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Efficient Image Stitching through Mobile Offloading

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Abstract

Image stitching is the task of combining images with overlapping parts to one big image. It needs a sequence of complex computation steps, especially the execution on a mobile device can take long and consume a lot of energy. Mobile offloading may alleviate those problems as it aims at improving performance and saving energy when executing complex applications on mobile devices. In this paper we investigate to which extent mobile offloading may improve the performance and energy efficiency of image stitching on mobile devices. We demonstrate our approach by stitching two or four images, but the process can be easily extended to an arbitrary number of images.
We study three methods to offload parts of the computation to a resourceful server and evaluate them using several metrics. For the first offloading strategy all contributing images are sent, processed and the combined image is returned. For the second strategy images are offloaded, but not all stitching steps are executed on the remote server, and a smaller XML file is returned to the mobile client. The XML file contains a homography information which is needed by the mobile device to perform the last stitching step, the combination of the images. For the third strategy the images are transformed into grey scale before being transmitted to the server and an XML file is returned. The considered metrics are the execution time, the size of data to be transmitted and the memory usage. We find that the first strategy achieves the lowest total execution time but it requires more data to be transmitted than both the other strategies.

Keywords: Image stitching, Mobile offloading, Program Partitioning

1 Introduction

Taking photographs has become one of the most widely used applications on mobile devices. Cameras in mobile phones have become very good over the past years. Images are used to preserve memorable moments, but also to take scans of documents. For panoramic pictures as well as for images of larger documents one image alone may sometimes not be enough to represent the full picture. Then several images of parts of the scene are taken. To restore the full picture those images must be

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combined by stitching them in the overlapping sections [16]. While this stitching of several images may be desirable also for environmental documentation purposes, the computations needed to stitch several images are rather extensive [13].

Even though the user of the mobile device produces the individual pictures and requests to obtain the combined image, the stitching itself need not be performed by the mobile device. Since the image stitching algorithms include heavy computation this work would ideally be performed by a powerful server, not by a mobile device. The execution of complex tasks on powerful remote devices can save time and extend the battery life of the mobile device, but the required data for the computation has to be transmitted to the server which after completion returns the results back to the mobile device.

Mobile application offloading is a technique that transfers heavy computation to a server to reduce the power consumption of mobile devices. In some cases completion of the task is faster when migrating the computation to a server. Different offloading strategies have been explored in [15,26,27]. Some requirements must be fulfilled for mobile application offloading to be beneficial. The transmitted data must not be too large and the network connection has to be sufficiently large and stable. The objective of this paper is to explore the potential benefits of mobile application offloading for image stitching.

We have implemented a local version of the image stitching algorithm as a mobile application which can use three different strategies to offload either the full computation or parts of it. Image stitching consists of five different steps, some of which need more processing than others. We used the execution time as the metric to measure the complexity of the five steps. The measurement results show that the computation in the first and last step are much heavier than for the other steps. As the image files are required for each step, once the computation is offloaded, it should stay on the server side as long as possible. Accordingly, offloading strategy 1 transfers the whole stitching process to the server while strategy 2 and 3 compute the last step locally in the mobile device. In order to reduce the size of the images to be transmitted, strategy 3 compresses the images into grayscale before sending them to the server. The performance of the three strategies is compared using experiments and we find strategy 1 to perform best according to our metric.

The remainder of this paper is organized as follows, in the next section we briefly introduce the method of image stitching and recapitulate the background of mobile offloading. In Section 3 the steps of stitching two images together are introduced, which can be easily extended to stitching more than two images. Then, in Section 4, three options of offloading different parts of the image stitching procedure are proposed. In Section 5 the experiment configuration and the metrics to evaluate the different methods are shown. In Section 6, the experiments with the different offloading methods are evaluated, the results are compared and discussed. The last section concludes this work.