Computer-Aided Visual Analysis of Feathers ICPR 2020 VAIB Workshop

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- Motivation
- Biological Background
- Related Work
- Method & Implementation
- Discussion & Conclusion



Motivation Understanding and Modeling the Shape of Feathers



Broggi et al. 2011



Vinther et al. 2009

Baron 2018



Biological Background What is a Feather?

- Shaft (blue)
- Vane
- Barb (yellow)
 - Ramus
 - Barbules





Nastase 2016

Related Work in Visual Computing and Ornithology



Baron 2019



Related Work in Visual Computing and Ornithology

Data Summary from Ornithological Studies					
Attribute	Feather Type(s)	Bird(s)	Value	Unit	Reference
Barb Angle	3 Primaries	60 Species	5-50	degrees	Feo, Field, & Prur
Barb Angle	Covert, Rectrex	Parrots	10-40	degrees	Feo & Prum [6]
Barb Length	3 Primaries	60 Species	10-60	mm	Feo, Field, & Prur
Barb Length	Covert, Rectrex	Parrots	5-25	mm	Feo & Prum [6]
Vane Width	Covert, Rectrex	Parrots	5-15	mm	Feo & Prum [6]
Barb Diameter	Contour	Ducks, Cormorants	56	μ m	Rijke [7]
Barb Spacing	Contour	Ducks, Cormorants	271	μ m	Rijke [7]
Barbule Angle	unknown	Hummingbirds	0-70	degrees	Greenewalt [8]
Barbule Length	unknown	Hummingbirds	100	mm	Greenewalt [8]
Barbule Diameter	unknown	Hummingbirds	15	mm	Greenewalt [8]
Penn. Barb Density	Contour	Tits	1.47	per mm	Broggi et al. [9]
Penn. Barbule Density	Contour	Tits	2.17	per 0.1mm	Broggi et al. [9]
Rachis Cross Section	2 Primaries	Common Buzzard	0.03-5.79 x 0.01-3.47	mm^4	Osvath et al. [10]
Rachis Cross Section	2 Primaries	White Stork	0.14-26.1 x 0.08-22.3	mm^4	Osvath et al. [10]
Rachis Cross Section	2 Primaries	House Sparrow	0.40-42.6 x 0.10-24.8	$\mu \mathrm{m}^4$	Osvath et al. [10]
Rachis Cross Section	2 Primaries	Pygmy Cormorant	5.00-55.0 x 4.00-55.8	$\mu\mathrm{m}^4$	Osvath et al. [10]



Methods & Implementation Visual Analysis for Feature Extraction

- The data & image segmentation
- FFT for barb density estimation
- Cross-correlation for barb tracing

Methods & Implementation

Step 1: Data Collection





Input Images and Metadata

Step 2: Image Analysis and Data Extraction







Image Segmentation



Landmarking

Higher-resolution and more images



Barb density estimation and new curve method



Methods & Implementation Visual Analysis for Feature Extraction



Watershed Segmentation



Outlines and Bounding Boxes





Methods & Implementation

 Cross-correlation for tracing barbs



Discussion & Conclusion Applications & Future Work

- ~2.0-2.5 barbs per mm
- Compares to Broggi et al. and manual counts





Discussion & Conclusion Applications & Future Work

- Future work
 - Extract and parameterize barb and shaft curves using the cross correlation.
 - Analyze more features such as barb angle, barbule density, barbule angle.





Thank you!

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