



Hitting imaginary walls, pulling virtual strings

What augmented reality can learn from urban dance

by Hanna Schraffenberger

A few weeks ago my colleagues convinced me to join their weekly Hip Hop fitness exercise at the University Sports center. Moving my limbs in the rhythm of well-known radio hits turned out to be more difficult than I had anticipated. After all, I had been running to similar music on a regular basis [1]! A particularly difficult move required us to turn 360 degrees while at the same time imitating a windmill with our arms. In order to help us get the movement right, our instructor gave us a simple but effective hint: “Imagine two walls, one in front of you and one behind you. You can only move between them,

your arms should not hit the walls.” To be honest, this tip didn’t help me at first. Rather, I was distracted - those invisible walls reminded me of my research into augmented reality (AR) and the presence of virtual objects in real space. These walls we had to avoid were solely a product of our imagination. Nonetheless, our movements acknowledged their presence. The walls were, in a most basic and fundamental way, becoming part of and augmenting our surroundings... Could we call this a form of imagination-based AR? Could it be that dance and AR had more in common than I thought?

Only minutes later this suspicion got confirmed. By now, our hands were connected to our feet with imaginary strings. In order to move our

same time mesmerized the audience with movements that made us doubt whether his hands were constrained by the same kind of bones we had. Among the videos that were shown, one dancer had left a lasting impression: Albert Hwang, a master in making three dimensional boxes appear in real space - solely by running his hands through thin air. A quick look at his YouTube channel [3] decided the matter; I had to find out how dancers created the illusion that imaginary objects existed in space, I wanted to know how much illusion-based

dance styles and augmented reality had in common and I definitely had to master some of those movements myself.

Dance AR?

Compared to learning the basics of liquid dancing, my theoretical considerations were rather simple. AR and illusion-based dance styles have one central aspect in common: both create the impression that virtual objects actually exist in our real, physical environment. If we understand augmented reality as a *concept* of combining and relating the virtual and the real [4] rather than a collection of technologies, it is not far fetched to think of these dance-illusions as a time and movement based form of augmented reality. What is more, the traditional, technology-focused field of AR can learn quite a few things from urban dance!

So how does urban dance approach the virtual and how do their methods inform the general field of AR?

feet, we had to pull the strings. To my surprise, when our teacher illustrated the movement, it appeared as if those strings did, indeed exist. Although I knew that they were merely imaginary, and even though I could not see the strings, some part of me was fooled into believing that they were actually there. Given the teacher's movement, her hands and feet simply had to be connected by a thin, invisible rope! There was no digital technology required, I was not wearing a headset, nor was I staring at a screen: a relatively simple movement was sufficient in order to convey the presence of virtual objects (or, to be precise, virtual strings) in real space. It might not have looked like it, but watching these invisible ropes certainly felt a lot like AR!

Over the next days, aching muscles reminded me to investigate this phenomenon further. Luckily, I already knew where to start. In 2013, I attended a presentation about illusion-based dance by Diego Maranan at the Creativity and Cognition conference in Sydney [2]. During his talk, Maranan not only illustrated technological metaphors used in the urban dance styles 'liquid', 'digitz' and 'finger tutting', but at the

No technology required!

First of all, dance teaches us that there are alternative means to display virtual objects in space besides AR technology. AR most commonly uses smartphone screens, heavy headsets or other kinds of visual displays that overlay the real world with virtual elements. In illusion-based dance, imaginary objects are revealed to the audience through a dancer's body movement. The dancer can, for instance, run his or her hands over the shape of an imaginary object in order to make it appear as if the object is actually present [5]. Illusion-based dance reminds us that AR is not restricted to *digital* mediums and that we do not have to resort to computer technology in order to make virtual objects appear in real space. Maarten H. Lamers discussed the Pepper's Ghost as an instance of *pre-digital* AR [6] in the third issue of AR[t]. In this regard, dance-illusions can serve as yet another compelling example of AR that remains in the physical domain.

Realism, really?

AR should be more like reality and virtual objects should both look and behave like real, physical objects! At least, this is the impression I get from existing AR research. Scientists and developers strive for photorealism, they struggle with occlusion and investigate how virtual objects can cause reflections and cast shadows just like real objects do (see, e.g., [7, 8, 9]). Likewise, virtual objects should behave and interact with the world like real objects [10]. A virtual ball is supposed to drop and bounce on the floor, just like a real ball would. There is certainly nothing wrong with that. However, illusion-based dance shows us that another approach is possible. Dance shines when it comes to expressing simple geometrical shapes and structures, such as rectangular boxes or walls. In some respect,

these 'dance-objects' could not differ more from real objects. First of all, dance-objects do not adhere to our physical laws; they commonly float in space, right before the dancer. At the same time, the way a dancer moves them about in space implies that they do, however, have a certain mass - it just does not cause them to fall down. And of course, unlike real objects, these imaginary objects are essentially invisible and certainly do not occlude what's placed behind them. More than that, they often appear out of nothing just to disappear in thin air a few seconds later. Fascinatingly, it does not bother us that these imaginary objects are not really present, don't look like real objects and do not behave like anything we know from the physical world - the objects are believable and convincing nonetheless (cf. [11])!

What you see isn't what you get

I expect multimodal AR to become one of the more interesting topics in the future. However, I do not think that a multimodal or richer sensory experience is always better. In their paper on illusion-based dance styles, Diego et al. [2] make an interesting observation: when dancers let imaginary boxes appear in space through their movement, the viewer can interpret this in two different ways. Either there is no box in space and the dancer is moving in a very complicated way or there is a box in space that guides the movement of the dancer's hand. While watching, our eyes tell us that there is no box but our body (or our embodied cognition) tells us that there is. Diego et al. propose that it is "*this moment of embodied/cognitive dissonance [that] makes the movement compelling*" [2, p. 173]. I believe that AR can benefit from a similar dissonance: looking at a breakfast cereal box through our phone's screen, we see the virtual dinosaur eating our cereal, but we cannot touch it. Our eyes tell us "*it is there*" while our body tells us that it

isn't. I do not claim that all AR benefits from such a dissonance. But I am convinced that getting contradicting information from our different senses can actually add to, rather than subtract from, the overall experience.

The power of movement

Ultimately, AR can learn from illusion-based dance that movement is a powerful means to express the presence and properties of virtual content. By moving virtual objects through space, AR can communicate that which it could hardly convey otherwise. If a virtual leaf moves through space in a certain way, its movement shows us that there is wind. If a virtual ball rolls over a real floor, it tells us something about its weight and resistance. Furthermore, using movement, we are able to create the impression of yet other - invisible - objects being present in space. How would you display an invisible wall with AR technology? Dance gives the answer: by having something bump against it, by movement! And there are more possibilities: if a virtual object looks heavy but moves through space weightlessly, we might be able to discern a change in gravity. By rewinding their movements, good dancers are almost able to fool me into believing that time goes backwards. Maybe AR technology can evoke a feeling of time moving differently by rewinding the movement of objects or by varying their speed. I hope future AR will explore what can be expressed by simply moving virtual objects through real space.

Future AR is not reality, it is our imagination

Let us return to the imaginary walls that were occupying the university's dance studio some weeks ago. I am not sure whether these walls can be called AR. But I am sure that a dancer will not be able to create the illusion of a virtual wall in space without imagining the wall first.

Likewise, I am sure you cannot build any virtual AR walls without imagining them beforehand.

In the future, AR will surely overcome many technical challenges. However, the future of augmented reality is not only about what is or will be possible technically. It is also about what we can imagine and how our imagination works. One of AR's unique powers is that it can be *different* from our real, unaugmented reality. But how can virtual objects differ from real objects without losing their believability? How can augmented reality differ from reality? Studying related arts such as dance, mime or magic helps us find answers and think outside of our imaginary, invisible and virtual boxes. ■

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