

**RESTORATION OF IMAGE BY THE CONJUGATE GRADIENT  
METHOD USING MATLAB APPS DESIGNER**

**MUHAMMAD AZHAN HILMI BIN KHAIROL AMALI**

**Thesis Submitted in Fulfilment of the Requirement for  
Bachelor of Science (Hons.) Mathematical Modelling and Analytics  
College of Computing, Informatics and Mathematics  
Universiti Teknologi MARA**

**August 2023**

## ABSTRACT

The Conjugate Gradient (CG) Method is a well-known iterative method for solving unconstrained optimization problems. Image restoration is among the most challenging problems and it is one of the unconstrained optimization problems. The most challenging process in image restoration is restoring an image affected by impulse noise. The impulse noise has two types: salt and pepper noise and random valued impulse noise. Solving the image processing problem using the CG method manually is tedious since it involves many iterative calculations. Hence, the main objective is to review the CG method development applied to image processing problems and to develop GUI MATLAB for image restoration using the CG method. The term "GUI" refers to the graphically represented user interface for computer operations, which serves as the channel for communication between the computer and its users. Using GUI MATLAB, users no longer need to use the combination of function and coding to perform image restoration. The GUI MATLAB facilitates the user by creating buttons and several callback functions. It was more convenient this way. In this research report, there are 42 lists of formulas in the standalone application GUI MATLAB. During the experiment, four lists of CG methods will be used for this research: HS, FR, PRP+ and WYL. The image that will be used is Lena, Man and Circle. Besides, the noise degrees 0.35, 0.45, 0.55 and 0.75 will be used in applying GUI MATLAB. In order to test the GUI, the result will be compared to the result from the paper by Ma et al., (2022) for FR, PRP+ and WYL.

## **ACKNOWLEDGEMENT**

In the name of Allah, the most compassionate and merciful, I am grateful to Allah for providing me with the opportunity and making it easier to complete this final-year project. All praise be to Allah.

First, I would like to thank my supervisor, Madam Nur Idalisa binti Norddin. I have been extremely lucky to have the opportunity to work with such a knowledgeable, inspiring and supportive researcher. I am deeply grateful to her for introducing me to this fascinating field of research and for all the assistance and encouragement that has been given to me since last year.

I want to express my gratitude to my colleagues, classmates and lecturers with whom I have had the pleasure of working. Finally, I must thank my family. Without their unwavering love and support, I would not be where I am today and eternally grateful.

# TABLE OF CONTENTS

	Page
DECLARATION BY THE SUPERVISOR	i
DECLARATION BY THE CANDIDATE	ii
ABSTRACT	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
1. INTRODUCTION OF RESEARCH	1
1.1 Introduction	1
1.2 Background Study	1
1.3 Problem Statement	3
1.4 Objectives	5
1.5 Significance of the Project	5
1.6 Scope of the Project	5
1.7 Project Benefits	6
1.8 Definition of Terms and Concept	6
1.9 Organization of Report	7
2. LITERATURE REVIEW	8
2.1 Introduction	8
2.2 Bibliometric Analysis	8
2.2.1 Methodology of Bibliometric Analysis	9

2.2.2	Results and Discussion	11
2.2.2.1	Conjugate Gradient and Image Evolution and Dissemination	11
2.2.2.2	Key Areas in Conjugate Gradient and Image Research	14
2.2.2.3	Major Players in Conjugate Gradient and Image's Research	17
2.3	Introduction to CG Method	24
2.4	Image Restoration	32
2.4.1	Existing Research on CG Method for Image Restoration	34
2.4.2	Sample of Images for Image Restoration Experiment	35
2.5	GUI MATLAB	38
2.6	Conclusion	38
3.	METHODOLOGY	39
3.1	Introduction	39
3.2	Research Step	39
3.3	Conclusion	46
4.	RESULTS AND DISCUSSION	47
4.1	Introduction	47
4.2	Results and Analysis	47
4.3	Discussion	53
4.3.1	Comparison result between standalone application and paper Ma et al., (2022).	54