosopher Michel Onfray, premiered in January 2018, used *SmartVox* on a very large scale for the first time. This piece was written for 5 singers (the *De Caelis* ensemble), 5 percussionists (the *Links* ensemble), 4 channels of electronics, and 75 junior high-school students, who were placed all around the audience. The setup required about 70 simultaneous connections. The size of the concert hall (600 seats) and the number of connexions required a powerful wifi network relying on several antennas placed where the singers stood. The recording of the piece (see footnote below) clearly manifests, in terms of pitch and timing, but also hearing the children's conviction and confidence, that such a degree of accuracy could not have been achieved in any other way.

3. CONCLUSION

Music technology is still hardly ever used at school. This reveals, according to Hitchcock: "the dichotomy between the ubiquity of music technology in the music world and technology's relative paucity in the school curriculum" [6]. Furthermore, smartphones are often considered as a parasite in the classroom environment: "most school's policies completely forbid mobile usage within lessons" [4]. Bridges between technology and music education, therefore, are often judged with mixed feelings, and yet, with digital-native generations, innovative solutions must be found to accompany a mutation which Georg Hajdu describes as a "slow but steady shift away from textualization in digital media" [5]. With such mutation, the classical score-based music-making apparatus, hitherto reserved to an elite, could be shared with a larger community. According to Wise, Greenwood and Davis, the challenge consists in "moving technology from its position as an *add-on* in the music curriculum to a position of being embedded within the curriculum" [10].

The originality of the present *setup* (the French term *dispositif* is here of particular relevance) consists in turning mobile devices into a learning-aid fostering collective music singing improvement. With its strong focus on music reading, it hopes to convey among young students a revival of interest in music notation and thus benefit to the school curriculum. It constitutes an original contribution to the difficult questions raised by the use of technology in music education. Whether in conservatoires [13] or uni-

[7] The computer plugged to the beamer just connects to the server like the performers (unless it is running the server itself, in which case the address is, for instance, localhost:8000) and displays the *conducteur* part.

[8] Recording by the students with the help of *SmartVox*: https://www.youtube.com/watch?v=bofWvTCNNKI

[9] Editing process exemplified in *Reaper*: https://youtu.be/HExNA5Z7eFY?t=34

[10] Brief description of the project: http://www.decaelis.fr/fr/programmes/534

[11] Live recording with animated full score of the piece: https://www.youtube.com/watch?v=8R4Twc1A7Ks

[12] Live recording of the piece: https://youtu.be/SyFdR2HiF00

[13] Live recording of a *SmartKids* reading session: https://youtu.be/syBZ3D8Pnjo

versities [14] , the use of *SmartVox* proved each time to be an invaluable tool for helping unexperienced music readers, thus disinclining non-readers to switch off, and putting 'on the same track' singers of different musical backgrounds.

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