# CONTENTS

ACKNOWLEDGEMENTS \quad v

LIST OF FIGURES \quad vii

LIST OF TABLES \quad xi

ABSTRACT \quad xiii

1 INTRODUCTION

1.1 Introduction \quad 1

1.2 Types of Image Resolution \quad 2

1.3 Digital Image Formation Model \quad 4

1.4 What is Image Super-Resolution? \quad 5

1.5 Classification of Image Super-Resolution Algorithms \quad 6

1.6 Image Enhancement and Interpolation \quad 8

1.7 Multi-Frame And Single Frame Image Super-Resolution \quad 9

1.8 Forward and inverse problems \quad 10

1.9 Well Posed and Ill- Posed Problem \quad 12

1.10 Tikhonov Regularization and Total Least Square Solutions \quad 12

1.11 Motivation and Scope of the Work \quad 14

1.12 Major Research Contributions \quad 15

1.13 Organization of the Thesis \quad 17

2 LITERATURE REVIEW

2.1 Introduction \quad 19

2.2 First Formulation \quad 20

2.3 Motion Based or Multi-Frame Image Super-Resolution \quad 20

\quad 2.3.1 Bounding Ellipsoid \quad 24

\quad 2.3.2 Regularization \quad 24

\quad 2.3.3 Constrained Least Squares \quad 25

2.4 Motion Free Image Super-Resolution \quad 30

2.5 Single Frame Image Super-Resolution \quad 31

2.6 Hybrid Methods of Super-Resolution Reconstruction \quad 35

2.7 Conclusions \quad 36
# 3 Learning Initial Estimate of HR Image Using Frequency Domain Methods

3.1 Introduction  
3.2 Frequency domain filtering  
  3.2.1 Previous Related Work  
3.3 Learning Initial Estimate Using DFT  
  3.3.1 Results  
3.4 Learning Initial Estimate Using DCT  
  3.4.1 Previous Related Work  
3.5 The Proposed Algorithm  
  3.5.1 Results and Observations  
3.6 Conclusions  

# 4 Super-Resolution Using Sparse Image Representation

4.1 Introduction  
4.2 Sparse Signal Representation  
  4.2.1 Coherence between Bases  
  4.2.2 Sparse Signal Sensing  
  4.2.3 Restricted Isometric Property  
4.3 Super-Resolution Using Sparse Image and Texture Prior  
  4.3.1 Previous Related Work  
  4.3.2 Methodology  
  4.3.3 Super-Resolution Using Sparsity Feature  
    4.3.3.1 Proposed Algorithm  
    4.3.3.2 Implementation of the Proposed Algorithm  
4.4 Experimental Results and Analysis  
4.5 Super-Resolution Using Sparse Image and SVD Prior  
  4.5.1 Experimental Results and Analysis  
4.6 Conclusions  

# 5 Multi Resolution Fusion for Image Super-Resolution

5.1 Introduction  
5.2 MAP–MRF Formulation for Multi Resolution Image Fusion  
  5.2.1 Previous Related work  
  5.2.2 Description of the Proposed approach
ANNEXURE-A1  GRAY LEVEL CO-OCCURRENCE MATRIX

A1.1  Introduction  131
A1.2  Computation of Statistical Parameters from GLCM Matrix  133

ANNEXURE-A2  IMAGE QUALITY METRICS

A2.1  Mean Square and Root Mean Square Error  136
A2.2  Peak Signal to Noise Ratio  137
A2.3  Structural Similarity Image Measure  138

ANNEXURE- A3  QUALITY METRICS FOR IMAGE FUSION

A3.1.1  Mean and Standard Deviation  139
A3.1.2  Entropy  140
A3.1.3  Definition  140
A3.1.4  Distortion Extent  140
A3.1.5  Deviation Index  140
A3.1.6  Correlation coefficient  141
A3.1.7  RASE  141
A3.1.8  RMSE  141
A3.1.9  ERGAS  142

REFERENCES  143
PUBLICATIONS  166