[WORKING TITLE] Improved Perception-Driven Semi-Structured Image Vectorization via a Machine-Learning-Based Approach

A Special Problem by

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This special problem, entitled "[**WORKING TITLE**] **IMPROVED PERCEPTION-DRIVEN SEMI-STRUCTURED IMAGE VECTORIZATION VIA A MACHINE-LEARNING-BASED APPROACH**", prepared and submitted by **SEAN FRANCIS N. BALLAIS**, in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN COMPUTER SCIENCE** is hereby accepted.

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Abstract

Although the abstract is the first thing that appears in the thesis, it is best written last after you have written your conclusion. It should contain spell out your thesis problem and describe your solution clearly.

Make sure your abstract fits in one page !

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Chapter 1

Introduction

In computer graphics, most images are typically stored as a sequence of dots in a rectangular grid (see Fig. 1.1). Each dot is called a pixel, a small part of an image that holds one specific colour, Photographs, also called natural images[7], are one of, if not the most, common images that are stored in this manner. Many digital forms of art or any graphics work, such as paintings, posters, and icons, are also stored the same. Digital images stored in this manner are called *raster images*. These images are stored in various image formats. The most commonly used formats are JPEG, GIF, BMP, TIFF, and PNG. Each have their pros and cons, from quality of the resulting image to the file size. Nevertheless, they all still accomplish the task of holding raster image data. Everything you see in the displays of devices such as laptops and mobile devices is a raster image. Computer displays are collections of pixels, in the common definition of a dot on the screen, which computers map images to to be able display them. This is the reason why **all** *displayed* images are raster images.

A positive aspect of raster images is their simplicity. As mentioned earlier, raster images consists of a grid of pixels (also called a pixel matrix in other literature [12]). This pixel grid can simply be assigned a combination of colour values to create an

Figure 1.1: When zoomed in enough, each individual pixel of a raster image is visible. Meme image obtained from `http://thesismemes.tumblr.com/post/73483120281`
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image. As such, working with raster images can be analogous to painting in the real world [3]. Given the right combinations of colours, we can produce natural images, i.e. photographs [7]. Intuitively, this means that we can store fine details in a raster image [10]. This is in contrast to *vector images*, which use a series of points and mathematical calculations to form lines and shapes. Vector images are unable to display lush colour depth and keep granularity, as found in raster images, as they use solid colours or gradients [3][4]. There are studies that have been conducted in improving and utilizing *gradient meshes*, a vector graphics primitive that allows for intricate colour gradients in regular quadrilateral meshes first introduced by Adobe Illustrator, to produce photorealistic vector images. However, as noted in the paper by Jian, S, Liang, L., Wen, F., and Shum, H., simple gradient meshes are insufficient to keep the fine details of images [5][10]. It is also important to mention that vector graphics, despite represented as mathematical calculations, are still converted to raster format in a process called *rasterization* for it to be displayed on-screen, since many modern screens are raster displays [11].

1.1 The Problems of Raster Graphics

With all the pros raster graphics have, it does not mean raster graphics are not without their caveats. Raster graphics have their own disadvantages which could affect the image quality and their use.

Raster graphics are **resolution-dependent**. This simply means that raster images are in their highest quality in the resolution they are initially created in and attempting to scale it up will gradually degrade the quality of the image as the image size or resolution grows larger. Rasters only have a finite number of pixels. Increasing the size of an image (also called upsampling [7]) would entail moving the individual pixels into different locations depending on the scaling factor, the distance the individual pixels will be moved to horizontally and vertically. Upsampling will create empty pixels in between the shifted pixels when there is nothing done to substitute the empty pixels. This will create an unusable image [6]. We can utilize interpolation to fill these empty pixels with colour. The approximate colour and intensity values of these empty pixels are calculated based on the values of surrounding pixels, typically the shifted pixels. However, the specifics are dependent on the interpolation algorithm used in upscaling the images. Commonly used interpolation methods for resizing images include Nearest-Neighbour, Linear Interpolation, and Cubic Interpolation [9], which most, if not all, are readily available in popular image editing applications, such as Adobe Photoshop [2] and GIMP [1]. But, the results produced by these interpolation algorithms typically suffer from blurring of sharp edges and ringing artifacts due to the fact that the algorithms do not assume anything about the data [8]. Talk about the non-classical interpolation and AI Gigapixel.

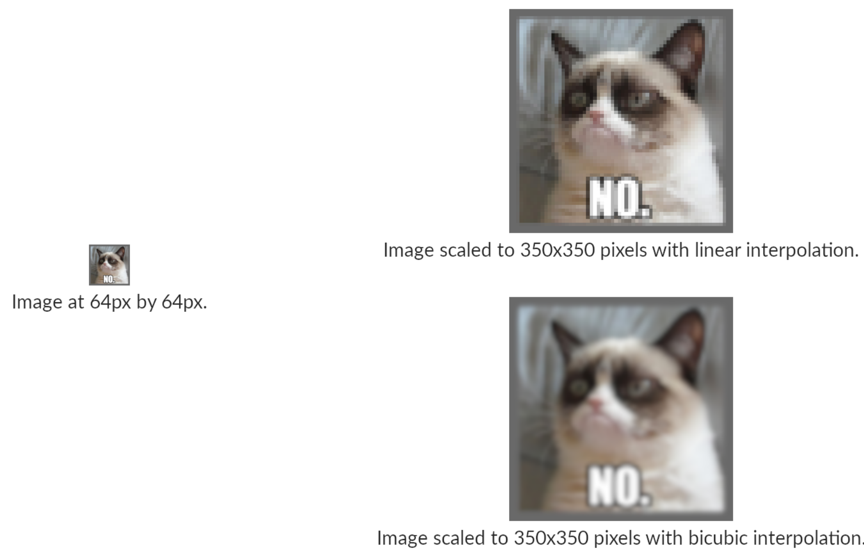

Figure 1.2: Different interpolation algorithms will produce different results. As seen in the image, the quality will also differ, from an image looking blocky to an image looking blurry. Cat meme image obtained from `https://www.hercampus.com/school/uwindsor/school-thoughts-told-grumpy-cat-memes`

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Chapter 2

Review of Related Literature

2.1 Background Information (optional)

A brief section giving background information may be necessary, especially if your work spans two or more traditional fields. That means that your readers may not have any experience with some of the material needed to follow your thesis, so you need to give it to them. A different title than that given above is usually better; e.g., "A Brief Review of Frammis Algebra" [**?**].

2.2 Review of the State of the Art

Here you review the state of the art relevant to your thesis. Again, a different title is probably appropriate; e.g., "State of the Art in Zylon Algorithms." The idea is to present (critical analysis comes a little bit later) the major ideas in the state of the art right up to, but **not including**, your own personal brilliant ideas.

You organize this section by idea, and not by author or by publication. For example if there have been three important main approaches to Zylon Algorithms to date, you might organize subsections around these three approaches, if necessary:

- Iterative Approximation of Zylons

- Statistical Weighting of Zylons

- Graph-Theoretic Approaches to Zylon Manipulation

Chapter 3

Research Question or Problem Statement

Engineering theses tend to refer to a "problem" to be solved where other disciplines talk in terms of a "question" to be answered. In either case, this section has three main parts:

1. a concise statement of the question that your thesis tackles
2. justification, by direct reference to Chapter 1, that your question is previously unanswered
3. discussion of why it is worthwhile to answer this question.

Item 2 above is where you analyze the information which you presented in Chapter 3. For example, maybe your problem is to "develop a Zylon algorithm capable of handling very large scale problems in reasonable time" (you would further describe what you mean by "large scale" and "reasonable time" in the problem statement). Now in your analysis of the state of the art you would show how each class of current approaches fails (i.e. can handle only small problems, or takes too much time). In the last part of this section you would explain why having a large-scale fast Zylon algorithm is useful; e.g., by describing applications where it can be used.

Since this is one of the sections that the readers are definitely looking for, highlight it by using the word “problem” or “question” in the title: e.g. “Research Question” or “Problem Statement”, or maybe something more specific such as “The Large-Scale Zylon Algorithm Problem.”

Chapter 4

Objectives

This part of the manuscript aims identify the specific objectives that your thesis aims to meet. These objectives must be in alignment with the problem identified in chapter 3.

Chapter 5

Describing How You Solved the Problem or Answered the Question

This part of the thesis is much more free-form. It may have one or several sections and subsections. But it all has only one purpose: to convince the examiners that you answered the question or solved the problem that you set for yourself in Chapter 3. So show what you did that is relevant to answering the question or solving the problem: if there were blind alleys and dead ends, do not include these, unless specifically relevant to the demonstration that you answered the thesis question.

Chapter 6

Describing How You Validated Your Approach.

Chapter 7

Stating Your Results and Drawing Insights From Them.

Chapter 8

Summarizing Your Thesis and Drawing Your Conclusions.

Appendix A

What should be in the Appendix

What goes in the appendices? Any material which impedes the smooth development of your presentation, but which is important to justify the results of a thesis. Generally it is material that is of too nitty-gritty a level of detail for inclusion in the main body of the thesis, but which should be available for perusal by the examiners to convince them sufficiently. Examples include program listings, immense tables of data, lengthy mathematical proofs or derivations, etc.

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