Software Requirements Specification for : Image Features Detection System

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Contents

Revision History

Date	Version	Notes
February 5	1.0	The first version

1 Reference Material

Richard Szeliski, Computer Vision – Algorithms and Applications(Second Edition), Springer, ISSN: 1868-0941, 2017
Wesley E. Snyder, Hairong Qi, Fundamentals of Computer Vision, Cambridge University Press, ISBN: 978-1-107-18488-6, 2017
E.R. Davies, Computer Vision-Principles, Algorithms, Applications, Learning(Fifth Edition), Elsevier, ISBN: 978-0-12-809284-2, 2018
Lowe, David G. Object recognition from local scale-invariant features. Proceedings of the seventh IEEE international conference on computer vision. Vol. 2. Ieee, 1999.

1.1 Abbreviations and Acronyms

The table that follows summarizes the Abbreviations and Acronyms used in this document. They were made to be consistent with the image processing and with existing documentation for Computer vision in OpenCV.

symbol	**description**
I(x)	Image I(x)
G(x)	Gaussian Transform or Guassian Filtering
L(x)	Laplacian Transform
DoG	Differential of Gaussian Transform of
LoG	Laplacian Transform of Gaussian Transform of
SIFT	Scale Invariant Feature Transform
R	Requirement
SRS	Software Requirements Specification

2 Introduction

Image features play a very foundational role in the area of image processing or, in another words,computer vision. Especially, When we decide to try 3d image reconstruction or 2d image stitching.
Some image features can be detected by specific image process algorithms, and these features can be used for distinguishing whether they are suitable for further processing visually.
So, we aim to develop a software system for image features detection to facilitate this step.

2.1 Purpose of Document

This document of SRS is for communication between developers, and it can also be used as a record for the development of this image features detection system.

2.2 Scope of Requirements

In this system, the images used for inputs should be RGB images with the format constrained as JPEG,PNG,BMP,TIFF.
And We assume that these picture are captured by the same device such as cameras or smartphones, which means they are with the same intrinsic parameter.
Meanwhile, in this system, we ignore the lens distortion, which means we assume the camera calibration has been performed during the step of capturing images.
As this system is planned to be used a preliminary step before we do 3d image reconstruction and 2d image stitching. we assume there are overlapping areas between the two images we mean to use as input images.
Finally, this software system will be run on MacOs or Windows OS.

2.3 Characteristics of Intended Reader

This document will be read by the team of developer of this image features detection system. They should already have understood the basic principles of software development and computer vision.

2.4 Organization of Document

The document of this system consists system introduction, general system description, inputs and outputs, constraints and assumptions, Models and Algorithms, Hardware and Software, References.

3 General System Description

This system will use two different images as the inputs. these two images should be used to do 3d image reconstruction or 2d image stitching after they are checked with this system. In this system, there will be several buttons which indicate the function they will perform. These function buttons are "Import","Grey","Edge", "Contour", "Corner", "Gradient", "SIFT". Their actual functions can be seen from their names. "Import" means importing these two images. "Grey" means transforming RGB images into Grey images. "Edge" means detecting the edge features, and so do the "Contour","Corner","Gradient" and "SIFT" buttons.

3.1 System Context

We can see the user interface of this system from the figure bellow. This interface showed those basic functions of this system context.

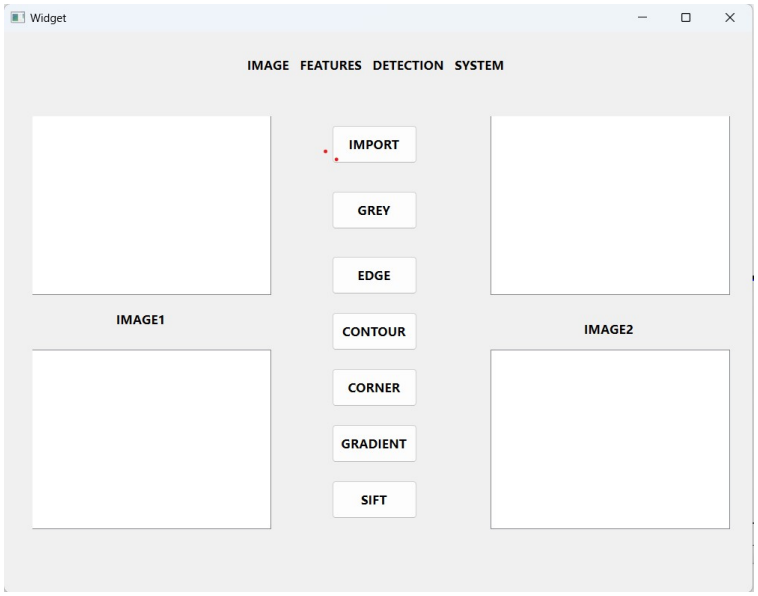

Figure 1: System Context

- User Responsibilities:
  - Develop the software as required in this document.
  - Keep adding any changes in future to make this document more detaied to the real development process.
- Responsibilities:

- This system will detect image features and display them for researchers or student who need to do 3d reconstruction or 2d image stitching to have a preliminary check on image features before they use these images.
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3.2 User Characteristics

Users of this system should understand these image features very well and they can judge the adaptability of these images to be used to do 3d reconstruction or 2d image stitching.

3.3 System Constraints

This system can only be run on MacOS and Windows.

4 Specific System Description

This system choose gradients of these images as the basic indicator. and further more, we will use Gaussian and Convolution to do image smoothing. These algorithms have been recognized as the most feasible methods to detect image features.

4.1 Problem Description

This system is intended to make it easier to find whether it is feasible to do 3d reconstruction or 2d image stitching with two different images.

4.1.1 Goal Statements

The goal of this system is to display the image features on the UI screen to make these feature visible to distinguish them.

4.1.2 Assumptions

These images should be RGB image with the formats as JPEG,PNG,BMP or TIFF.

4.1.3 Theoretical Models

There we will use the gradients of an image as the fundamental indicator to do further processing.

RefName: **Gradients Calculation**

Label: Gradients Calculation

Equation:

$$J(x) = \nabla I(x) = \left(\frac{\partial I}{\partial x}, \frac{\partial I}{\partial y}\right)(x),$$

Description: Here,

$$J(x)$$

stands for the gradients,

$$\nabla I(x)$$

stands for the operation to calculate gradients of image I(x).

RefName: **Image smoothing and convolution**

Label: Image smoothing and convolution

Equation:

$$J\sigma(x) = \nabla[G\sigma(x) * I(i)] = [\nabla G\sigma](x) * I(i)$$

Description: Here,

$$J\sigma(x)$$

stands for the filtered gradients,

$$\sigma(x) * I(i)$$

stands for the operation to Gaussian transform or filtering of image

$$I(i)$$

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RefName: **Laplacian Transform of Gaussian Kernel**

Label: Laplacian Transform of Gaussian Kernel

Equation:

$$\nabla^2 G_\sigma(x) = \left(\frac{x^2 + y^2}{\sigma^4} - \frac{2}{\sigma^2} \right) G_\sigma(x)$$

Description: Here,

$$\nabla^2$$

stands for the Laplacian operation,

$$G\sigma(x)$$

stands for the Gaussian kernel.

5 Requirements

These models used to detect image features are all based the prerequisites that all the input images have been transformed into grey images from RGB images. This means that all these image can be seen as matrices so that we can do apply these models into them for do the detection operations.

6 Likely Changes

LC1: We may change the image detection algorithms depending on the current proceedings of computer vision research. If one method has been proved in the state of art, we may apply it into our detection model.

7 Unlikely Changes

LC2: The methods of calculate the gradients of these images will not likely be changed in future.

8 Development Plan

We will firstly develop the module to calculate the gradients of images.
Then, will will develop the module of Edge, Contour, Corner points feature detection.
Thirdly, We will develop the module to do SIFT detection.
And then, We will create the UI interface of this software system, and integrate all the detection modules into the whole system. Finally, we will do the verification and validation.

References

Richard Szeliski, Computer Vision – Algorithms and Applications(Second Edition), Springer, ISSN: 1868-0941, 2017

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