AvatAR: Tangible interaction and augmented reality in character animation

Adso Fernández-Baena
Seamless Interaction, GTM
La Salle RD, La Salle - URL
08022 Barcelona, Spain
adso@salleurl.edu

David Miralles
Seamless Interaction, GTM
La Salle RD, La Salle - URL
08022 Barcelona, Spain
davidme@salleurl.edu

ABSTRACT
In this paper, we present a novel interaction system, which combines tangible interaction and augmented reality for controlling a virtual avatar. By physically interacting with a cube, it is possible to drive avatars motion that occurs in the real world. The cube acts as a motion controller and as an AR marker reaching input and rendering purposes. The cube facilitates users the avatar positioning and motion customization, providing a fine control for both. In this first version, the avatar is able to stand and move. The current motion state is picked rotating the cube over the same plane where the avatar lies. We have implemented two scenarios in our prototype: a sketch-based controller and an interactive controller. The first one enables users to draw paths on the floor that the avatars follow; on the contrary, the second allows drive avatars position during all the time. The idea of using tangible objects in augmented reality environments for controlling avatars strengthens the link between the user and the avatar providing a better sense of control and immersion.

Author Keywords
tangible interaction; augmented reality; character animation

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation (e.g. HCI): Input devices and strategies

General Terms
Human Factors; Design.

INTRODUCTION
User interfaces have been evolved a great deal from command-line interfaces, through graphical interfaces to last generation. This last generation brings together tangible and natural interfaces. Tangible user interfaces (TUI) [3] permit to interact with digital content through a physical environment. TUI allows to design interactions using everyday objects, breaking the traditional approach of interacting with computers and giving a strong sense of immediacy to the user.

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These objects which are involved in TUI applications are regarded as kind of smart objects.

In computer animation, intuitively controlling the motion of a virtual character is considered as a difficult task. One reason for this is that a virtual character usually used in the field has a high degree-of-freedom (DOF) for controlling the position and orientation of all body joints, thus difficulting the design of an intuitive interface to manage the individual body joints. One intuitive approach to solve it is using an instrumented puppet in order to retarget puppet pose to a virtual character [5]. Along the same lines, Oshita et al. [6] propose to use hand manipulation based on traditional puppet mechanism to control a character. Both approaches obtain a virtual character moving, but their move is restricted by the input. Even though the efficiency of motion retargeting is high, it makes the generation of real motion very difficult for the user. So, to obtain more natural complex motions (which involves a coordinated movement of different body parts) it is necessary to add an intermediate layer to select proper motion capture data. This is what Lockwood et al. [4] done. They use a touch-sensitive tabletop for generating full-body animations, where two fingers are used to pantomime leg movements. In this work, we would go a step further and control motion of a virtual character using objects (see Figure 1), but even providing a higher layer to reproduce plausible whole body motions like locomotions.

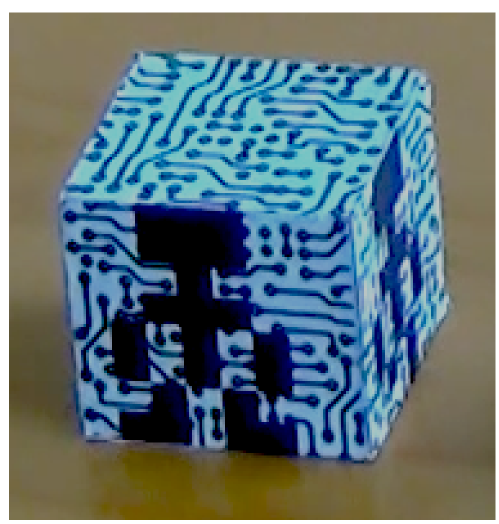

Figure 1. Cube for controlling avatAR.

Turning to another issue, augmented reality is a growing area of interest because it provides an enhancement of physical information, which is presented jointly facilitating the user understand correspondences. Moreover, interaction in augmented reality environments is lifelong investigating in character animation although some advances have been achieved in other topics like Internet of Things (IoT). Recently, Heun et al. [2] propose smarter objects, which among other things, it consists on associate a virtual object with physical object to support an easy means of modifying the behavior of that physical object. It uses augmented reality to match physical and virtual objects and supports both tangible and graphic interaction (through a tablet). Furthermore, Amores et al. [1] present SmartAvatars. SmartAvatars is a concept that also relies in a augmented reality environment and uses virtual characters to display system feedback. They propose a prototype called Flexo where virtual characters interact with objects but their behavior is constraint for the system reaction. However, they do not have neither tangible and direct control on avatars motions, which is precisely what we do in the interaction system described below.

Thus, we propose a tangible interface for controlling avatars in a augmented reality environment. We use a physical cube for driving virtual character motion, which in turn, it is used as augmented reality target. In this manner, the cube is mixed in the virtual scene providing more awareness in spatial perception, enhancing the character animation controllability of the user. To our best knowledge, there is no other character controller than mixes tangible interaction and augmented reality.

INTERACTION SYSTEM

AvatAR interaction system (see Fig. 2) is formed by a cube, a tablet and a plane surface. The tablet is placed on a stand in landscape position, looking in at the surface and in turn defining the interaction area. So, the interaction area is located behind the screen. The cube is our character controller and at the same time our AR marker. So, a virtual character appears inside the cube when such cube is detected. In this manner, augmented reality becomes tangible. From this moment the virtual character is mixed with the reality viewed by the camera of the tablet.

Our character is able to move on a horizontal plane that in this prototype coincides with the tablet orientation (due its pose). For this purpose, we only consider idle motion and locomotion. We indicate through the cube the position where the avatar has to move on. Indicating positions is straigthforward due the cube lies in the scene jointly with the avatar. The local orientation of the cube defines the type of motion providing a range that covers from walking, through running to sprinting. Stablishing the analogy that likens the cube movement to a potentiometer. If we rotate the cube by 360 degrees, the motions displayed are: idle, walking, running, walking, idle. So, the avatar step displacement varies jointly with the type of locomotion.

Up to this point, we can get locations and a variety of motion

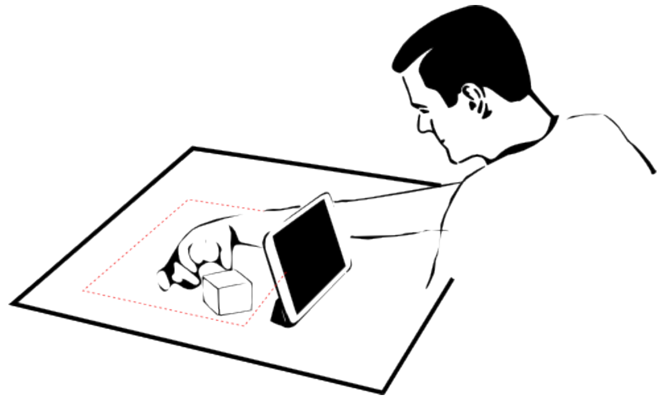

Figure 2. Interaction system

of our avatar by moving and rotating the cube. Nevertheless it has to be decided how to use locations in order to design an easy-to-use character controller. To get started, we design two scenarios.

Scenario 1: Sketch control

This scenario allows to define paths where the virtual character has to follow. So, we propose two steps. First, the path is defined by the translation of the cube across the scene. In order to guide the user in the path creation, we draw intermediate points (see Figure 3). Once we have the path defined (now we have restricted to eight points), the virtual character traces the path in loop mode. While it is moving, the user can control its behavior by rotating the cube. In this manner, it is possible to observe how the avatar can covered the same path performing different motions. Moreover, the user can interrupt avatars movement by assigning idle motion which leads the avatar to remain in a static position.

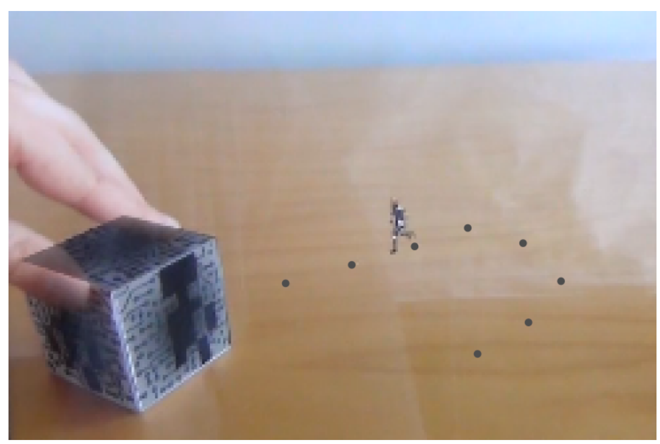

Figure 3. The avatar walk along the path.

Scenario 2: Interactive control

One of the most common uses of virtual characters is in videogames. In this context, virtual characters are driven by players allowing positioning and behavior performing at all times. In the same way, we implement this scenario.

In this case, the virtual character have always defined its target position, which is the cube position. So, the virtual character follows the cube. How longs it takes to reach the cube depends on the type of locomotion. Obviously, if we set running locomotion, the character achieve faster the cubes, in case of setting walking locomotion, the character comes later.

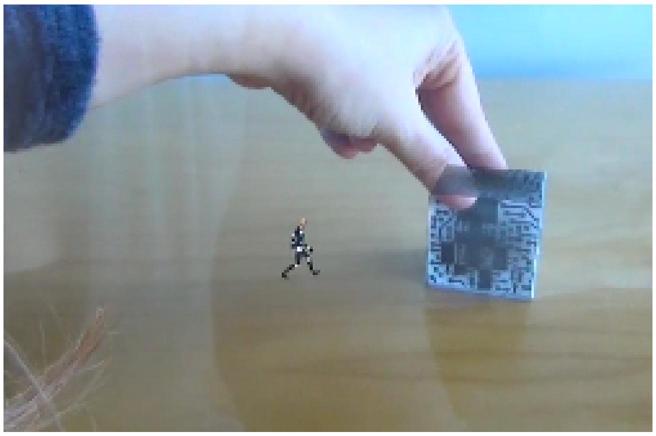

Figure 4. The avatar is walking to the cube.

IMPLEMENTATION

In order to make our first prototype we use Unity Game Engine [8]. Unity is a game development ecosystem which includes Mecanim [9], a powerful and flexible animation system which we use for create our animation controller. For augmented reality purposes, we use the software platform Vuforia [7] developed by Qualcomm. The following is a more detailed explanation of the animation controller, the motion control interface and the cube target we use.

Animation controller

Mecanim enable easily contruct and edit complex state machines and blend tree for complete control of how the virtual characters move. We want that our virtual character can perform different motion clips which are idle, walking and running. For this purpose, we have constructed a locomotion controller composed by two states: Idle and WalkRun. Idle state is an idle loop motion, and WalkRun is a blend tree which we will deeply explain later. To decide the current motion state we use "Speed" motion control parameter. Speed parameter balance between Idle and WalkRun states, assuming that if speed is greater than 0.5 the avatar is moving, and so, walkRun must to be the current state. On the contrary, the avatar is in Idle state.

As we have mentioned, WalkRun state (see Figure 5) is a blend tree which in turn is formed by Walks and Run blend trees. Blend trees provide variations of motion clips by blending similar phases of the input motions, so, motions have to be previously aligned. For both Walk and Run, we implement a classic blend tree which is composed by turn left, straight and turn right motions. The "Angular" motion control parameter for the turn key goes between -90 and +90, controlling which animation is being played. In case of walk blend tree, it is formed by short, medium and wide strides; and for run blend tree medium and wide. Moreover, "Speed" motion control parameter is also used to discriminate between Walk and Run blend trees, where its value goes from 0.5 to 5, remaining Walk state until 3.

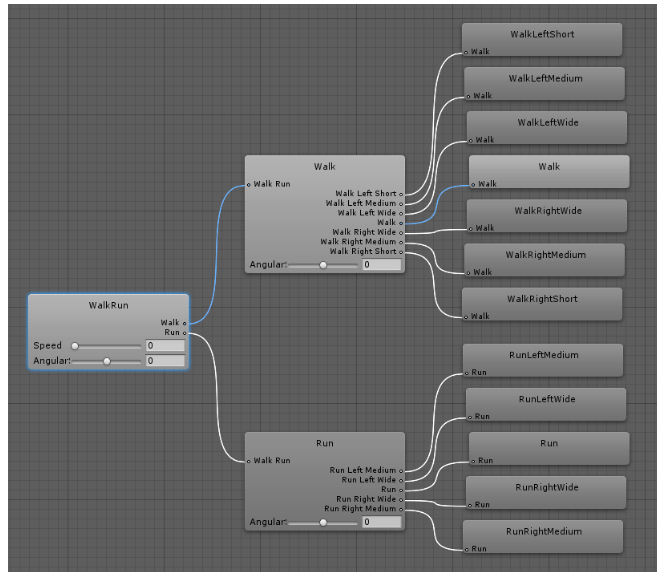

Figure 5. WalkRun state blend tree

Cube target

We design a cube with a set of image targets in its faces. Each face is illustrated by an icon that denotes one of the motion clips. We use 3 icons: idle, walking and running. The idea is to drive the virtual character by the cube faces. How to do this is addressed below. Moreover, we have texture the background with a chip pattern. In this manner, we improve the proper detection of the marker. In Figure 6 it is illustrated the graphic design of the marker.

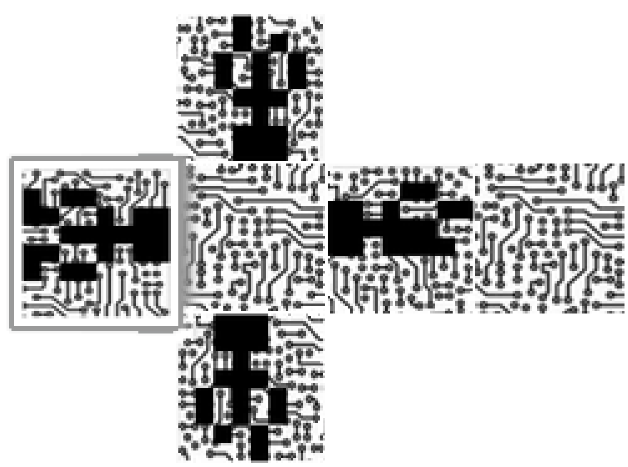

Figure 6. Graphic design of the target cube

Motion control interface

As we have mentioned, there are two motion control parameters in our animation controller which are ”Speed” and ”Angular”. The way we infer ”Speed” value is by computing the cube orientation respect to the camera orientation, taking into account the images on the cube faces. So, we compute the angle between the forward vector of the camera and the forward vector of the cube. Then, we transform this value depending on the section. If the obtained angle is between 0 and 45, ”Speed” value is directly 0. In other cases, ”Speed” value is obtained by linearly transforming the range of the value from 0 to 180 to 1.55 to 5.55. As for the ”Angular” motion control parameter, it is extracted from the difference between the current direction of the movement and the previous one. This depends on the interaction scenario.

DISCUSSION AND FUTURE WORK

This work comes up with a proposal to improve the intuitive control of virtual characters and its inclusion of them in daily environment. We use a cube as a tangible interface that permits positioning and to select motion clips for latter drive a virtual character. The graphic design of the cube and the interaction model allows to easily understand how it works. This is because motion control parameters have been taken into account in the design process.

Although the proposed interaction already fulfill the animation system requirements, it is limited by the cube rotation. The cube rotation only allows a degree of freedom, and therefore manage one motion control parameter. In our prototype, it is to only support locomotion control, which in terms of videogames community, it is denoted as a gameplay. Change the gameplay by performing a gesture (i.e. shake the cube) and controlling it with rotation could be a possibility to increment the avatar capabilities, and to improve the character controller. As a consequence, the graphic design of the marker should be changed for not confusing the users since the cube faces denote the active motion.

On the other hand, the fact of using augmented reality to display the character performances produces several benefits. Firstly, the user can feel and see the digital content at same time. This way provides more visual and spatial awareness to the user. Secondly, it allows the scene and the interaction area to move to different locations This would allow to drive the virtual characters in different places through using mobile devices. However, some changes may to be introduced in the current prototype for computing the appropriate poses of the virtual characters.

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