[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

Many images in typical use, from photographs to pixel art, are composed of pixels. Each pixel in an image contains a value that represents the colour it displays. These images are called, *raster images*. This type of image are ideal when creating images that are rich and detailed. However, raster images suffer from their inability to scale well. Scaling raster images will output grainy and distorted results, sometimes even blurry ones[2]. *Vector graphics* are an alternative to raster graphics, being resolution-independent and based on objects (often called *primitives*) and mathematical statements[3][1]. As a result, vector graphics generally tend to be easier to manipulate[3].

Semi-structured images can benefit from vectorization. As defined by Hoshyari, S., et.al., these images "consists of distinctly coloured regions with piecewise continuous boundaries and visually pronounced corners". Frequently, many digital artworks, specifically computer icons, comic book imagery, and simple graphic illustrations, are considered to be semi-structured images. Many legacy semi-structured images, typically those considered to be icons and clip arts, are stored in raster formats[4]. Additionally, in manual vectorization of images, artists often have to hand-trace each stroke and region using specialized software, such as Inkscape or Adobe Illustrator, which is a labourious task[5]. Automatic vectorization tools, such as Adobe Live Trace and Potrace, often demand more time rectifying the numerous tracing errors the tool produces by hand[5], and does not always produce results aligned with human perception[4]. Most vectorization algorithms are geared towards natural images (i.e. photographs) which frequently produce results not aligned with human expectations on artist-drawn imagery[4]. These cases call for a robust vectorization algorithm for semi-structured images that produces outputs that primarily align well with human-perceived results As noted by Hoshyari, S., et. al., human observers have a clearer mental image of the expected vector result from a raster semi-structured data. As such, vectorization results of semi-structured images require to be as close as possible to the mental image produced by humans[4].

Due to the fact that semi-structured images consists of distinct regions based on colour, the general flow of vectorizing semi-structured images can simply be boiled down into extracting those distinct regions and their boundaries, performing vectorization on those boundaries and appropriately colouring them, and combining the resulting vectors into a single vector object. The major technical challenge for this is vectorizing the region boundaries via piecewise free-form vector curves[4]. The most recent work on this topic is that of Hoshyari, S., et. al. Their work revolves primarily on accuracy and two key principles of Gestalt psychology: *simplicity*, and *continuity*. Simplicity simply states that human observers prefer simpler interpretations of geometric interpretations of raster images. Continuity states that human observers have a tendency to group stimuli into one continuous curves and patterns. Jagged raster boundaries are perceived to be piecewise smooth curves in their vector forms. In addition, observers would only mentally segment boundaries at a small set of discontinuous corners. Their work, however, becomes computationally expensive on larger inputs. Despite utilizing a corner classifier developed via machine learning as part of their vectorization, their classifier still produces results that require them to have an additional processing step, called *corner removal*, to produce better results.

I propose a method that is an improvement of the work done by Hoshyari, S. et. al. by improving the corner classifier in an attempt to render the corner removal step unnecessary, and utilizing machine learning to automatically draw the appropriate vector curves and lines, without relying on greedily computing and fitting the appropriate curves on the region boundaries. The latter, of which, is the method utilized in the framework devised by Hoshyari, S., et. al., which, as stated earlier, is computationally expensive at higher image resolutions.

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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