

Contents

List of Figures	x
List of Tables	xiii
List of Abbreviations	xiv
List of Symbols	xvi
1 Introduction	1
1.1 General	1
1.2 Need for VNPR	3
1.3 Challenges involved in VNPR	6
1.4 Motivation of Research	10
1.5 Objectives of the present work	11
1.5.1 Uncertainty in localization of license plate	11
1.5.2 To deal with orientation problems	12
1.5.3 Feature based character recognition	12
1.6 Scope of the Research	12
1.7 Thesis Outline	12
2 Literature Review	15
2.1 Facets of vehicle number plate recognition systems	15
2.2 VNPR Process	16
2.2.1 Image Acquisition	16
2.2.1.1 High Dynamic Range Imaging	18
2.2.1.2 Spectral Imaging	19
2.2.1.3 Light field acquisition	20

2.2.1.4	Phase and Fluid Imaging	20
2.2.2	License Plate Localization	20
2.2.2.1	Boundary information	21
2.2.2.2	Texture	26
2.2.2.3	Color	27
2.2.2.4	Global Image Information	28
2.2.2.5	Character features	28
2.2.2.6	Histogram of Oriented Gradient (HOG) features .	29
2.2.2.7	Eigenspace approach	30
2.2.2.8	Connected Component (CC) Based Methods . .	30
2.2.3	License Plate Segmentation	31
2.2.3.1	Segmentation of plate using binary image processing	33
2.2.3.2	Segmentation of plate using Grey scale processing .	33
2.2.4	Character Recognition	33
3	Problem Formulation and Solution Strategies	35
3.1	Introduction	35
3.2	Problem Formulation	37
3.2.1	Orientation of camera, skewness of license plate or text . .	37
3.2.2	Uncertainty in localization of license plate	37
3.2.3	Improper segmentation of license plate	38
3.2.4	Improvement in feature based Character recognition	38
3.3	Solution Strategies	39
3.3.1	Strategy for dealing with orientation of camera, skewness of license plate or text	39
3.3.2	Strategy for dealing with the uncertainty in localization of license plate	39
3.3.3	Strategy for dealing with improper segmentation of license plate	40
3.3.4	Strategy for improvement in feature based Character recognition	40

4 Vehicle Number Plate Extraction and Recognition	42
4.1 Introduction	42
4.2 Related Works	43
4.2.1 Binary Image Processing	43
4.2.2 Grey-Level Processing	44
4.2.3 Color Processing	44
4.3 The proposed method	45
4.3.1 Image Capture and pre-processing	45
4.3.2 License plate localization	45
4.3.3 Number recognition	49
4.4 Experimental Results	50
4.5 Conclusion	50
5 Skewed Number Plate Recognition	61
5.1 Introduction	61
5.2 Related Work	62
5.3 Orientation detection and correction	63
5.3.1 Radon Transform	63
5.3.2 The proposed method	65
5.3.2.1 Read the license plate image	66
5.3.2.2 Pre-processing	66
5.3.2.3 Radon transform	66
5.3.2.4 Orientation angle detection	67
5.3.2.5 Image rotation	68
5.3.2.6 Noise removal	69
5.4 Experimental Results	70
5.5 Conclusion	70
6 Localization of License Plate for moving Vehicles	72
6.1 Introduction	72
6.2 Motion Analysis	73
6.3 Computing Eigen License Plate	77
6.4 Locating License Plate	79

6.4.1	Step1- Capturing image	79
6.4.2	Step2- Spatio-Temporal Filtering	80
6.4.3	Step3- Thresholding	81
6.4.4	Step4- Motion Analysis	81
6.4.5	Step5- License Plate Localization/Recognition	81
6.5	Experimental Results	85
6.6	Conclusion	86
7	Feature Extraction using Snakes	87
7.1	Introduction	87
7.2	Related work	89
7.2.1	Normalization	89
7.2.1.1	Base line estimation an slope correction	90
7.2.1.2	Slant correction	91
7.2.1.3	Smoothing and thinning	91
7.2.1.4	Parameterization	92
7.3	Finding alpha numerals Features	92
7.3.1	Finding strokes	93
7.3.2	Using Snake model	93
7.3.3	Finding feature matches	98
7.4	Conclusion	99
8	Feature Extraction and Recognition of Characters using Vector Contour	100
8.1	Introduction	100
8.2	Related concepts	101
8.2.1	Character Normalization	101
8.2.2	Thinning	102
8.3	Feature Extraction and character identification	103
8.3.1	Phase1: Character Preprocessing	104
8.3.2	Phase2: Contour analysis of characters for its pre-classification	107
8.3.3	Phase 3: Character embedding in circle	110
8.3.4	Phase 4: Circle partition	110

8.3.5 Phase5: Data Normalization & character identification using Monte Carlo Method	111
8.3.6 Phase 6: Back propagation Algorithm	112
8.3.7 Phase 7: Type classification	114
8.4 Pros and Cons of two stage Back propagation neural classifier	115
8.5 Experimental Results	116
8.5.1 Sample Text Files	116
8.5.2 Pre-processing of characters	116
8.5.3 Normalized circle data of file	116
8.6 Limitations	117
8.7 Conclusion	117
9 Conclusion and Future Research	121
9.1 Orientation of camera, skewness of license plate or text	121
9.2 Uncertainty in localization of license plate	122
9.3 Improper segmentation of license plate	122
9.4 Improvement in feature based character recognition	123
9.5 Future Work	123
Bibliography	124
List of Publications	146