

Accelerated 4K Video Stitching for Digital Backlots

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1. Abstract

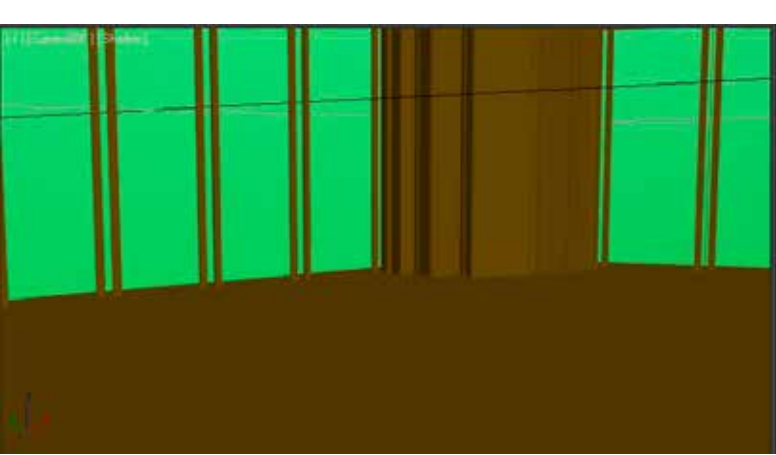
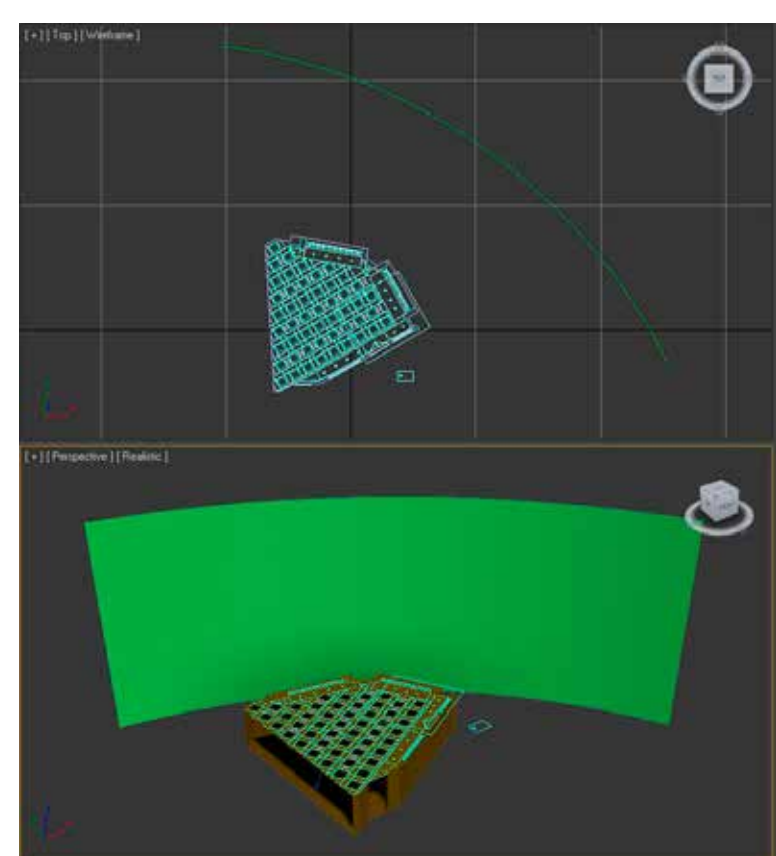
Currently, the use of visual effects resources is increasingly important for cost reduction and quality of films and novels. The Digital Backlot is one of the most commonly used features. However, with the increase of cameras resolution, the quality and final size increases more and more, making the generation process of them very costly and complicated.

This paper presents a workflow-oriented automatic and semi-automatic (with the help of artists) generation of Digital Backlot using cameras with 4K resolution.

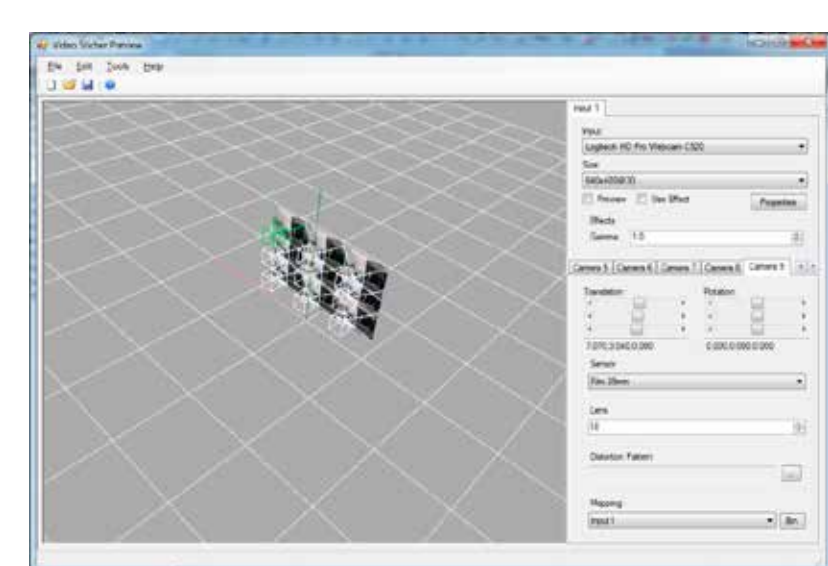
2. Motivation

To produce a Digital Backlot is the fulfillment of several steps. At a high level of abstraction, we have a planning stage, the recording stage and finally the post processing stage. Our goal is to automate the last step.

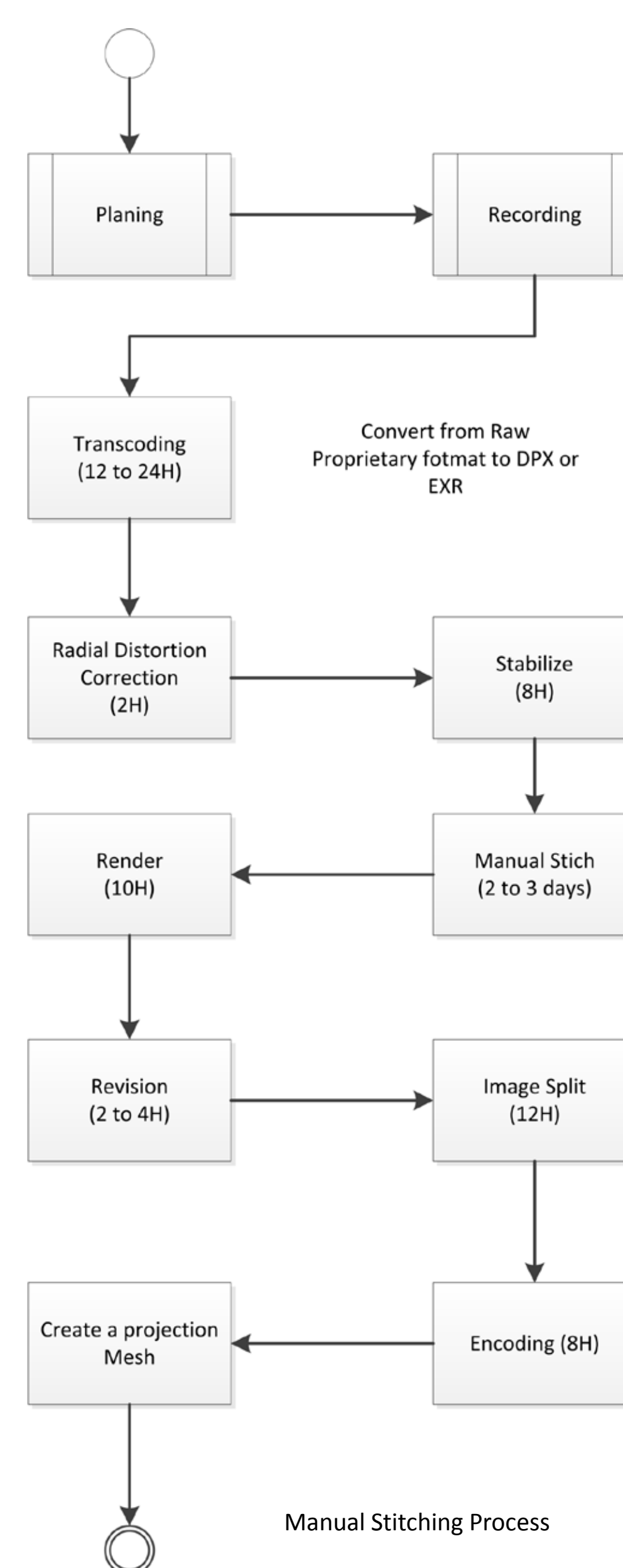
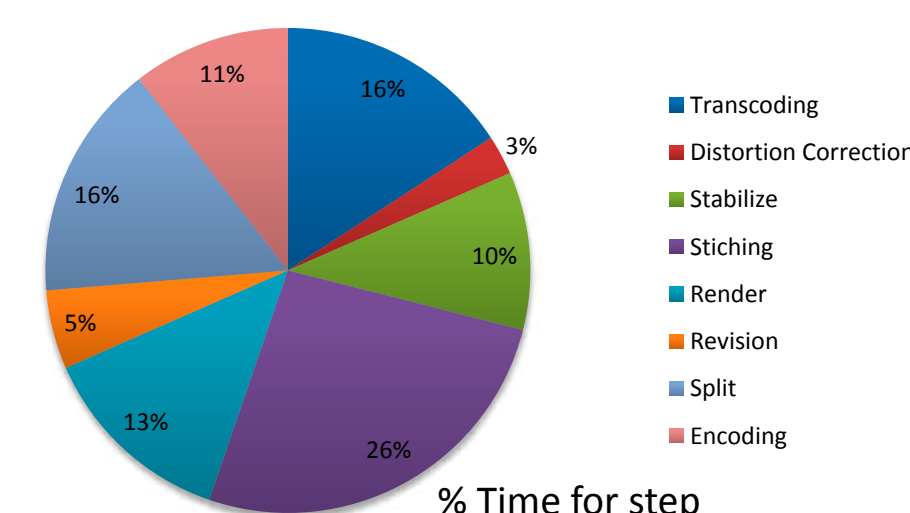
In the figure below can observe the traditional production workflow, each step is done serially because it shares usually the same human or computational resource. The number inside the items is the average time for one Digital Backlot of 5 minutes and 9 camera positions.



Digital Backlot Simulation



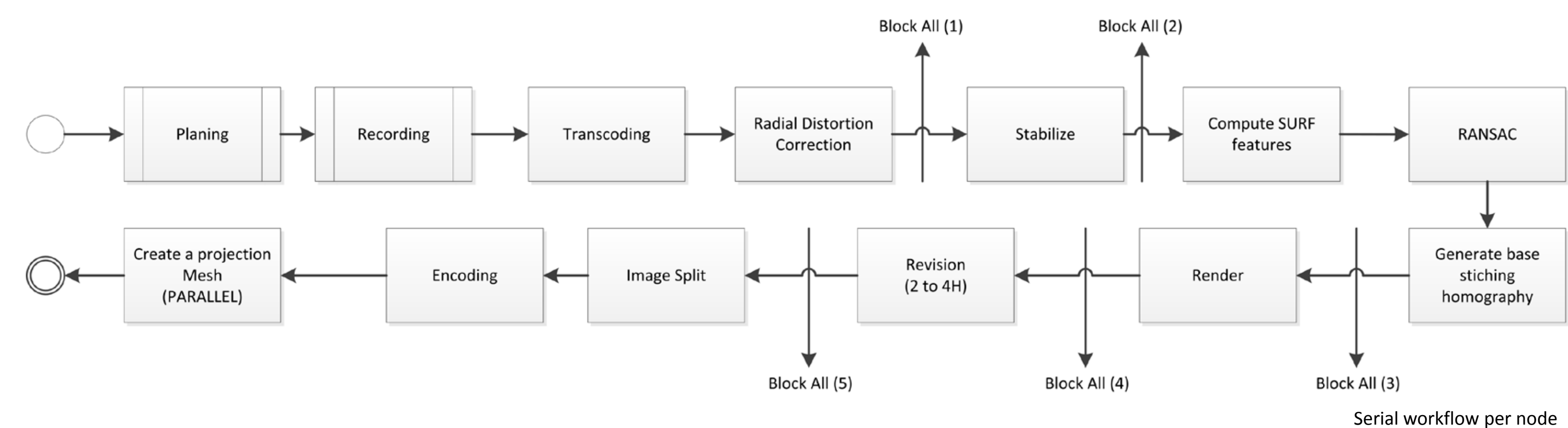
Camera Rigging Planning System



3. Project Concept

The system concept is to create a sequential workflow for image processing and divide that between nodes in a cluster. In the figure below is presented this process, and there are 5 locking points, which all nodes should wait for synchronization.

During processing, each picture must be transcoded into a common format (OpenEXR) and corrected the radial distortion, which is dependent on the lens used. After that begins the stabilization of the images by using the algorithm from Matsushita et al. (2006). Then the feature points are computed with SURF and RANSAC. The workflow for stitching follows the model proposed by Brown & Lowe (2007).



4. Parallelization

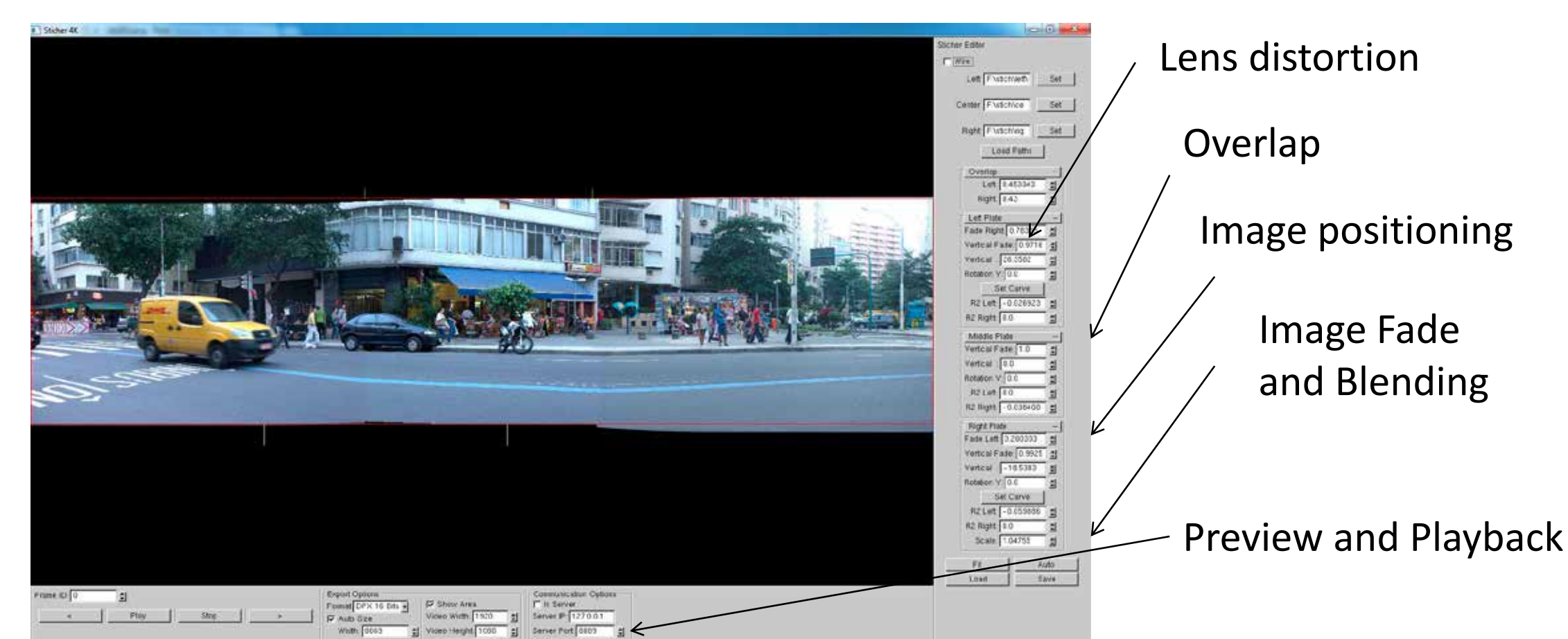
To parallelize the servers, we used a concept of processing queues, in the same way as processing in the cloud. Thus, each node performs a procedure removing an item from a queue. In the figure is shown this procedure. The RAW data is stored in a high performance storage system and can be accessed by mapping CIFS or NFS.

Finally, the results of interest are stored in the same storage. Internal data are processed in the node memory or temporarily stored on the node.

The whole process uses CUDA to parallelize the image processing procedures and algorithms, such as image stabilization, SURF, RANSAC and image stitching.

5. User Assisted Sticking

Sometimes the generation of Digital Backlot needs for a manual intervention. However, this can be facilitated using an application with tools for this purpose. Thus, we can use what has been done automatically and allow fine adjustments, like, positioning and lens distortions corrections. The figure below shows the application interface.



The entire panorama display and preview uses OpenGL with GLSL shaders for real-time adjustments.

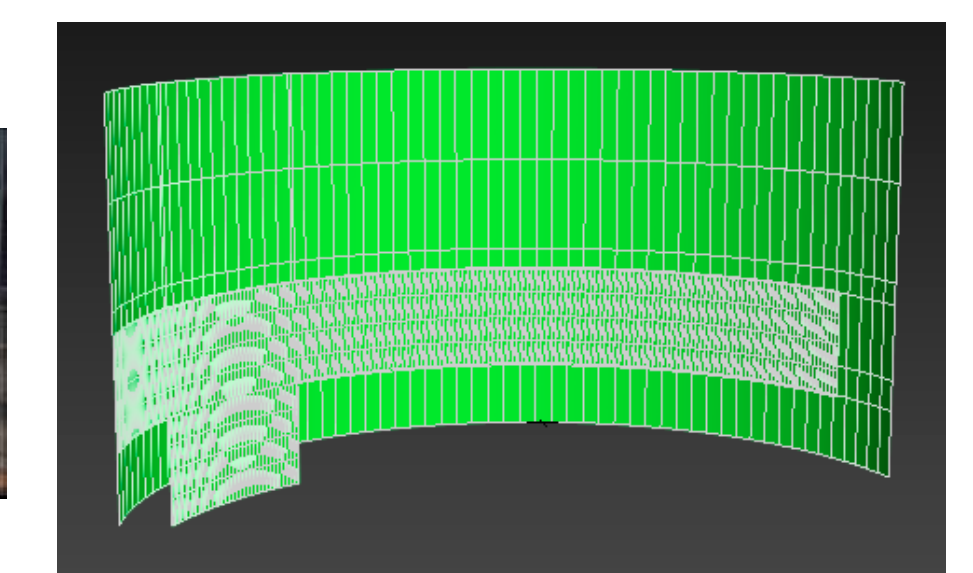
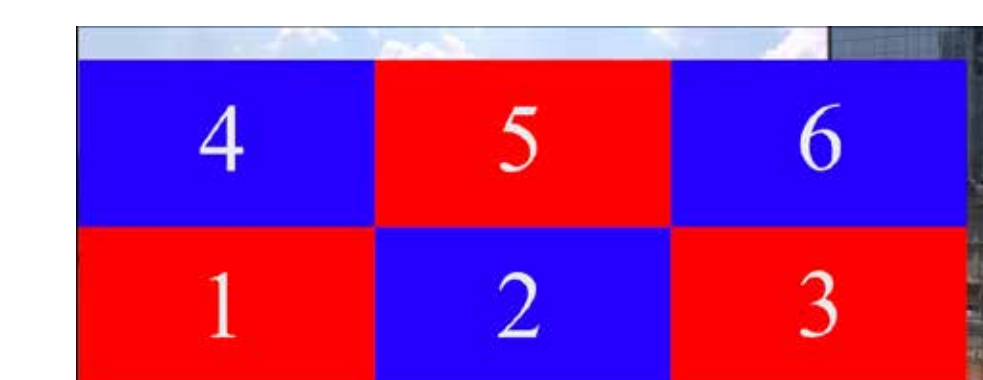
CUDA Kernels are used for feature points computing and exhibition, which can be manually edited for better results.

6. Rendering and Splitting

The rendering process is one of the last steps and consists in putting together the images frame by frame and make a composition between them. This smoothing uses the control points obtained by SURF and which generate masks for the composition.

When a frame is generated it starts the splitting process to allow use of compatible encoders with the most diverse composition systems for real-time or not. The division can be done manually by selecting a Full HD frame, or automatically by detecting areas of greatest optical flow. Moreover, we can use a static image for the areas of slow moving and create regions of high motion video integrated to this static image.

To do this, the system must generate a mesh, apply the static image as a texture and then crop the same regions that possess videos. For encoding the system uses the H264 through the library Nvidia Cuvid.

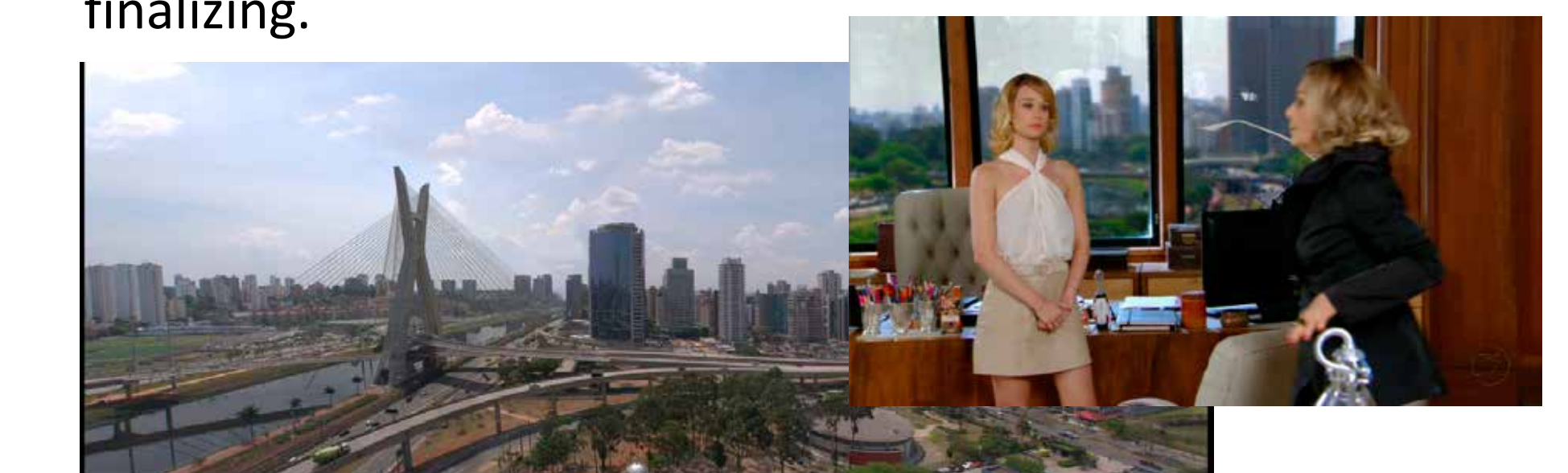


7. Results and Conclusion

The final system used a small cluster of 4 computers, each using a NVidia Quadro 5000 and one of them using also a Nvidia Quadro K5000. In this context, the total time to produce the result was an average of 5 hours, regardless of the time of transcoding, which can not be performed by the system because the copyright of the RAW format. The final image size was 10438x3855.

The use of an automated workflow for Digital backlots production provided a great increase in productivity and quality. Also, now we can work with larger sequences, because the editing process is now done after the processing, making better recording.

Finally, the use of GPUs with CUDA enabled reduce even more the processing time and provide a preview of the result before finalizing.



M. Brown and D. Lowe. Automatic Panoramic Image Stitching using Invariant Features. International Journal of Computer Vision, 74(1), pages 59-73, 2007.

Matsushita, Y. Ofek, E. Ge, W. Tang, X. Shum, H.-Y. Full-Frame Video Stabilization with Motion Inpainting. IEEE Transactions on pattern analysis and machine intelligence, 2006