

Low-cost and home-made immersive systems

For home or for work

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Abstract—A lot of professionals or hobbyists at home would like to create their own immersive virtual reality systems for cheap and taking little space. We offer here two examples of such “home-made” systems using the cheapest hardware possible while maintaining a good level of immersion: the first system is based on a projector (VRKit-Wall) and costs 1000€, while the second system is based on a Head-Mounted Display (HMD) (VRKit-HMD) and costs 600€. We also propose a standardization of those systems to enable simple application sharing. We have also created a method to calibrate the stereoscopy of a NVidia 3D Vision system.

Keywords: *Immersive Virtual Reality, Low-cost, DIY, Stereoscopy, System design, Real-time graphics, Interactive systems.*

I. INTRODUCTION

We believe the minimum capabilities of a “generic” VR system should be:

- For an immersive wall we need to track the **head’s position**. The head’s orientation can be omitted if we suppose the user keeps his head facing the screen.
- The **head’s orientation** is essential for an HMD, but we also believe that we should track the head’s **position** to get more natural viewpoint control.
- Tracking of at least one **hand (position and orientation)** seems important to be able to interact with the virtual environment in both systems.
- Having a few **buttons and a joystick** to simplify the interaction is interesting too.
- For the immersive wall, a **stereoscopic screen** two meters wide is a good minimum because it provides a large enough field of view.

II. RESOURCES

A. Input devices

There are a lot of alternatives for cheap head or hand tracking: optical tracking with a Wiimote or TrackIR[1], Sixense magnetic tracking [2], Playstation Move,

Microsoft Kinect. For our particular setup we chose to use the Gametrak [3] which can be found on eBay for 20€, but any of the aforementioned alternatives are valid. As the Gametrak only gives a position but no orientation, we used the SpacePoint Fusion by PNI[4] which can be bought for 100€ to track the user’s head or hand orientation.

We have used a Wiimote or a regular gamepad to provide us with the buttons and the two-axis joystick.

B. Display

It is now possible to find cheap 3D projectors, compatible with NVidia’s 3D Vision system [5]. We chose to use front-projection because it doesn’t require space behind the screen, and we can simply project on a white wall. In this situation, a wide-angle projector is a very interesting because it gives a large picture even with little space, and it can be setup close to the screen so that the user is less likely to cast shadows.

We have been using the Viewsonic PJD6381 [6] projector. It has a 1024x768@120hz resolution and can create a 2.2m wide image with a distance from the screen of only 1.5m.

Regarding HMDs, The Vuzix VR920 [7] offers a reasonable quality for a reasonable price: 400€. It has two 640x480 LCD displays and a 3-axis more or less reliable orientation tracker.

III. VRKIT-WALL

By combining the different elements cited above, we obtain the following result for a total budget of approximately 1000€:



IV.VRKIT-HMD

Here's a picture illustrating the setup that we have achieved for a budget of 600€:



V.STANDARDIZATION

The goal of these kits is that anyone can build their own VR system at home and share VR applications developed by others. The amount of possible combinations of different hardware to achieve similar results is vast, so we offer some standardization so that those systems remain compatible in terms of hardware capabilities and software interfacing.

The hardware should support the minimal capabilities defined in the introduction and the software should rely on VRPN[9]. The application should support three different generic VRPN devices: a head tracker, a hand tracker, and a joystick, matching the hardware capabilities.

VRPN uses a client/server architecture, thus the client application should use devices with specific names matching the names in the VRPN server.

This allows to setup a VRPN server only once for your particular system and run different compliant applications without reconfiguration. We have chosen the following names:

- The VRPN head tracker should be named "HeadTracker@<host>",
- The VRPN hand tracker should be named "HandTracker@<host>",
- The device offering two axis and four buttons should be named "Joystick@<host>"

<host> is the network name of the computer where the VRPN server(s) run(s).

To simplify the use of VRPN, we have written a tutorial [10].

VI.CONCLUSION

We have presented two low-cost home-made immersive VR systems:

- VRKit-Wall: a projector-based stereoscopic VR wall with a 2.2m wide image for 1000€,
- VRKit-HMD: an HMD-based VR system for 600€

We have demonstrated that we can create really immersive VR systems for cheap.

We have also introduced a hardware and software standard based on minimum hardware capabilities and on VRPN.

All this information can be found on the VR Geeks website [11].

RESOURCES

- [1] NaturalPoint TrackIR - <http://www.naturalpoint.com/trackir/>
- [2] Sixense - <http://www.sixense.com/>
- [3] Gametrak - <http://cb.nowan.net/blog/2006/09/25/gametrak-a-first-impression/>
- [4] PNI SpacePoint Fusion - <http://www.pnicorp.com/products/spacepoint-fusion-demo-module>
- [5] NVidia 3D Vision - <http://www.nvidia.com/object/3d-vision-main.html>
- [6] Viewsonic PJD6381 Projector - <http://www.viewsonic.com/products/projectors/pjd6381.htm>
- [7] Vuzix VR 920 - http://www.vuzix.com/consumer/products_vr920.html
- [8] VRPN - VRPN - <http://www.cs.unc.edu/Research/vrpn/>
- [9] Calibration 3D Vision - <http://cb.nowan.net/blog/2010/07/03/nvidia-3dvision-and-vr-cameras/>
- [10] Tutorial VRPN - <http://www.vrgeeks.org/vrpn/tutorial---use-vrpn>
- [11] VRGeeks - <http://www.vrgeeks.org>