Capture of Omni-Directional Stereoscopic Panoramic Images

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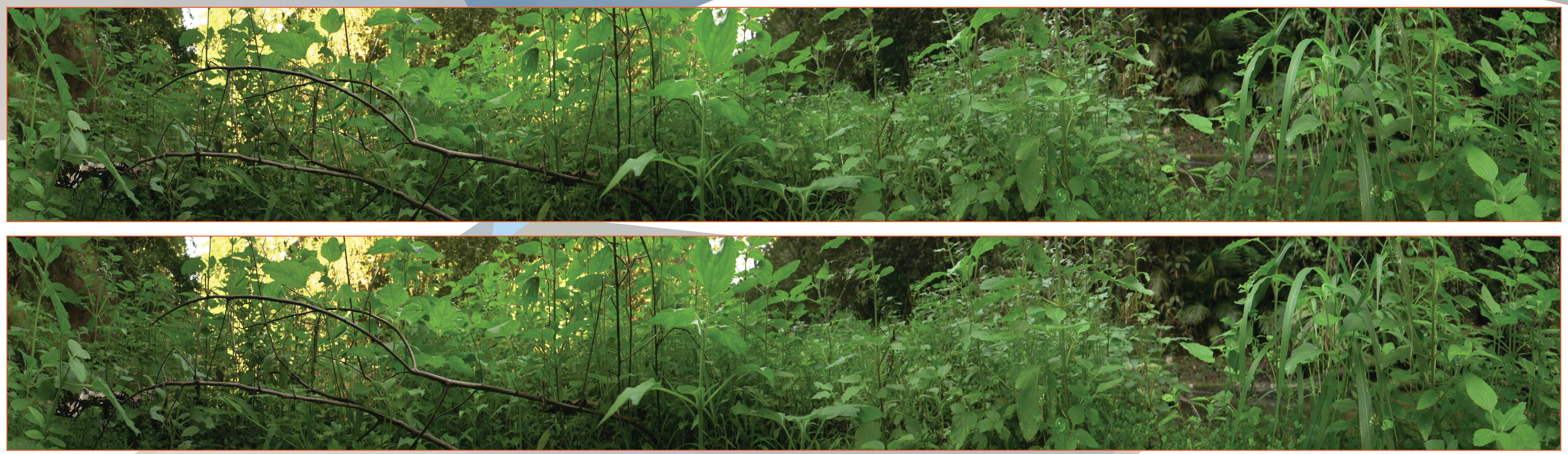
Highly immersive displays are those that are both stereoscopic 3D enabled as well as filling the viewers field of view. Traditionally these are built from multiple planar walls that surround the viewer, the most well known being the CAVE [1]. Due largely to the discrete nature of the walls, head tracking is required in order to create the correct stereo pairs on each wall, and as such, these displays are inherently single person experiences.

Another category of immersive displays are based upon a cylindrical surface, such as the AVIE [2] (Advanced Visualisation and Interaction Environment) and the CAVE2 [3]. These generally encompass a larger space and are capable of hosting a number of participants all potentially looking in different directions. This raises the question of whether the need for head tracking can therefore be relaxed. The solution is generally referred to as omni-directional stereo, that is, an acceptable stereoscopic 3D experience can be enjoyed by multiple participants without the need for head tracking.

Figure 3



Two technological developments that allow sufficient resolution capture are HD or 4K video cameras, providing 2K or 4K pixel high panoramas, and SLR cameras with fast continuous capture modes (eg: 6 fps of the Canon 5D Mk III) resulting in 5.5K pixel high panoramas. Note that in both cases the camera is typically mounted in portrait mode and the horizontal resolution is dictated by the field of view of the lens.

The current and future work will explore and document the relative trade-offs between the parameters involved, how they can effect the quality of the panorama pair, and how they can be used to achieve particular artistic goals. The key parameters are the radial offset of the camera, the separation of the extracted slits, the capture time and the intended resolution/fidelity of the final panorama. This future work will be in the form of guiding principles presented both quantitatively and qualitatively to practically assist in the effective capture of these image pairs for high resolution stereoscopic 3D capable cylindrical display environments.

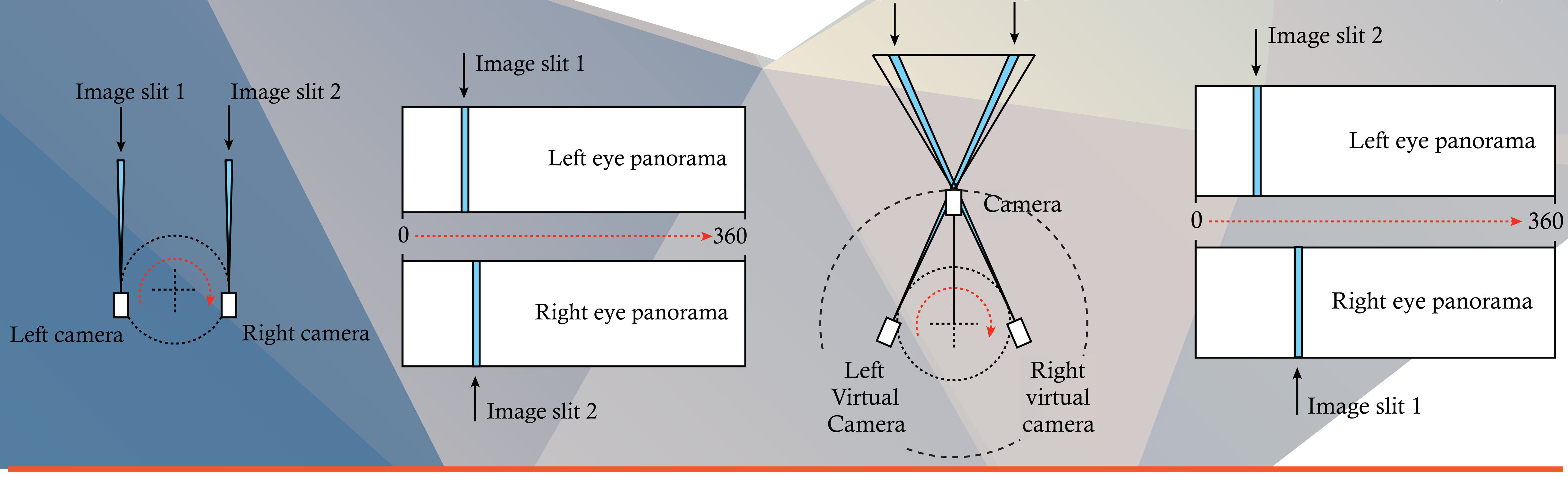


Figure 1

Figure 2

Figure 4

Figure 5

The creation of synthetic omni-directional stereoscopic 3D panoramas for cylindrical displays is well understood [4] but the capture of digital panorama photographs is challenging. Successful film based cameras [5] have been built which are based upon the optics illustrated in figure 1 with the basic principle being a pair of slit cameras rotating about a central location exposing two strips of film, one for each eye. This is the same model typically employed for computer generated panorama pairs.

This poster presents exploration into a viable digital alternative for capturing a stereoscopic panorama pair using off-the-shelf components. There is additionally the requirement to capture these panoramas at sufficiently high resolution to match the growing resolution of modern cylindrical displays.

It has been previously proposed that, perhaps surprisingly, only a single camera is required [6,7,8,9,10]. This is achieved by taking a large number of photographs with only a single camera rotating at an offset position from a central axis, and pointing perpendicular to the axis of rotation. The final panorama image pairs are assembled in post-production by mosaicing precisely selected columns from the source images. Figure 2 illustrates that if two image slits are extracted from the frames captured by such a perpendicularly arranged camera, then the strips form the same images as would be obtained from a pair of slit cameras. This not only reduces the cost but removes many of the complications of stereoscopic video capture employing two cameras, such as camera calibration and colour matching.

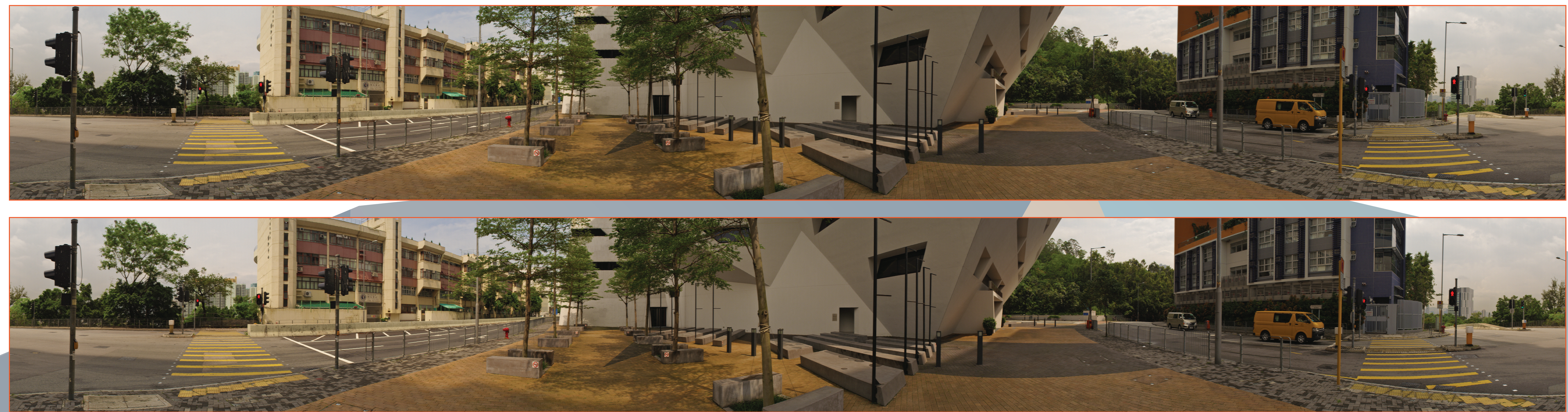
A powerful consequence of this mode of capture is that the interocular separation can be adjusted in post production simply by choosing the distance between the two image slits extracted.

Choosing the "best" depth for a stereoscopic image is as much a creative decision as a technical challenge for the photographer.

Such control in post production over the disparity and perceived depth is normally not possible and has the important consequence of being able to adjust content for different screen dimensions, optimise viewing comfort, as well as providing significant creative control.

Implementing the configuration shown in figure 2 requires a motorised unit to automatically rotate the offset camera. If long capture times are possible then the head may rotate discretely but typically it is rotated continuously.

There are two options for the camera, it may be either a video camera or a SLR still camera. The relative merits of the former can result in faster acquisitions times at the expense of image resolution. Two examples of prototype cameras built for this work are shown in figure 5. Cameras being tested include, but are not limited to, the Red Scarlet, Canon 5D MkIII and Sony FS700.



Acknowledgements

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