



INTELLIGENT VISION SYSTEM FOR DYNAMIC ENVIRONMENTS

A thesis submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
Degree of Master of Engineering

By
H.Y. ARUNA HEWAWASAM

Supervised by: Dr. Lanka Udawatta

Department of Electrical Engineering
University of Moratuwa, Sri Lanka

2005

83813



Abstract

This dissertation describes an intelligent vision system that absorbs useful information from its environment and draws useful conclusions. This system can give the instructions to locate vacant seats that are currently occupying in a cinema theater. Extraction of useful information without viewing or exposing inside details of an environment through an active vision system is proposed. Reasoning based conclusions are drawn for optimum searching. The effectiveness of the proposed method is demonstrated using an experiment.

Three reasoning criteria are developed and experimentally tested for identifying the states of seats, States of seat can be vacant state, occupied state, or a state with an object placed on the seat. First criterion basically uses binary image analysis and with the introduction of white reference value it can also be applied for environments where there are intermittent variations of illumination level. Second criterion is based on the analysis of color image and it can be basically used for identifying objects placed on seats. Third criterion based on the analysis of intensity image.

Intelligent vision system was developed using the combination of first and second criteria. The created graphical user interface provides links for setting up the system, and setup program 1 provides an interface and instructions for user to find seat locations and entering those locations in the main program and other setup programs. Setup program 2 is given for automatically calculating the other necessary parameters and white reference program for setting up white reference values.

The intelligent vision system can be further developed and generalized for other applications. Mainly it can be used for intelligent building applications. For example in designing an intelligent room where the movements and changes occurring inside the room could be monitored using a camera system. In a multi storey building, required information of a particular floor that is used for common seating could be displayed at other floors. In a vehicle park, the registration number and the entering



time of the vehicles could be recorded. Available parking spaces can be displayed at the entrance.

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.



.....
H.Y. Aruna Hewawasam

July 20, 2005

I endorse the declaration by the candidate.

UOM Verified Signature

.....
Dr. Lanka Udawatta



ACKNOWLEDGMENTS

Thanks are due first to my supervisor, Dr. Lanka Udawattha, for his great insights, perspectives, guidance and sense of humor. My sincere thanks should also go to the other lectures, Prof. Lucas, Prof. Ranjith Perera, and Prof. Sriyananda, who gave instructions and pointed out shortcomings during my presentations.

Sincere gratitude is also extended to the people who serve in the Department of Electrical Engineering, University of Moratuwa, Sri Lanka for helping in various ways to clarify the things related to my academic works in time with excellent cooperation and guidance.

I should not forget the corporation and the support given by my family members, my wife, parents, and brothers. May be, I could not have made it without their support.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

I would also like to thank all of my friends who supported me in this attempt specially helping me to get pictures and setting up the camera etc

Lastly, I should thank many individuals, friends and colleagues who have not been mentioned here personally in making this educational process a success.

H.Y.Aruna Hewawasam

July 20, 2005

LIST OF FIGURES

Figure	Page
1.1 Intelligent Vision System Architecture	1
1.2 RGB Image Structure	5
2.1 Use of Marks on Seats	16
2.2 System Architecture for the Experiment	17
3.1 Repeated Dilations of Marker Image, Constrained by Mask	24
3.2 Intermediate Stages in Processing a Color Image	25
3.3 Matrices A_k and \hat{A}_k	26
3.4 Use of Color Image Matrix	27
3.5 Creating Color Components Matrices	28
3.6 Improving the accuracy	33
(a) Improved seat marks	
(b) Fine thick edge marks	
3.7 Effect of Enhancement	36
4.1 Seat Arrangement	37
4.2 Hall Arrangement	39
(a) Effective Length	
(b) Effective Width	
6.1 Achieving Illumination Level Variation	53
6.2 Illumination Level Variation	54
6.3 Variation in Color Components with Illumination Level for White Color Mark	55
6.4 Variation in Color Components with Illumination Level for Blue Color Mark	55
6.5 Variation in Color Components with Illumination Level for Yellow Color Mark	56
6.6 Testing Different Types of Images	58
6.7 Testing Different Types of Images	59

6.8	Testing Different Types of Images	60
6.9	Object Identification– Result 1	61
6.10	Object Identification – Result 2	62
7.1	Graphical User interface	64
7.2	Graphical User Interface Showing Setup Menu Options	65
7.3	Graphical User Interface Showing Help Menu Options	65
7.4	Results of Setting up Program 1	66
7.5	Graphical User Interface Showing a Stage of Demo 1	68
7.6	Results of Demonstration 3– Result 1	69
7.7	Results of Demonstration 3 – Result 2	69



LIST OF TABLES

Table	Page
3.1 Condition Table	34
4.1 Example for Determination of 'd' Values	42
6.1 Variation in Color Components with Illumination Level	56
6.2 Summary of Object Identification Result	63



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

CONTENTS

Page

<i>Declaration</i>	<i>i</i>
<i>Abstract</i>	<i>ii</i>
<i>Acknowledgement</i>	<i>iii</i>
<i>List of Figures</i>	<i>iv</i>
<i>List of Tables</i>	<i>vii</i>

Chapters

1	Introduction	01
1.1	Background and Literature Survey	02
1.2	Motivation	13
1.3	Goals	14
1.4	Achievement in brief	15
2	System Overview	16
2.1	The approach	16
2.1.1	White reference	17
2.1.2	Algorithms	18
2.2	System components	19
2.2.1	Camera	19
2.2.2	Transmitter receiver system	20
2.2.3	Computer	20
2.2.4	Lights	20



3	Image analysis	22
3.1	First reasoning criterion	22
3.2	Second reasoning criterion	27
3.2.1	Determination of mark locations	27
3.2.2	Analysis for mark 1	28
3.2.3	Analysis for mark 2	30
3.2.4	Analysis for mark 3	31
3.2.5	Ultimate reasoning	32
3.3	Third reasoning criterion	32
3.4	How to use criteria 1, 2 & 3	33
3.4.1	Condition table	34
3.5	Detection of illumination level variation	35
3.5.1	White reference	35
3.6	Image enhancement	35
4	Setting up the system	37
4.1	Setup program 1	39
4.2	Setup program 2	41
4.3	White reference program	43
5	Image acquisition and processing	45
5.1	Image acquisition	45
5.1.1	Basic image acquisition procedure	45
5.1.2	Image acquisition algorithm	49
5.2	Image processing	49
5.2.1	Running algorithm	50
6	Experimental Results	53
6.1	Intensity variation	53
6.2	Testing for different conditions	57
6.3	Object identification	60
6.3.1	Summary of the results	63

7	Graphical User Interface	64
7.1	Setup program 1	66
7.2	Setup program 2	67
7.3	White reference program	67
7.4	Demonstration 1	67
7.5	Demonstration 2	68
7.6	Demonstration 3	68
8	Concluding Remarks and Further Developments	70
8.1	Conclusions	70
8.2	Recommendations for Future Research	71
	References	72
	Appendices	75
Appendix A	: Graphical user interface program	75
Appendix B	: Running program	77
Appendix C	: Setting up program 1	79
Appendix D	: Setting up program 2	80
Appendix E	: White reference program	81
Appendix F	: Demonstration 1	82
Appendix G	: Demonstration 2	83
Appendix H	: Demonstration 3	84