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Removing shadows from ortho-photo images

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Abstract

The goal of this seminar was to implement an algorithm that takes as an input an aerial ortho-photo image and outputs an image with removed shading/shadows. To do this we were tasked to either apply one of the algorithm presented in [FHD02, KBST15] or some other state-of-the art shadow removing algorithm. The developed algorithm is able to read images and output an another image. The application also supports piping so it can be used in various image processing pipelines.

CCS Concepts
•***Computing methodologies*** → *Image processing; Computational photography;* •***Applied computing*** → *Media arts;*

1. Introduction

Informatics, software engineering and the field of computer vision have made great strides in the fields of shadow detection and shadow removal, especially in recent years. An ortho-photo image is an aerial photograph or satellite image that has been geometrically corrected ("orthorectified") so that the scale is uniform: the image follows a given map projection. Because it is an accurate representation of the Earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt, an ortho-photo can be used to measure true distances. Ortho-photo images are commonly used in geographic information systems (GIS) as an accurate background image. Production of ortho-photo images was historically achieved using mechanical devices.

Shadows in images can be problematic if we for example wish to create a surface model of a certain terrain or simulate the day and night cycle using terrain imaging technology. In these cases we do not desire shadows in the image as they can misrepresent the terrain or time of day. As such it is necessary to detect and remove these shadows from the image in question before creating terrrain models from them.

The final product was created using Matlab.

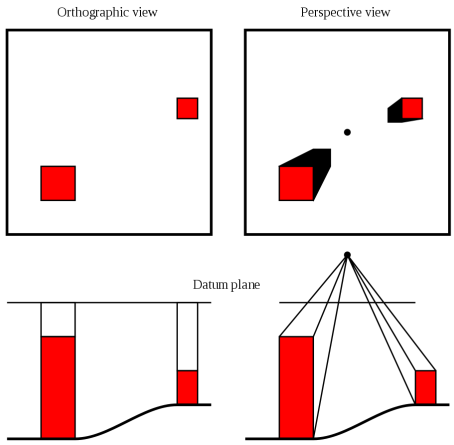

Figure 1: *Difference between orto-photo images and regular perspective images. Source:* `https://en.wikipedia.org/wiki/Orthophoto`

2. Tools

Matlab is used by millions of engineers and scientists worldwide to analyze and design the systems and products transforming our world. It is commonly used in automobile active safety systems, interplanetary spacecraft, health monitoring devices, smart power grids, LTE cellular networks. Other fields using this application include: machine learning, signal processing, image processing, computer vision, communications, computational finance, control design, robotics, and much more. As such it was more than appropriate for our goal with the only real downside being that it's not an open-source application. Matlab allows for

- High-level language for scientific and engineering computing
- Desktop environment tuned for iterative exploration, design, and problem-solving
- Graphics for visualizing data and tools for creating custom plots
- Apps for curve fitting, data classification, signal analysis, control system tuning, and many other tasks

- Add-on toolboxes for a wide range of engineering and scientific applications
- Tools for building applications with custom user interfaces
- Interfaces to C/C++, Java, .NET, Python, SQL, Hadoop and Microsoft Excel
- Royalty-free deployment options for sharing MATLAB programs with end users

Figure 2: *The official logo of Matlab.*

The application allows for quick and simple mathematical analysis as well as image segmentation and manipulations as well as a wide array of available functions that can be used. As for the images used to test the algorithm, we used images publicly accessible on the internet, both ortho-photo images as well ass regular images in order to test the algorithm's robustness.

3. Implementation

For the seminar we implemented an algorithm that reads a JPG image that uses a median filter to calculate the shadow ratio of the image, we then remove any shadows that are too small for us to consider and create and use the found shadows to create an image mask. After that we take the parts of the image outside the image mask and calculate the average saturation and brightness values. Then we alter the saturation and brightness values of the detected shadows and then combine the non-shadowed part of the original image and the shadowed part of the brightened image in order to get an image that no longer has shadows. For our implementation we drew inspiration from the following articles in addition to the ones given in the instructions: [SCC90, LYSS10, XLP05, XXZC13, SU09].

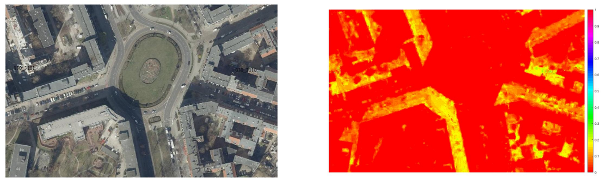

Figure 3: *The original image and the image after color segmentation.*

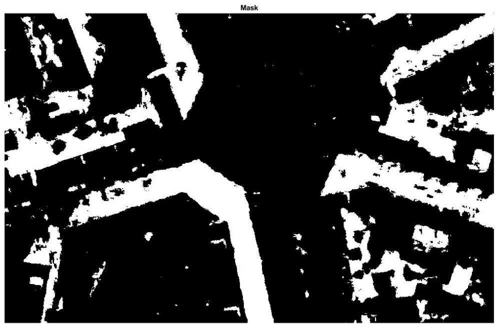

Figure 4: *We create a mask from the previous image.*

Figure 5: *We outline the detected shadows for easier viewing.*

Figure 6: *The final result where we removed the shadows.*

4. Conclusions

Our image successfully removes shadows from a desired image, both orto-photo or regular. The algorithm is designed as a function so that we can easily add it to an image processing pipeline and outputs and image where the shadows are no longer present. Thought for certain examples we get better results if we alter the median filter size or the threshold value for the minimum shadow size: A possible improvement would be to use automatic threshold estimation algorithms that calculate the optimal threshold values for shadow size, saturation and brightness.

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