Cirque des Bouteilles: The Art of Blowing on Bottles

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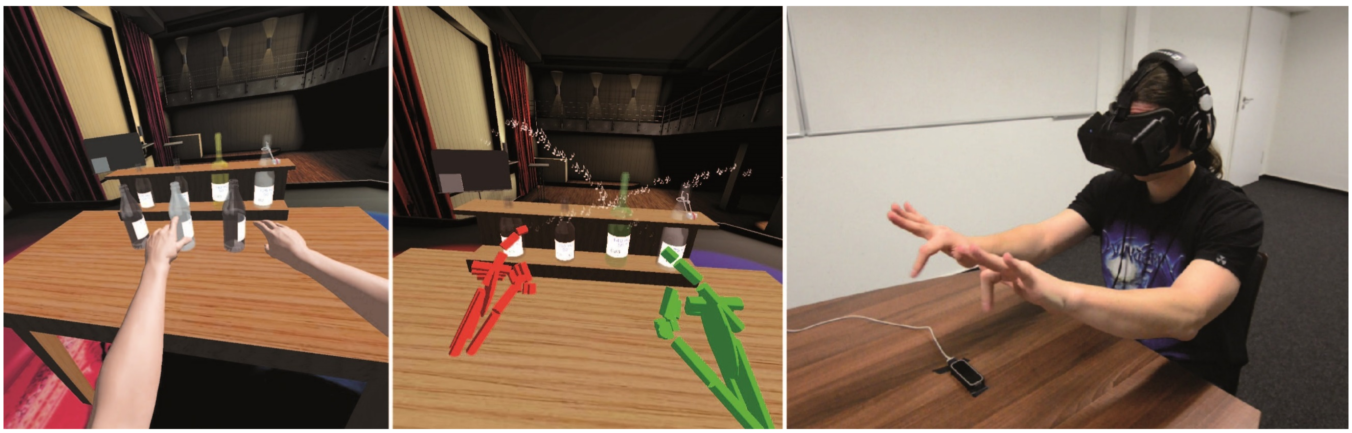

Figure 1: Application setup of the Cirque de Bouteille: The virtual environment (left/middle) and the hardware setup (right).

Abstract

Making music by blowing on bottles is fun but challenging. We introduce a novel 3D user interface to play songs on virtual bottles. For this purpose the user blows into a microphone and the stream of air is recreated in the virtual environment and redirected to virtual bottles she is pointing to with her fingers. This is easy to learn and subsequently opens up opportunities for quickly switching between bottles and playing groups of them together to form complex melodies. Furthermore, our interface enables the customization of the virtual environment, by means of moving bottles, changing their type or filling level.

1 Introduction

This year's 3DUI contest (3DUIdol) calls for the creation of a virtual music instrument (VMI) playable via a 3D user interface. Most acoustic instruments have evolved over centuries, so we did not believe in inventing a novel music instrument with an impact and usability comparable to the existing ones. For this reason, we decided to search for an existing but hard to play instrument and make it more accessible through our 3D user interface similar to the work by Mäki-Patola et al., the virtual Theremin called Gestural FM synthesizer [2]. We finally decided for bottle blowing. Of course, it can be argued that getting a tone out of a half-full bottle by blowing over its opening is not really difficult and everybody has already tried this. But have you ever tried to play Frère Jacque with a single bottle? Ok that is not fair, but is it easier on a set of bottles? Setting the bottles to produce the right tones and then playing them in the right order and tempo can be difficult or at least tedious for most people.

Additionally, our VMI should be easy to use, but simultaneously rich in potential for expert users. This means on the one hand that anyone who knows the notes to play Frère Jacque should be able to play it and on the other hand, that an expert user should not be kept by the interface from play, e.g., Beethoven's 9th symphony. The latter implies the possibility to play more than one tone at the same time. As a user naturally only has one mouth we decided to capture the user's blowing by a microphone and redirect the air flow in a virtual environment through her fingers to bottles they are pointing to (Fig. 1). The fingers are tracked with a Leap Motion and the user wears an Oculus Rift to get her immersed in the scene for an optimal control of her gestures. The coupling between breath control and finger positioning is comparable to some wind instruments and already got attention by previous VMI implementations like Scavone's wind controller The Pipe [4]. With this metaphor we do not exploit all the human movements that a virtual music instrument can map into the space of sound to its full extend (Fig. 2 and [1]), but keep the mapping intuitive to use.

2 Technique Design

In the following sections we will first describe the audio setting of our solution. Then, the basic interface to play tones on the bottles is introduced and finally we outline the environmental customization capabilities of the system.

2.1 Audio

To keep a close relation to real bottle blowing, our first input parameter is the strength of blowing that is mapped to the tone volume. Therefore, the user's breath is captured by a microphone, processed to a single strength value and exponentially smoothed. As audio framework we use OpenAL. Most important is that the latency between the audio in- and output is kept as low as possible. Several studies in the context of auditory displays report a listener's detec-

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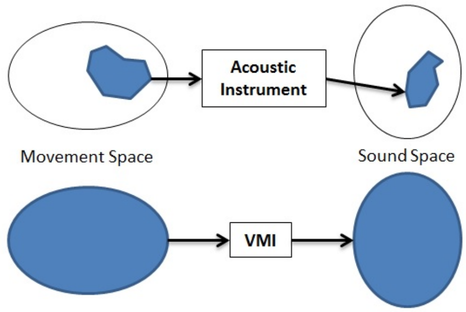

Figure 2: The potential of acoustic and virtual music instruments in comparison, based on [3]. **Left:** all possible human movements; **Right:** all possible audible sounds.

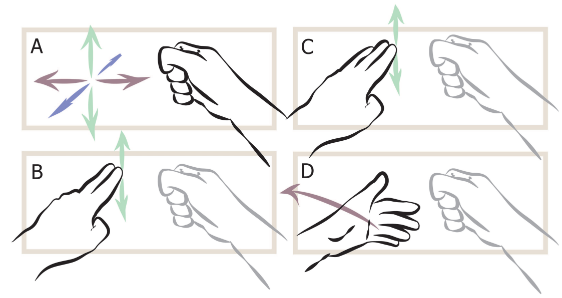

Figure 3: Interaction gestures: (A) placing bottles, (B) continuously change filling level, (C) discretely change filling level by tones, (D) switch bottle type.

tion threshold of around 50ms [5]. We use a buffer size of 1378 samples and a sample rate of 40kHz resulting in a delay of 30ms, with a neglectable processing time of a few microseconds. The audio output is based on self-recorded tone samples for different bottle types. As the effort to record every possible tone for every type of bottle is too high, we take the nearest available sample with known frequency and change its playback speed such that the desired frequency is reached.

2.2 Basic Interface

The remaining input is generated by gestures of the user's fingers, tracked by a Leap Motion. The resulting joint positions are mapped to a virtual hand model. This model is combined with a physiological one to filter jitter and finally prevent unnatural finger positions that otherwise can have disturbing effects on the user. To give the user the right feeling for her virtual hands and the interaction with the scene, the target display system is an HMD, in our case an Oculus Rift DK2. We give preference to an HMD over a CAVE as it is portable, which is necessary for participating in the final contest presentation.

As soon as the user blows into the microphone and simultaneously points to one or more virtual bottles, these bottles start playing. The user can choose how many fingers she wants to use. To support her in recognizing where she is pointing to, selected bottles are highlighted by illuminating them. Additionally, an air stream originating at the position of her virtual mouth passes the tips of the actually extended fingers in the direction they are pointing. If the respective finger is currently pointing at a bottle the stream additionally passes the opening of this bottle. This air stream is only faintly visible if the user is not blowing and becomes more clearly visible with increasing blowing strength. The paths from the mouth to the fingers are described using splines. On random positions along this path particles are created in a certain distance from the spline. The velocity is directed along the tangent at this point of the path and each particle is equipped with a clockwise momentum describing an orbit around the center. Together with a very short live time of below 0.5 seconds this creates the impression of an air vortex with a very small computational complexity.

Last but not least, every bottle's label shows the name of the note it represents (see section 2.3).

2.3 Environmental Interaction

Beyond the basic interface the user is able to customize her environment (cf. the Virtual Xylophone [2]). This VE is a table with bottles on the stage of a small club. It is possible to rearrange these bottles, change the fill level of each individual bottle, create new or remove existing ones.

On the implementation side every bottle is a widget and every finger is an input device. Blowing into the microphone and exceeding a calibrated threshold is considered as a activation event for the pointed to bottle. Above this threshold the blowing strength is directly mapped to the tone amplitude. Furthermore, the existing widget framework is used to provide grabbing and releasing a bottle to rearrange them. For this purpose a bottle is a draggable widget and its trigger is a dragging gesture (see Fig. 3). While dragged, the filling level of a bottle is freely adjustable by using the other hand with two extended fingers to point to the desired level. Instead, the user can extend three fingers to snap the filling level to related tones of the chromatic scale. The tone of every bottle is defined by its filling level and its type. Currently, we have samples and models for one wine, one water and two beer bottles. The type can be changed by performing a wisp gesture while grabbing a bottle. New bottles can be created by dragging a special self-replicating one and can be destroyed by hitting them from above. Finally, a wiping gesture over the table, the bottles are standing on, clears the whole table and leaves behind only a pile of broken fragments. All gestures are designed to work ambidextrous.

3 Conclusion and Future Work

We introduced a novel 3D user interface to play songs on bottles in a customizable virtual environment. The user blows into a microphone and the stream of air is recreated in the VE and redirected through the fingers of virtual hands to the bottles she is pointing to. In our opinion, a very interesting further development of the existing VMI would be the possibility to collaboratively use it with more than one user, to e.g., play even more complex compositions. This, of course, makes it necessary to add useful collaborative features, such as displaying the virtual hands of the other users, to coordinate with each other.

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