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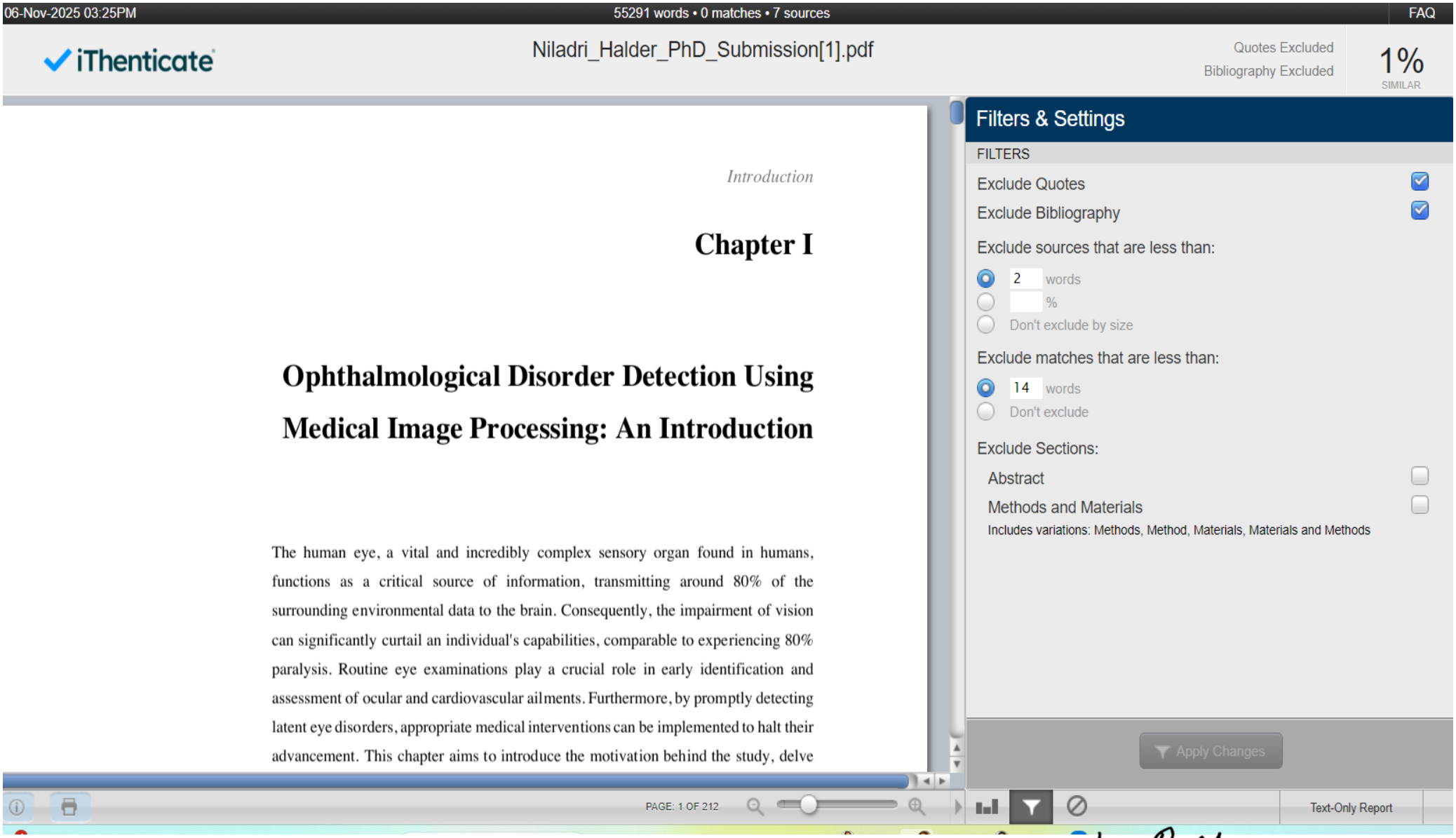

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Chapter I

Ophthalmological Disorder Detection Using Medical Image Processing: An Introduction

The human eye, a vital and incredibly complex sensory organ found in humans, functions as a critical source of information, transmitting around 80% of the surrounding environmental data to the brain. Consequently, the impairment of vision can significantly curtail an individual's capabilities, comparable to experiencing 80% paralysis. Routine eye examinations play a crucial role in early identification and assessment of ocular and cardiovascular ailments. Furthermore, by promptly detecting latent eye disorders, appropriate medical interventions can be implemented to halt their advancement. This chapter aims to introduce the motivation behind the study, delve into ophthalmic disorders and their effects on the human body, and tackle the challenges encountered in this field.

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Response to Reviewer 1's comments:

General Comments:

Comment 1:

Figure captions and table titles could be made more descriptive to help readers understand their context without referring back to the main text.

Response:

Thank you for the valuable feedback. All figure captions and table titles have been revised to be more descriptive, ensuring that readers can easily understand their context and relevance without referring back to the main text.

Fig. No.	Initial Caption	Final Caption
Fig. 2.1	Examples of retinal images from DRIMDB, showcasing (a-b) good-quality images and (c-e) bad-quality images [156].	Representative retinal images from the DRIMDB dataset illustrating variations in image quality: (a–b) depict clear, well-focused retinal images with good illumination and contrast, while (c–e) present poor-quality images affected by issues such as blurring, uneven lighting, or low contrast [156].
Fig. 3.1	Generalized block diagram of the proposed research	The diagram outlines the overall workflow comprising image acquisition, pre-processing, segmentation, detection of retinal features (OD/OC, blood vessels, hemorrhages, exudates, microaneurysms, venous beading, and neovascularization), followed by feature extraction and statistical validation using ground truth data.
Fig. 3.2	The result explains (a) the retinal gray image, and (b) it's histogram.	The result explains (a) a grayscale retinal fundus image and (b) its corresponding intensity histogram illustrating the distribution of pixel values across the image.
Fig. 3.3	The result shows (a) the histogram equalized image, and (b) it's histogram.	(a) Histogram-equalized retinal fundus image and (b) the corresponding histogram showing enhanced contrast with a more uniform distribution of pixel intensities.
Fig. 4.2	Detection of the optic disc from retinal fundus image and segmentation of optic disc from retinal fundus images.	Block diagram of the proposed method for optic disc detection and segmentation from retinal fundus images, incorporating red plane conversion, CLAHE-based image enhancement, region-based classification, and morphology-based segmentation operations.
Fig. 5.2	Proposed System Architecture of ASBV.	Proposed system architecture of the ASBV method, showing green component extraction, preprocessing, top-hat transform,

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		multilevel thresholding, and morphological operations for retinal vessel segmentation.
Fig. 6.1	PSO-HRVSO method of vessels segmentation	Proposed PSO-HRVSO method for retinal vessel segmentation, incorporating PSO-based enhancement, homomorphic filtering, optimized top-hat transform, and matched or median filtering for refined vessel extraction.
Fig. 9.1	Block diagram explaining the CDR Evaluation in Active-BDCLF.	Proposed Active-BDCLF framework for CDR evaluation, involving median filtering, CLAHE-based enhancement, region-based classification, and morphological segmentation of OD and OC regions.

Table No.	Initial Caption	Final Caption
Table 2.1	An evaluation table of existing methods for the detection and segmentation of the retinal optic disk's performance.	Comparative evaluation of existing methods for retinal optic disc detection and segmentation based on performance metrics.
Table 2.2	Evaluation of the Segmentation Performance of Retinal Vessels Using Matched Filter Techniques.	Quantitative Evaluation of Retinal Blood Vessel Segmentation Accuracy Using Various Matched Filter-Based Techniques, Highlighting Their Comparative Performance Across Key Image Quality Metrics.
Table 2.3	Evaluation of the Segmentation Performance of Retinal Vessels Using Region Growing Techniques.	Performance Evaluation of Retinal Vessel Segmentation Using Region Growing Techniques Based on Sensitivity, Specificity, and Accuracy Metrics.
Table 2.4	Evaluation of the Segmentation Performance of Retinal Vessels Using Multi-Scale Approaches.	Comparison of Retinal Vessel Segmentation Results Obtained from Different Multi-Scale Methods, Showing Key Performance Indicators to Assess Accuracy and Robustness.
Table 2.5	Evaluation of the Segmentation Performance of Retinal Vessels Using Active Contour Model-based Approaches.	Quantitative evaluation of retinal vessel segmentation performance obtained using various Active Contour Model–based approaches. The table compares key performance metrics—such as accuracy, sensitivity, specificity, and Dice coefficient—demonstrating the effectiveness of each method in accurately delineating retinal vasculature from fundus images

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Comment 2:

There are a few instances where sentences are overly long or repetitive. These could be revised for clarity and conciseness. Keeping paragraphs short and focused will make the thesis easier to read.

Response:

The sections containing lengthy or repetitive sentences have been carefully reviewed and revised to improve clarity and conciseness. Paragraphs have been reorganized to maintain focus and coherence, ensuring smoother readability throughout the thesis.

Comment 3:

The list of references is extensive but should be double-checked for accuracy and formatting consistency (for example, uniform use of initials, capitalization, and punctuation in author names and journal titles).

Response:

The entire list of references has been carefully reviewed and verified to ensure accuracy and uniformity. All entries have been checked for consistent use of author initials, capitalization, and punctuation in accordance with the required reference style. The following citation format has been uniformly applied throughout the thesis:

"Surname, Name., Title of the Journal, Journal Name, Volume No., Page No., Year."

Comment 4:

Some acronyms and abbreviations are introduced without definition at first mention. Defining them on first use (for e.g., "CLAHE – Contrast Limited Adaptive Histogram Equalization") would improve readability for non-specialist readers.

Response:

The acronyms and abbreviations have now been defined at their first occurrence throughout the thesis. For instance, terms such as CLAHE (Contrast Limited Adaptive Histogram Equalization) and other technical abbreviations are clearly introduced upon first use to enhance readability and ensure better understanding for non-specialist readers.

Comments:

Literature Search and Understanding of Prior Art:

Comment 5:

The review tends to list many references without always specifying what each author's key contribution or method was. For example, when comparing proposed methods with existing work (Tables 2.1-2.8, 4.1, 5.1, 6.3, etc.), the comparison is primarily by author name rather than by algorithmic approach.

Suggestion:

Including both the author and their associated technique or approach (e.g., "Author X – used neural network–based segmentation") would make the review more informative and analytical.

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Response:

The literature review and comparison sections have been revised to clearly highlight the specific contributions, methodologies, and distinctive features of each referenced work. In the updated version, the comparisons in Tables 2.1–2.8, 4.1, 5.1, and 6.3 now emphasize the underlying algorithmic approaches rather than merely citing the authors. This modification ensures that the reader can better understand how the proposed methods relate to, differ from, or improve upon existing techniques in terms of model design, feature extraction strategy, and performance outcomes.

For example, in Table 2.1, the entry previously written as "R. Rangayyan et al. [168]" has now been revised to "R. Rangayyan et al. – Gabor Filters and Phase Portrait Analysis [168]", explicitly indicating the technique used.

Comment 6:

The review is more descriptive than analytical. It lists what others have done but does not sufficiently synthesize this information to define the research gap that this thesis will address sharply.

Suggestion:

The literature section would benefit from a clearer summary of research gaps — identifying what has not yet been achieved and how this work addresses those gaps.

Response:

The review section has been revised to include a more analytical synthesis of the existing literature rather than merely describing previous studies. The updated version critically evaluates the methodologies, findings, and limitations of prior works, highlighting their interrelations and contrasting perspectives. Furthermore, the research gap has been explicitly defined at the conclusion of the chapter, emphasizing the specific limitations in current segmentation techniques that this thesis aims to address through the proposed Active Contour Model–based approach.

<u>Materials and Methods:</u>

Comment 7:

It would strengthen the work if there were a clearer justification for the selection of particular methods or parameters — in other words, why certain choices were made.

Response:

The justification for the selection of specific methods and parameters has now been clearly incorporated throughout Chapters 4 to 9. Each chapter provides a rationale for the methodological choices made, supported by theoretical considerations, literature references, and experimental evidence. These explanations collectively establish why the selected approaches and parameter settings were most appropriate for addressing the research objectives and improving retinal vessel segmentation performance.

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Comment 8:

A brief mention of any limitations or assumptions made during the process would also enhance transparency.

Response:

The limitations and assumptions related to the study have been discussed in detail in Chapter 10, within the Conclusion section, to ensure transparency and provide a comprehensive understanding of the research scope.

Results and Discussions:

Comment 9:

The thesis could more explicitly address why this research matters beyond technical accuracy.

For example, how might these findings influence early screening, accessibility of ophthalmic care, or reduce diagnostic burden in low-resource settings?

Suggestion:

Highlighting these broader outcomes would appeal to a multidisciplinary audience and underscore the social relevance of the work.

Response:

The significance and broader impact of this research have been clearly discussed in Chapter 1, Section 1.3 (Significance of the Study). This section highlights how the proposed work contributes not only to improving the technical accuracy of ophthalmological disorder detection but also to addressing real-world challenges such as early diagnosis, cost-effective screening, and accessibility of eye healthcare services. Hence, the relevance and importance of the research beyond its technical scope have already been incorporated in the thesis.

Conclusion:

Comment 10:

Including a short discussion of potential limitations or challenges (e.g., dataset variability, computational time) and recommendations for future work would demonstrate critical self-assessment and awareness of ongoing research possibilities.

Response:

A detailed discussion of the potential limitations and challenges associated with this research — including aspects such as dataset variability, limited availability of annotated medical images, and computational time requirements for model training and validation — has been incorporated in Chapter 10 (Conclusion and Future Work). This section outlines the possible constraints encountered during experimentation and provides directions for future studies to overcome these limitations.

Strength of the Research Narrative:

Comment 11:

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The work would benefit from a stronger narrative flow that clearly guides the reader through the research journey—from the problem statement through the methodological design to the implications of the findings. At times, the transitions between sections feel abrupt, with each chapter functioning somewhat independently.

Suggestion:

A more connected storyline or summary chapter tying together the results could improve cohesion and readability.

Response:

The strengths of this research have already been categorically highlighted. This type of study is highly essential for the advancement of medical science, as it supports the economic interpretation of medical data with improved efficiency and expertise.

Ethical and Societal Awareness:

Comment 12:

Since the work involves medical imagery, it would strengthen the thesis to include a brief discussion on ethics and data governance.

Suggestion:

Even when publicly available datasets are used, acknowledging patient privacy, consent, and responsible AI considerations shows awareness of the wider responsibilities that come with research in healthcare technology.

Response:

This type of research is vital for the economically disadvantaged groups in our society, offering medical solutions at a lower cost.

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