



UNDERGRADUATE THESIS

**A COMPARATIVE MULTI METHOD STUDY FOR
CARDIAC ULTRASOUND IMAGE
ENHANCEMENT USING RETINEX BASED**

TALITHA BERTHA ARVYANDITA
NPM 21081010253

THESIS ADVISOR

Dr. I Gede Susrama Mas Diyasa, S.T., M.T., IPU
Fetty Tri Anggraeny, S.Kom, M.Kom

**MINISTRY OF HIGHER EDUCATION, SCIENCE, AND TECHNOLOGY
UNIVERSITAS PEMBANGUNAN NASIONAL VETERAN JAWA TIMUR
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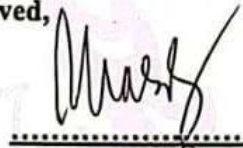
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By:
TALITHA BERTHA ARVYANDITA
NPM. 21081010253

Has been defended before, and accepted by, the Board of Assessors of the Thesis Examination of the Informatics Study Program, Faculty of Computer Science, Universitas Pembangunan Nasional Veteran Jawa Timur, on Juli 23, 2026:

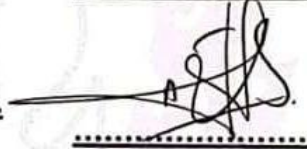
Approved,

I Gede Susrama Mas Diyasa, S.T., M.T.,
IPU
NIP. 19700619 2021211 009



(Advisor I)

Fetty Tri Anggraeny S.Kom., M.Kom.
NIP. 19820211 2021212 005



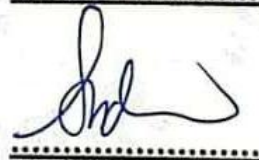
(Advisor II)

Dr. Faisal Muttaqin, S.Kom, M.T
NIP. 19851231 202121 1 009



(Assessor I)

Andreas Nugroho S., S.Kom., M.Kom.
NIP. 19900412 202406 1 003



(Assessor II)

Acknowledge by,

Dean of the Faculty of Computer Science



Prof. Dr. Ir. Novirina Hendrasarie, MT.
NIP. 19681126 199403 2 001

APPROVAL SHEET

A COMPARATIVE MULTI-METHOD STUDY FOR CARDIAC ULTRASOUND IMAGE ENHANCEMENT USING RETINEX BASED

By:
TALITHA BERTHA ARVYANDITA
NPM. 21081010253

Approved to proceed to the Thesis Examination

Approved by,

**Coordinator of Informatics Study Program
Faculty of Computer Science**



Intan Yuniar Purbasari, S.Kom. M.Sc
NIP. 19800602 202521 2 029

STATEMENT OF ORIGINALITY

I am the undersigned:

Student Name : Talitha Bertha Arvyandita
NPM : 21081010253
Degree Program : Bachelor (S1)
Study Program : Informatic
Faculty : Faculty of Computer Science

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Surabaya, Juli 23, 2026
The Declarant,



Talitha Bertha Arvyandita
NPM. 21081010253

ABSTRACT

Student Name / NPM : Talitha Bertha Arvyandita / 21081010253
Thesis Title : *A Multi-Method Comparative Study for Cardiac
Ultrasound Image Enhancement Using Retinex-
Based Methods*
Advisor : 1. Dr. I Gede Susrama Mas Diyasa, S.T., M.T., IPU
2. Fetty Tri Anggraeny, S.Kom, M.Kom.

Cardiovascular disease is the leading cause of death worldwide, making accurate diagnosis essential. Cardiac ultrasound (echocardiography) is a commonly used imaging modality, yet its images often suffer from low visual quality due to speckle noise, poor contrast, and uneven illumination. This study conducts a multi-method comparative analysis for cardiac ultrasound image enhancement using Retinex-based methods, namely Single Scale Retinex (SSR), Multi Scale Retinex (MSR), and Multi Scale Retinex with Color Restoration (MSRCR), combined with Bilateral Filter and Median Filter preprocessing, together with Contrast Limited Adaptive Histogram Equalization (CLAHE) as a non-Retinex comparison method. The cardiac ultrasound dataset was obtained from the Unity Public Portal, focusing on the parasternal long axis (PLAX) view. Six enhancement combinations (K1–K6) together with CLAHE were evaluated quantitatively using PSNR, SSIM, Entropy, and CII metrics. The results show that Retinex-based methods excel in Entropy (average 7.07) and CII (average 1.22), which are most relevant to the enhancement objective, whereas CLAHE excels in PSNR (24.32 dB) and SSIM (0.5383). Based on the aggregate score of the four metrics, stability, and the percentage of images with CII greater than 1, the K1 combination (Bilateral Filter + SSR) was determined to be the most optimal, achieving the lowest aggregate score (2.50), the highest Entropy (7.3040), and a CII > 1 percentage of 95.95%. This combination enhances contrast smoothly and evenly without introducing artifacts that interfere with clinical interpretation, making it the most suitable for cardiac ultrasound image enhancement.

Keywords: *cardiac ultrasound, echocardiography, image enhancement, Retinex, SSR, MSR, MSRCR, CLAHE.*

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Surabaya, 22 July 2026

The Author,

Talitha Bertha Arvyandita

NPM. 2108101025

TABLE OF CONTENTS

APPROVAL SHEET	i
APPROVAL SHEET	iii
STATEMENT OF ORIGINALITY	v
ABSTRACT	vii
ACKNOWLEDGEMENTS.....	ix
TABLE OF CONTENTS.....	xi
LIST OF TABLES	xiv
LIST OF FIGURES	xv
LIST OF PROGRAM CODE	xvi
CHAPTER I INTRODUCTION.....	1
1.1. Background	1
1.2. Problem Formulation.....	2
1.3. Research Objectives	3
1.4. Research Benefits.....	3
1.5. Problem Limitations.....	4
CHAPTER II LITERATURE REVIEW.....	5
2.1. Previous Research	5
2.2. Theoretical Foundation	8
2.2.1. The Heart	8
2.2.2. Cardiac Anatomy.....	9
2.2.3. The Cardiac Cycle	11
2.2.4. Ekokardiografi.....	13
2.2.5. Principles of Anatomy in Echocardiography.....	14
2.2.6. <i>Parasternal View</i>	15
2.2.7. <i>Apical View</i>	16

2.2.8.	<i>Image Enhancement</i>	17
2.2.9.	<i>Retinex Algorithm</i>	18
2.2.10.	<i>Single Scale Retinex (SSR)</i>	19
2.2.11.	<i>Multi Scale Retinex (MSR)</i>	20
2.2.12.	<i>Multi Scale Retinex with Color Restoration (MSRCR)</i>	21
2.2.13.	Manual Calculation of the Retinex Method.....	22
2.2.14.	Implementatiton on Grayscale Cardiac Ultrasound Images	24
CHAPTER III METHODOLOGY		26
3.1.	Problem Identification.....	27
3.2.	Literature Review.....	27
3.3.	Data Collection.....	27
3.4.	System Design	28
3.5.	System Development.....	30
3.6.	Test Scenario Design	32
3.7.	Image Quality Evaluation	36
3.8.	Manual Calculation	37
3.8.1.	Median Filter	38
3.8.2.	<i>Bilateral Filter</i>	38
3.9.3.	<i>Single Scale Retinex (SSR)</i>	39
3.8.4.	<i>Multi Scale Retinex (MSR)</i>	39
3.8.5.	<i>Multi Scale Retinex with Color Restoration (MSRCR)</i>	40
3.8.6.	<i>CLAHE</i>	40
3.8.7.	<i>PSNR</i>	41
3.8.8.	<i>SSIM</i>	41
3.8.9.	<i>Entropy</i>	42
3.8.10.	<i>CII</i>	42
BAB IV RESULT AND DISCUSSION <i>x·i·i</i>		43
4.1	Data Preprocessing	43

4.2. Image Enhancement Result (K1–K6 and CLAHE)	48
4.3. Quantitative Evaluation Result.....	49
4.4. Method Comparison Analysis	52
4.4.1. Effect of the Enhancement Method (<i>SSR</i> , <i>MSR</i> , and <i>MSRCR</i>).....	52
4.4.2. Effect of the Preprocessing Method (Bilateral vs Median).....	52
4.4.3. Retinex vs CLAHE	53
4.5. Determination of the Optimal Combination.....	54
4.5.1. Recommendations	55
4.5.2. Development Suggestions.....	55
4.6. Key Program Code Impementation	56
4.6.1 <i>Median Filter</i> (Manual Fallback Implementation).....	56
4.6.2. <i>Bilateral Filter</i> (Approximation Implementation)	56
4.6.3. <i>Single Scale Retinex (SSR)</i>	57
4.6.4. <i>Multi Scale Retinex (MSR)</i>	57
4.6.5. <i>Multi Scale Retinex with Color Restoration (MSRCR)</i>	58
4.6.6. <i>CLAHE</i> (Comparison Method).....	59
4.6.7. Quantitative Evaluation Metrics.....	59
CHAPTER V CONCLUSION.....	61
5.1 Conlusion	61
5.2 Suggestions.....	62
REFERENCES.....	64

LIST OF TABLES

Tabel 2. 1 illumination and Reflectance Calculation Result for Each Scale .	23
Table 3.1 System Development.....	29
Table 3.2 Test Scenario Design.....	32
Table 3.3 Manual Calculation of The <i>Median Filter</i>	37
Table 3.4 Manual Calculation of The <i>Bilateral Filter</i>.....	37
Table 3.5 Manual Calculation of <i>Single Scale Retinex (SSR)</i>	38
Table 3.6 Manual Calculation of <i>Multi Scale Retinex (MSR)</i>	38
Table 3.7 Manual Calculation of <i>CLAHE</i>.....	39
Table 3.8 Manual Calculation of <i>SSIM</i>.....	40
Table 3.9 Manual Calculation of <i>Entropy</i>.....	41
Table 4. 1 Median Filtering Result on Cardiac Ultrasound.....	44
Tabel 4.2 Bilateral Filtering Result on Cardiac Ultrasound.....	46
Table 4.3 Summary of Quantitative Evaluation Combination	49
Table 4. 4 Effect of the Enhancement Method on Image Quality	52
Table 4.5 Effect of thw Preprocessing Method on Image Quality	53
Tabel 4.6 Agregat Comparison Retinex vs CLAHE.....	53
Table 4. 7 Summary of Criteria for Determining the Optimal Combination	54

LIST OF FIGURES

Figure 2. 1 Position of the Heart and Lungs within the Human Body	10
Figure 2. 2 Internal Anatomy of the Human Heart	11
Figure 2. 3 The Cardiac Cycle	12
Figure 2. 4 Cardiac States (a) Diastole (b) Systole	13
Figure 2. 5 Parasternal Long Axis	16
Figure 3. 1 Research Flowchart	26
Figure 3.2 Public Cardiac Ultrasound <i>PLAX</i> View Dataset	27
Figure 3.3 System Architecture Diagram	28
Figure 4.1 K1-K6 and <i>CLAHE</i> Enhancement Result on a Sample Image.....	47
Figure 4.2 K1-K6 and <i>CLAHE</i> Enhancement Result on a Second Sample Image.....	47
Figure 4.3 Comparison of Average PNSR, SSIM, Entropy, and CII Values between Combination	50
Figure 4.4 Radar Chart of the Performance Profile of Combinations K1–K6 and <i>CLAHE</i>	51
Figure 4.5 Box Plot of the Distribution of Evaluation Metric Values across All Test Images	51
Figure 4.6 Average Combined Metric Score Combination.....	54

LIST OF PROGRAM CODE

Code 4.1 Manual Median Filter Function (fase2_preprocessing.py)	55
Code 4.2 Bilateral Filter Approximation Function (fase2_preprocessing.py)	56
Code 4.3 apply_ssr() Function (fase3_enhancement.py)	56
Code 4.4 apply_msr() Function (fase3_enhancement.py)	57
Code 4.5 apply_msrr() Function (fase3_enhancement.py)	58
Code 4.6 apply_clahe() Function (fase3_enhancement.py)	58
Code 4.7 compute_psnr() Function (fase4_evaluasi.py)	59
Code 4.8 compute_entropy() Function (fase4_evaluasi.py)	59
Code 4.9 compute_cii() Function (fase4_evaluasi.py)	59