IM520/MC505 Computer Vision
Term Report

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Abstract

This document is adapted from the HgbTermReport template and based on the hgbreport LaTeX class, which is part of the HagenbergThesis document package. See https://github.com/Digital-Media/HagenbergThesis for the most recent version and additional materials (tutorial, manual etc.). Use this *Abstract* to provide a short summary of the contents in the remaining parts of the document. Note that it may be easier to place the individual chapters ("assignments") in separate files and include them using \include{..}.

Contents

Assignment 1

Circle detection in binary dot images

1.1 Introduction

The goal of this exercises was to find a points which could form a circle in a black-white image, consisting of random-noise. While the definition of the problem might not sound serious, research for possible solutions carried out.[2] proposes Harmony Search, an optimization method inspired by music.In [1] authors propose randomized algorithm, incorporating also edge detection.

1.2 Approach

To describe approach which was used to solve the problem, firstly some notation should be stated. A point in a 2 dimensional space is defined as follows:

$$p_i = (u_i, k_i)$$

where ıis an index of i-th point Equation of a circle is defined as follows:

$$(x - x_i)^2 + (y - y_i)^2 = r^2$$

where ıis an index of i-th point

The algorithm is based on collecting all of the points (that is to say, checking which pixel of an image is black, when we operate on white background or white, when the colors are reversed). In the next step random sample of three points is performed. Having three points selected, it is possible to obtain circle equation. Basing on [4] and high school mathematics materials available in the internet, such as [3], following equations are obtained:

$$x_i = \frac{(x_1^2 + y_1^2)(y_2 - y_3) + (x_2^2 + y_2^2)(y_3 - y_1) + (x_3^2 + y_3^2)(y_1 - y_2)}{2(x_1(y_2 - y_3) - y_1(x_2 - x_3) + x_2 y_3 - x_3 y_2)}$$

$$y_i = \frac{(x_1^2 + y_1^2)(x_3 - x_2) + (x_2^2 + y_2^2)(x_1 - x_3) + (x_3^2 + y_3^2)(x_2 - x_1)}{2(x_1(y_2 - y_3) - y_1(x_2 - x_3) + x_2 y_3 - x_3 y_2)}$$

$$r = \sqrt{(x - x_i)^2 + (y - y_i)^2)}$$

In every iteration of the algorithm basing on sampled points a circle equation is estimated. In further step it is verified how many points lay near formed circle. Some treshold must be put to measure closeness to the obtained circle. For this purpose following equation was used:

$$|(x - x_i)^2 + (y - y_i)^2 - r^2| \leq 0.5$$

Formula above describes how far the point could lay from the obtained circle, regardless of direction (inside or outside the circle) to be considered.

Algorithm 1.1: Algorithm pseudocode

```
Result: Best parameters for circle
Set following variables:
    $max\_number\_of\_points\_near\_circle = 0$
    $best\_radius = 0$
    $best\_x = 0$
    $best\_y = 0$
for $i \leftarrow 0$ to $number\_of\_iterations$ do
    Randomly sample three points
    $number\_of\_points\_close\_to\_circle = 0$
    if if not collinear then
        Calculate circle equation
        foreach point in points do
            if if not collinear then
                $number\_of\_points\_close\_to\_circle + +$
        end
end
```

1.3 Research question B

Summary

Finally, summarize what has been accomplished in this semester and what not. Point out topics that were instructive, confusing, too hard, too easy etc. Perhaps you even found problems that you would like to explore deeper (e.g., in a project).

References

[1] Yazan Alomari, Siti Norul Huda Sheikh Abdullah, and Khairuddin Omar. “Randomized Circle Detection Performance Based on Image Difficulty Levels and Edge Filters”. In: *FIRA RoboWorld Congress*. Springer. 2013, pp. 361–374 (cit. on p. 3).

[2] Jaco Fourie. “Robust circle detection using Harmony Search”. *Journal of Optimization* 2017 (2017) (cit. on p. 3).

[3] Robert Eisele. *Create a circle out of three points*. URL: https://www.xarg.org/2018/02/create-a-circle-out-of-three-points/ (cit. on p. 3).

[4] Wikipedia contributors. *Ellipse— Wikipedia, The Free Encyclopedia*. [Online; accessed 22-July-2004]. URL: https://en.wikipedia.org/wiki/Ellipse#Circles (cit. on p. 3).