Do Training Bikes Dream of Electric Cities ?

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Virtual reality (VR), Augmented Reality (AR) and Mixed Reality is making the headlines in the newspapers and magazines today. But unlike 25 years ago when the first VR rage started with the first Cave Automatic Virtual Environments (CAVE) infrastructures VR is now a technique that is available at very low costs.Especially the recent advances and developments in low cost VR hardware mainly the Head mounted displays (HMD), in particular those that use mobile phones but also the PC based systems like the Oculus Rift and the HTC Vive together with recent software developments allow this change. Naturally this is based on the interest of the Gaming Industry and the big players in the smartphone industry. But at the moment there are nearly no tools for architects available within these systems. In our point of view there is the big potential that these technologies can give new opportunities to architects and designers to use VR and AR as part of their design toolbox and not only as a presentation tool. For us this is the most important aspect. In our projects we therefore try to develop a workflow that can be easily used even without programming and scripting skills.

Keywords: *Virtual Reality, Interfaces*

INTRODUCTION

This paper tries to address the old problem of "using the right tool at the right time". In a first step we tried to tune existing systems for architectural use. To experience a virtual space in a believably immersive way, we should be able to navigate it in as natural manner as possible - using a mouse or proprietary controller to experience architecture is only a partial and often unnatural solution. Ideally, users should be able to replicate their natural movements in the virtual world. The project to use a "mechanical finger" (see the Oulu presentation) to transform the movement of feet walking in the real space into the virtual world turned out to deliver very promising results. The main advantages of this very low tech version was that it was completely independent in space - there was no setup with a limited tracking area necessary - the system can be used everywhere the limits are only the available real space. Additionally it used only the basic sensors in the smartphone so the problem of different smartphones behaving differently was overcome. Gaze determines direction of navigation i.e. whilst wearing the Google Cardboard headset, the direction of travel is determined by where the user is looking. The sensors for the movement were attached to the users' shoes. It was really striking that this very low cost idea gave a much better feeling of immersion then walking by pressing a button on your HMD device or being transported by staring into a corner or being teleported using a controller. In

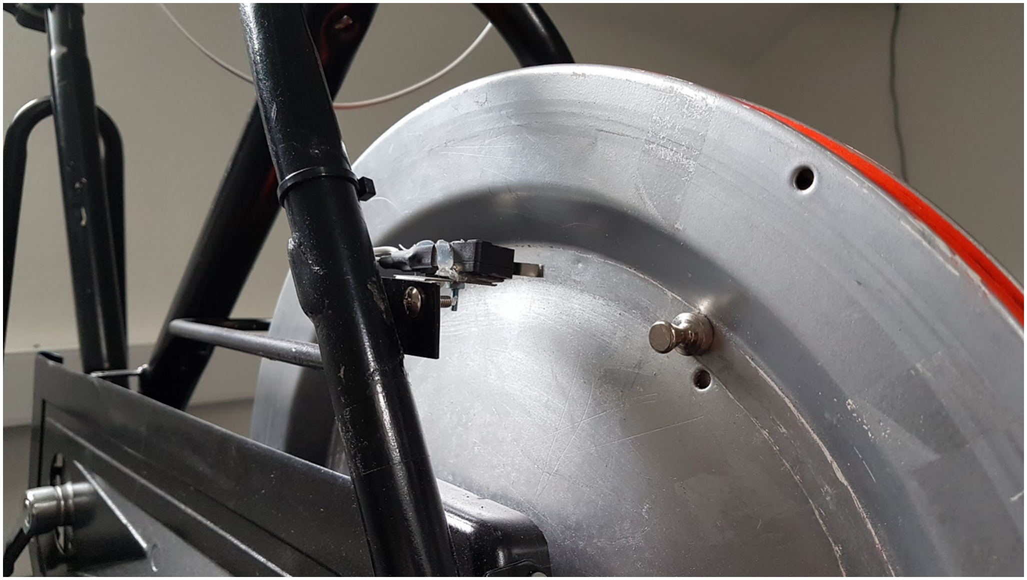

Figure 1
Detail of Microswitch mounted to the bike and the Magnet - Speed defined by number of Magnets

our previous experiments that we had the chance to present at past eCAADe conferences we used the system mainly for interior spaces but we discussed the possibility to use it also in an urban setting. During our first attempts we found out that walking a virtual city with our eeZee click equipped HMDis very nice but sometimes it would be good to use something a bit quicker - like a bicycle. We presented the first results of a workshop with students using our newly developed bicycle interface already at the EAEA conference in Glasgow and I will give a short overview of our findings there.At the School of Architecture in Liverpool as early as 1999 a bicycle was already used as an interface for VR. The Project used a modified exercise bike to be able to cycle round urban environments in front of a VR screen. It was already constructed in the spirit of low cost/home brew computing and the maker spirit and used a disassembled wheel mouse mounted on an exercise bike as interface. Users cycled on the exercise bike sitting in front of a large projected. The system used the 'Unreal' Game engine of that time to generate the environments which was good for 1999. Current software like Unity has advanced significantly not only in terms of quality of real-time rendered graphics, but also in the degree of flexibility and customisation options. The project was presented at eCAADe in 1999 and was quite successful in terms of the overall degree of immersion that users experienced at very little costs compared to other methods at the time. Due to lack of time and the fading interest in using VR in architecture after the first VR craze the experiments with this bike did not go on very long and it ended up in a storage room for nearly 20 years.But now we developed the idea to extend the principal of the mechanical finger - using a cheap flexible interface that simulates the movement in the real world as good as possible and overcomes the unnatural interfaces for movement like clicking a button on the HMD or using a stare or a teleporting beam on a controller.

Figure 2
The Bicycle in Action

THE BICYCLE INTERFACE

The new idea now was to combine the mechanical finger with the exercise bike. The solution of riding a real bike in real space with HDM devices was quickly abandoned - we already experienced with our original mechanical finger tests that the real world can have rather hard boundaries. We also investigated into previous experiments using bicycles in a VR setting. Colleagues reported about an exhibition in Vienna in 2016. In this setting the movement of the handlebar of the bicycle was used to determine the direction of movement which is a very logical idea if you want to simulate the movement of a real bike in real space. But the bike was fixed at a certain spot so it could not fell over. This caused a complete irritation to the senses of the users and people experienced a lot of dizziness and some even fell from the bike although the bike was fixed.The exercise bike without a movement of the handlebar idea was much safer idea. The disadvantage compared to the walking movement with our eezee click interface was twofold. First it also did not move which in itself is a certain problem when you try to simulate the real world experience. But because of the fact that you had to use your feet to pedal the bike to move like in the real world it gave a sufficient "logical" feedback to your senses. For the directions of movement we still used the interior sensors in the smartphone and kept the handlebars of the exercise bike fixed. It turned out that this was an acceptable compromise although the users had to use the rotation of their head for the direction of cycling and not the movement of the handlebar. Another problem to adapt our eeZee click device to the bike was to bring the micro switches from the shoes to the bike and to define the speed of movement triggered by the switches. (see Figure 1 and Figure 2) To give a natural feeling we wanted the bike to move at a rather leisurely pace through the cityscape. Ideally someone would be able to walk the Virtual city and use the bike whenever necessary to speed up a bit. This would mean that you could just disconnect your HMD from the bike when you unmount and reconnect it with the switches on your shoes. In our first attempts it turned out rather quick that this idea of a rather seamless transition from walking to biking was not so easy to achieve. We experimented with different ways to mount the magnets that triggers the microswitch at the bike to enable different speeds but found out that the frequency of the speed of the mechanical finger in combination with the smartphone tap is a limiting factor. Within walking one step produced one tap on the screen and triggered one step in the virtual world. This step was scaled to a normal walking experience and that worked rather nicely even with a slow cycling speed. If the frequency is too high when you cycle rather quickly the smartphone does not identify individual taps and therefore does not interpret the taps correctly. So when we used it within the bike system it turned out that this was too quick for the combination of the Mechanical Finger and the Smartphone. So in fact for the bike system the only solution would be to change the width of one step (tap on the screen) to allow for a quicker movement. The problem is, that this would spoil the idea of being able to easily switch between walking and cycling within the same model. So although we don't really like the idea of the teleporting movement like in the HTC Vive this seems to be one possibility to solve the issue. How to implement that as seamless as possible within our interfaces is an ongoing discussion.

THIS YEAR'S WORKSHOP

For this year's workshop we planned to overcome some of the hardware and software problems we experienced and reported about in the past. Within a 4 days workshop with a group of students at the School of Architecture in Liverpool we wanted to fine tune our workflow. In the past we still had a lot of problems because we used the current available smartphones of the students for our experiments and in combination with different versions of Operation Systems we experienced several incompatibilities. But we wanted them to use their own smartphones to be able to use our workflow for their own projects after the workshop. Because of the very limited time we had available during the workshop we decided that this year we would provide two state of the art smartphones to be used during the workshop - a Samsung Galaxy S9 and a Huawei P20pro. We also adapted the eeZee click setting and used oversized garden shoes to fix our microswitches. In the past we had to fix the switches on the different types of shoes the students used in a rather crude way - this time we just wanted them to step into the prefabricated shoes (see Figure 3 and 4) and plug the eezee click system into them. Although this worked rather nicely and saved a significant amount of time there were still several other problems to solve. We also gave them a detailed workflow that they should follow in doing their geometry models and how to use a Unity workflow to produce the APK files out of their geometry files for the use in the HMD. For comparison we also produced files for the HTC Vive to discuss with them the differences.We had mixed results this year - on the one hand several things went much more smoothly than in past years but on the other hand we could not overcome several problems within the limited time available. The scaling up from the interior models that we were rather successful with was not as easy as expected. The use of the "state of the art" smartphones made less change than we thought it would. It is of much more importance to make efficient CAD models for the use in the smartphone based VR systems. We had problems with certain models although they were not bigger in size than others and seemed to have ticked all the necessary boxes. And naturally in the combination of these systems size matters - we could not get some of our urban models to work at all and had to split them up.

FUTURE WORK

We plan to work together with the city department of surveying and will use their data from the city model and our VR setting to identify problem zones in the bicycle lane. The idea is that we test these existing zones in our VR setting and then generate different virtual versions. Additionally we want to add some augmented features into these scenes information

Figure 3
The Garden shoe
and eeZee click

Figure 4
Garden Shoe with
mounted
Microswitch

about the problems we found and the improvement we made. From our point of view one of the problems is that most traffic planners only work in 2D - bicycle lanes are mainly designed on plan. 3D information is most of the time neglected - only when there are steep slopes there might be an influence on the design.

OUTLOOK

So we are still not where we want to be - especially with the training bike. The workflow for walking within VR using Eezee click is working quite nicely - the next step here would be to get rid of the cables and trigger the steps from the real world wirelessly into the smartphone. At the moment we are discussing the use of systems like an Arduino nano and a Bluetooth connection in combination with the new developed garden shoes.Our aim to provide a cheap and quick workflow and interface for every designer to evaluate architectural design solutions by walking through it in the virtual world seems within reach. One of the problems (but also one of the chances) is that the field is developing rather quick but the focus is still not on architecture and even less on architecture in the design stage. Because the focus is not in architecture you never know what the big players in this field like Apple, Google or Microsoft decide to develop or abandon in the future. And it is not always guaranteed that the new solutions are better suited to be used in the way we want to use the VR systems. Last year you could buy a Google cardboard system easily nearly everywhere - this year it was pretty hard to replace a broken system. And you never know if "the next big thing" is a big thing for the use in the Design Process.

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