

# VISION BEYOND PIXELS

FOUNDATIONS OF IMAGE  
PROCESSING AND COMPUTER VISION



A PRACTICAL GUIDE FOR STUDENTS,  
ENGINEERS, AND RESEARCHERS

M. AKSHARA VIJAYAN, M.TECH (PH.D)  
A. MARRY JOSI CECILIAH, M.E (PH.D)

# Vision Beyond Pixels: Foundations of Image Processing and Computer Vision

**M Akshara Vijayan**

Department of Computer Science and Engineering &  
Researcher in Computer Vision

**A Marry Josi Ceciliyah**

Department of Computer Science and Engineering &  
Researcher in Computer Vision & Medical Imaging



**DeepScience**

*Published, marketed, and distributed by:*

Deep Science Publishing, 2025  
USA | UK | India | Turkey  
Reg. No. MH-33-0523625  
[www.deepscienceresearch.com](http://www.deepscienceresearch.com)  
[editor@deepscienceresearch.com](mailto:editor@deepscienceresearch.com)  
WhatsApp: +91 7977171947

ISBN: 978-93-7185-636-2

E-ISBN: 978-93-7185-395-8

<https://doi.org/10.70593/978-93-7185-395-8>

Copyright © M Akshara Vijayan, A Marry Josi Ceciliyah, 2025.

**Citation:** Vijayan, M. A., & Ceciliyah, A. M. J. (2025). *Vision Beyond Pixels: Foundations of Image Processing and Computer Vision*. Deep Science Publishing. <https://doi.org/10.70593/978-93-7185-395-8>

This book is published online under a fully open access program and is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0). This open access license allows third parties to copy and redistribute the material in any medium or format, provided that proper attribution is given to the author(s) and the published source. The publishers, authors, and editors are not responsible for errors or omissions, or for any consequences arising from the application of the information presented in this book, and make no warranty, express or implied, regarding the content of this publication. Although the publisher, authors, and editors have made every effort to ensure that the content is not misleading or false, they do not represent or warrant that the information-particularly regarding verification by third parties-has been verified. The publisher is neutral with regard to jurisdictional claims in published maps and institutional affiliations. The authors and publishers have made every effort to contact all copyright holders of the material reproduced in this publication and apologize to anyone we may have been unable to reach. If any copyright material has not been acknowledged, please write to us so we can correct it in a future reprint.

## *Dedication*



*To my grandmother, Jayalakshmi,*

*You were more than a grandmother—  
you were my mother, my guardian, my everything.*

*From the moment I was born, you held my hand,  
guiding me with your unconditional love, patience, and strength.*

*For 27 years, your arms were my home,  
your words were my wisdom,  
your prayers were my protection.*

*Losing you has left a silence in my heart that words cannot fill.*

*But through this book, a part of you lives on—  
because everything I am is shaped by you.*

*I miss you every single day,  
and this book is my way of saying:  
Thank you for raising me, loving me, and never letting go.  
I miss you deeply, and I carry you in every word I write.  
This is for you, Paati. Forever and always.*

## Acknowledgments

This book, *Vision Beyond Pixels: Foundations of Image Processing and Computer Vision*, would not have been possible without the invaluable support, guidance, and inspiration of many individuals.

First and foremost, I thank my husband **Mr. M. Vijayan** for their unwavering encouragement and patience during the writing and research process. Their belief in my goals kept me going through the long nights and early mornings.

To my PhD advisor **Mr.C. Chella swamy** and academic mentors, thank you for your insightful feedback and for nurturing my passion for computer vision and research. Your guidance has shaped my academic and professional journey.

To my students and colleagues at **St. Joseph's College of Engineering and Technology**, Thanjavur, your questions, enthusiasm, and collaboration provided both motivation and clarity throughout the book's development.

I am also deeply grateful to the developers and contributors behind open-source tools like OpenCV, PyTorch, and TensorFlow, without which the practical examples in this book would not have been possible.

A special thanks to **Josi ma**, for being a constant source of positivity and support during this journey and motivate me spark of inspiration ignited the idea of writing this book. Without you, this book would have never been written, thanks for giving birth to this book. This book carries a piece of your inspiration in every chapter.

I am also deeply grateful to my close friend **Jayashree** for her heartfelt support and being more than friend, for understanding without words, and for cheering me on, even in silence. Your presence means more than words can say.

Lastly, I acknowledge the researchers, engineers, and visionaries who continue to push the boundaries of computer vision and make this field as vibrant and impactful as it is today.

## Table of Content

Chapter no	Contents	Page no
1	Fundamentals of Image Processing and Visual Computing.....	1
2	Feature Extraction, Segmentation, and Morphology.....	26
3	Machine Learning and Deep Learning for Vision.....	51
4	Object Detection, Recognition, and 3D Vision.....	75
5	Applications, Tools, and Future Directions.....	98