

A COMPARATIVE ANALYSIS OF TEXTURE ANALYSIS METHODS ON ANT IMAGES

A Thesis Presented to
The Faculty of the Computer Science Department

by

Noah Gardner

In Partial Fulfillment
of Requirements for the Degree
Master of Science in Computer Science

Kennesaw State University

May 2022

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ABSTRACT

There is a large variety of ant species, and most species are diverse in terms of size, shape, behaviors, and especially skin (cuticle) textures. However, the significance of ant cuticle texture is not widely researched. This research employs modern machine learning methods such as texture analysis and classification with CNN and clustering to automatically group similar ant species to allow for the study of influences cuticle texture on ant ecology.

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Never fail to have this attitude of mind, go forward without hurry, learn the essence of things through frequent experiences, taking advantage of every occasion. Fight against all kinds of people and be aware of their mind. Follow a road that is a thousand leagues long one step at a time. Be without haste and be convinced that all these practices are the duty of a bushi. Be victorious today over what you were yesterday; tomorrow be victorious over your clumsiness and then also over your skill. Practice in accordance with what I have written without letting your mind deviate from the way.

Miyamoto Musashi ¹

¹Miyamoto Musashi, The Book of Five Rings

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It is a bit cliché for an author to thank their family. Nevertheless, I would have given up a long time ago without the support of my family. So, I would like to thank my loving family for their support throughout the completion of my graduate degree. I would also like to thank Dr. Chih-Cheng Hung for his mentorship for my thesis and for his guidance in my other research projects. Finally, I would like to thank Dr. Zhiling Long for his insights for machine learning and texture analysis.

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CHAPTER 1 - INTRODUCTION AND BACKGROUND

Introduction

Texture is an important feature in many applications, such as image processing, pattern recognition, and computer vision. Analysis of textures can be broken into three main categories: texture classification, texture segmentation, and texture synthesis [1]. The process of classifying a texture into a set of categories and relies on three different approaches. In this paper, we focus on a *model-based approach* which attempts to extract parameters to reveal common patterns and use those parameters to automatically distinguish between different textures [2]. Although there is some work regarding grouping ants into categories of similar cuticle, automated classification has yet to become an active area of research. Due to the large number of different ant species, the classification of ants into categories of similar texture is difficult to accomplish manually. Texture analysis has shown promising results in related fields, such as plant identification [3]. With modern texture analysis methods, the classifications of ants can be automated and the results can be used to study the influence of cuticle texture on ant ecology.

Research Question

The overarching question that we wish to address by beginning this research is: *how does the texture of ant cuticle affect the ant ecology?* However, to even begin contemplating this questions requires a substantial amount of preliminary research. One point that is necessary to begin this research is to propose a method of group ants by texture. Additionally, due to the sheer number of ant species, an automated effort is necessary to group similar ant species. Therefore, we start our endeavor with a more straightforward research question: *are texture*

analysis methods able to group similar ant species? By the end of this research, we will answer this question by demonstrating a variety of texture analysis methods and comparing their results on a custom dataset.

Proposed Approach

In order to group similar ant species, we require mostly uniform images that depict the texture of the ant cuticle. We source our raw images from AntWeb [4], a database of ant head images. An example image is shown in Figure 1. In general, the ant head images are centered in the image, facing the front, and share a similar posture. However, some images may not be centered, show the ant head in a different orientation, or may have a drastically different resolution from the average image. The dataset shall be covered in more detail in the methodology section.

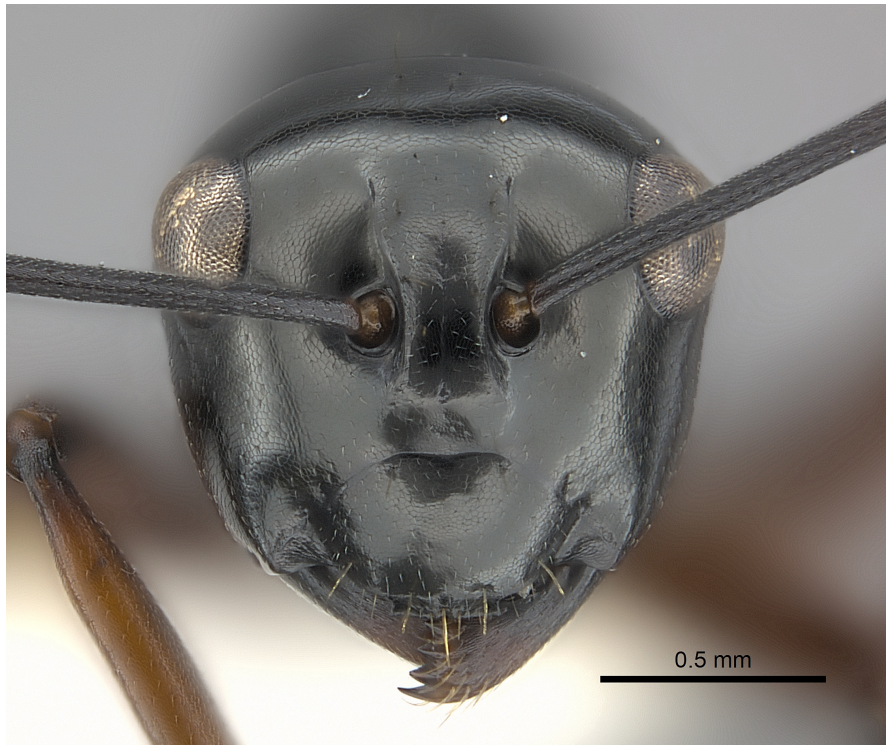


Figure 1: An example ant head image from AntWeb of species *Polyrhachis abbreviata* - specimen [CASENT0217419](#) by [Estella Ortega](#), from [AntWeb](#), is licensed under [CC BY 4.0](#).

Research Impact

The primary contribution of this research is the development of a unique dataset for ant cuticle texture classification.

CHAPTER 2 - LITERATURE REVIEW

CHAPTER 3 - METHODOLOGY

CHAPTER 4 - EXPERIMENTAL RESULTS AND ANALYSIS

CHAPTER 5 - CONCLUSION

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