Sound and Movement Visualization in the AR-Jazz Scenario

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Abstract. This paper describes AR-Jazz, an augmented reality application designed to visualize sound and movements in live jazz performances. The augmented scenario is achieved within the program Max MSP Jitter, with an integrated inertial sensor and a microphone. As a display, a cinema screen is used. The application was first shown at the SedaJazz Festival 2007 in Valencia (Spain). In first place, a workshop was made in order the musicians to become familiar with the application. Secondly, a live performance was shown. The experience is described in this paper.

Keywords: augmented reality, jam session, sound visualization, inertial sensor.

1 Introduction

Augmented Reality (AR) is an emerging technology that has a great potential in several fields of knowledge, such as art [1], entertainment [2], education [3], psychology [4] and architecture [5]. This technology progresses towards collaborative and highly interactive systems, with the integration of hybrid devices that perform the 3D real-time registration. Multimodal systems are increasing, with the consideration of visual, sonic and/or haptic stimuli [6], thus enlarging the concept of AR towards more than mere visual systems.

In this paper the AR-Jazz application is described, an interactive AR system designed for live jazz performances. This paper explores the sound and movement as input data to manage the projected representation of a geometrical figure, with a group of musicians who jointly control the display of the augmented object.

This work was performed for a specific event, the Jazz & Arts Meeting inside the Panorama Jazz Festival 2007, organized by the Big Band Sedajazz and held in the auditorium of Torrent (Valencia). Jazz & Arts Meeting is an event for the interaction between Jazz and other arts such as cinema, theatre, painting, sculpture, poetry, electronics, media arts, etc., through different formative experiences and to develop creative synergies. The event is organized through a series of lectures and practices, promoting the participation of musicians and artists from other disciplines. It aims to bridge the gap between artists from different fields, to further the spread of jazz as a universal language. For this event, we prepared a workshop that was held in the morning and afternoon, and make a live performance in the evening with the students attending the workshop.

2   AR-Jazz in Detail

The parameters of height, intensity, timbre and spatialization are aspects that determine the sonic language. Thus, these four factors can serve as a starting point in investigating sonic augmented reality. AR-Jazz develops some of these parameters augmented in a visual projection. Physical contact of musicians with their own instruments introduces another parameter, the synaesthesia. This gesture perception in the interpretive technique is transmitted to the shape and characteristics of the projected object, creating an interaction between the musician and the computer through the sound, which may affect the interpretation of the first.

2.1   Physical Components

The elements that integrate the AR-Jazz augmented environment are (Fig. 1): A standard personal computer; The Max/MSP (v. 4.5.5) software within Jitter (v. 1.5.1); The MT9 inertial sensor of Xsens; A web cam (we used the *Live Cam! Voice* camera of Creative, within a FOV of 85º and a video resolution of 640x480 pixels); A cinema screen that acts as a mirror. The *Auditori de Torrent* screen size is of about 15x11 m; A powerful multimedia projector; A microphone; Several musical instruments.
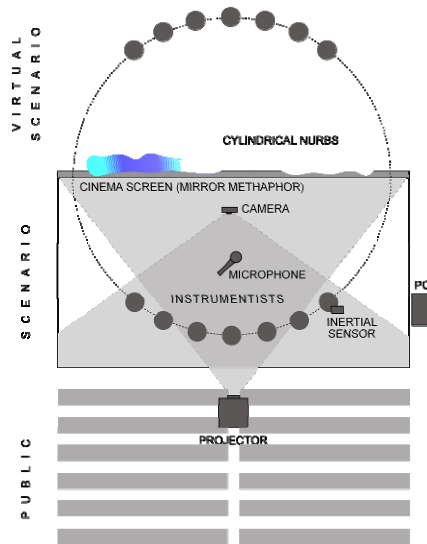

Fig. 1. Spatial arrangement of elements in the AR-Jazz application

The camera remains fixed during the performance and pointing to the musicians, so that the visual display (the cinema screen) follows the metaphor of a magic mirror (see section 2.3). The microphone is located between the camera and musicians. The spatial distribution of musicians on stage is such that, together with their own projected image, form a circle in the middle of which is the visual representation of live sound (a kind of cylindrical NURBS). The musicians give the back to the public, in such a way that they do not loose visual contact with the in real time generated virtual

object. The public can see the face of the musicians from the projected image on the screen (as it were a mirror).

2.2   Virtual Elements

The produced sound is visually represented by a virtual element that consists of a modifiable cylindrical NURBS (Non Uniform Rational B-Splines), made from the Jitter object *js jitaudio2nurbs.js*. Its shape, colour, brightness and texturing varies according several characteristics of sound. Thus, the virtual element will vary depending on the timbre of each instrument, the emitted notes (height) and intensity (amplitude). Moreover, other parameters that vary randomly or at a temporary rate are introduced, as well as a change in the object orientation according to the registered rotations of the inertial sensor. The 3D position and one rotation of the object are fixed; only vary two of its rotations, which are recorded from the inertial sensor that can be carried by one of the instruments, by a dancer or by another user.

2.3   Magic Mirror Metaphor

In AR-Jazz the 'magic mirror metaphor' is introduced, as opposed to the 'magic lens metaphor', widely used in augmented reality systems. Based on the distinction between the lens and mirror, we can say that depending on the type of display used and the spatial arrangement of the camera, the augmented reality can be viewed through a window into a fictional world or as a reflection of that. The magic lens metaphor is most evident in the handheld devices, such as PDAs or mobile phones with integrated cameras, which is approximated to a lens through which we discover a new reality (the augmented environment). In AR-Jazz, the new reality is shown as an altered reflection of the real environment, reversing the spatial arrangement of the camera that shows the user as a fundamental part of the augmented environment, also increasing the sense of presence [7, 8].

2.4   Computational Processes

Jazz-AR was designed within the program Max/MSP Jitter. The human-computer interaction takes place at two levels: sonic and haptic. In the first case, the interface is a microphone that captures the sounds emitted by the musicians; in the latter case, the interface is an inertial sensor that is carried by one person (a musician, a dancer or other user). The program is composed of a principal patch and a set of sub-patches; these are described in the following lines.

The main patch is based on *jit.gl.nurbs-audiorender.pat,* which is free distributed within Jitter. The main object is *js jitaudio2nurbs.js*, which defines the shape of a cylindrical NURBS that changes its shape according to the microphone audio input. Some random values have been defined in order to change the appearence of the NURBS (blending, smooth shading, wired, surface dimensions, etc.). All the elements that define the cylinder are sent to the object *jit.gl.nurbs*.

In the *p sonido* sub-patch (Fig. 2), an analysis of the registered sound is analysed by the *fiddle~* object, obtaining the sound height and amplitude. Because these values change very quickly, the mean value of the last 20 records is considered. Then, these values are scaled and assigned to the red colour and luminosity parameters of the virtual cylinder. The values of green and blue are selected randomly.
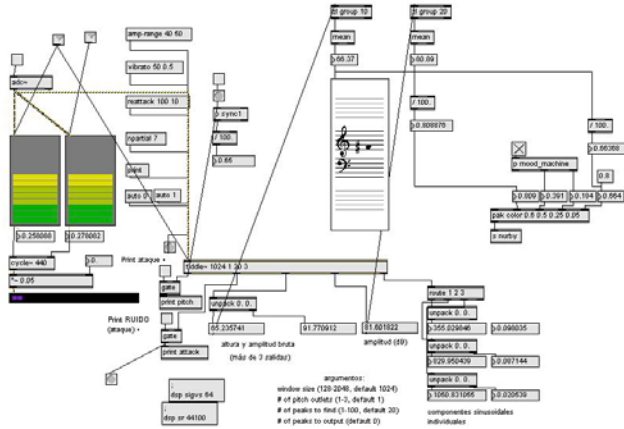
Fig. 2. Visualization of the *p sonido* sub-patch

The *p model plano* sub-patch loads a plane in *obj* format where the image captured in real time by the camera is mapped.

The *p IMU* sub-patch picks up the values registered by the inertial sensor and assigns the X and Y rotations to the virtual cylinder. This sub-patch consists of an interface between the MT9 inertial sensor and the Max/MSP Jitter software. It has been developed by Laboratorio de Luz [9] and can be freely downloaded at [10].

3 User Interaction

3.1 Workshop

The workshop was held on the stage of the auditorium for two hours in the morning and another couple of hours in the afternoon. It was attended by a total of nine musicians: a drummer, a flute, an electric guitar, a piano, an alto saxophone, two trombones, a tuba and a singer. After mounting the piece on stage, it was explained to the musicians. Then they played their instrument one by one, to see the AR-Jazz feedback to their individual interpretation. Finally several pieces of music were interpreted together in a jam session. In Fig. 3 some images are depicted.

Fig. 3. Images at the workshop

3.2 Live Performance

The live performance took place at 20:00 in the Torrent auditorium with the assistance of public. First, the *AR-Jazz* application was explained to the audience. To understand the direct relationship between the emitted sound by the instruments and the displayed graphics on the screen, each of the musicians made an improvisation with their own instrument. To make the explanation clear, at this stage the NURBS was shown on a grey background, and its rotations were fixed. In Fig. 4 some examples are depicted.

Fig. 4. Musicians playing one by one in AR-Jazz, where: a) Tuba; b) Saxo alto; c) Flute

Afterwards, some pieces were interpreted in a *Jam session* (Fig. 5). The inertial sensor was carried by one person of the audience. The represented pieces were two items that had been tested in the workshop, the first was an improvisation on the Spanish scale, whereas the second was an improvisation based on a blues rhythm.
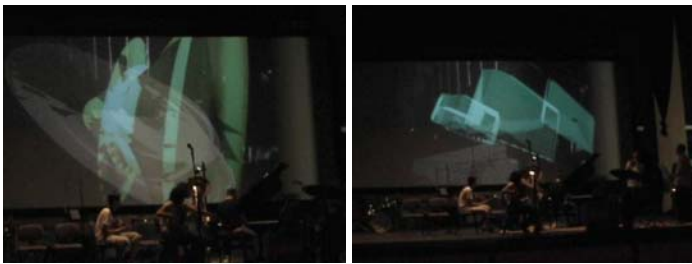

Fig. 5. Jam session in *AR-Jazz* environment

4 Conclusions

AR can be used in many different fields; in our case we show a successful integration of this technology within the artistic discipline of jazz by means of AR-Jazz, an application designed to visualize music and movements during live performances. The use of the magic mirror metaphor allows a new distribution of musicians on the stage: although they give their back to the public, the audience is able to see their faces as a projection on a cinema screen. Interaction is achieved by means of a microphone and a miniature inertial sensor, thus integrating visual, sonic and haptic stimuli, some real

and some virtually generated. Our experience shows that the use of multimodal systems does greatly enrich AR applications, increasing user and audience engagement.

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