Drone Inspection of Fences
- Periodic Structure Detection

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Introduction

Unmanned Aerial Systems (UAS), or the more common name drones, are a rapidly expanding area within research and innovation. In collaboration between SDU and UAS Test Center Denmark, this project focuses on easing airports' burden of numerous required inspection tasks to maintain a high level of safety and security. A drone rather than the current manual labor may advantageously perform some of these tasks.

In the project a specific need for frequent inspection of the fence surrounding the airport is targeted. The inspection concerns fence holes or similar anomalies. It is hypothesized that a drone will be capable of unsupervised autonomous inspection of the airport fence and detect holes down to a radius of 5 cm. With a camera installed on the drone, the fence will be video-photographed while the drone navigates along the fence.

The progress of the development of a computer vision algorithm, which identifies holes in the fence, is presented here.


[1]

Present situation

A computer vision algorithm has been developed to identify the fence. There are still some problems with snow and background variation. Especially tree lines constitute a challenge. Future work will focus on preventing false hole detection in images. The idea is to compare two images with different perspectives of a section of the fence with a hole and if the hole is identified in both images.

HCA Airport with the fence colored red

Method

To ease video analysis, the drone is oriented with the camera directly at the fence at a distance of approximately 2 meters and at a height of 1 to 2 meters.

Each video frame is processed in the steps described below. Corresponding output images are presented.

1. Fisheye correction

The camera used is a GoPro which have a fisheye lens distorting the image. The distortion parameters are estimated by looking at the bending of a chessboard, which then are used to correct the distorted image. Straight lines now appear straight.

2. Contrast enhancement

To improve the contrast in the image, Mahalanobis distance to some predefined color of the fence is computed. This operation also prepares for the next step providing an output image in grayscale.

3. Frequency filtering

By converting the image to frequency domain and using a bandpass filter, the frequency of repeated structure in the fence can be filtered out. When converting the image back to the spatial domain the fence is highlighted in the image. [2]

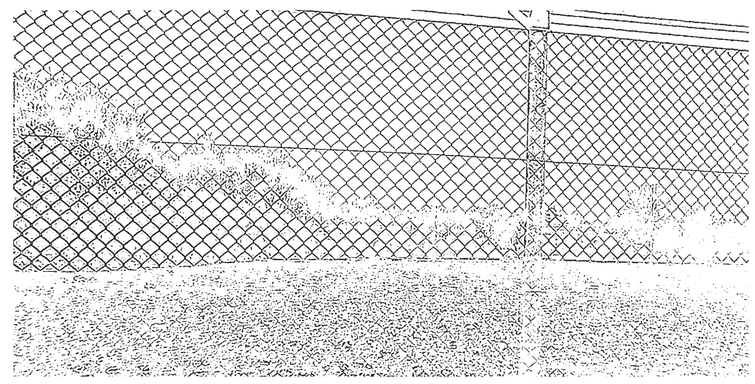
4. Segmentation

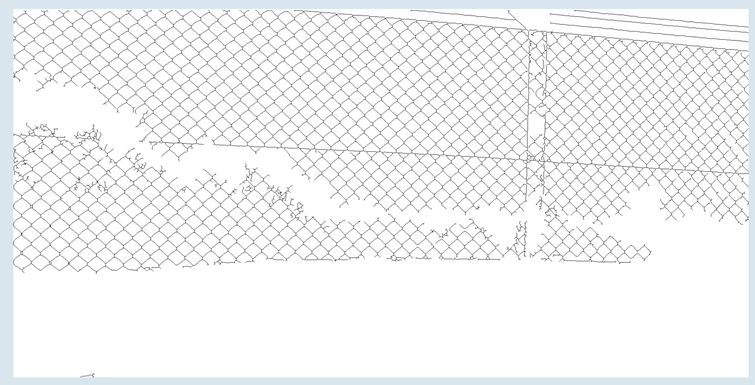
The image is segmented by Otsu threshold to separate the fence from background and to extract a black and white image. The image still contains some noise as indicated in the output to the right.

5. Noise removal

Morphological operations remove the noise. Structures are skeletonized and dots smaller than 10 pixels are removed. Remaining structures are dilated to connect and than skeletonized. Structures smaller than 1000 pixels are removed and leaving only the fence. [3]

Results





REFERENCE LIST

[1] Drone in front of fence, courtesy of Energi Fyn.
[3] R. Hettiarachchi, J. Peters, and N. Bruce. 2014. Fence-like Quasi-periodic Texture Detection in Images. *Theory and Applications of Mathematics & Computer Science* 4(2), 123–139.
[2] P. Soille. 2013. *Morphological Image Analysis: Principles and Applications*. Springer Berlin Heidelberg.